Mohanlal Sukhadia University

Udaipur

Department of Biotechnology

Syllabus and Scheme of Examination

For

B.Sc. CBCS Programme with Biotechnology

B.Sc. Biotechnology (CBCS)

Total Seats: 60*
(All Seats are Self Finance Seats)

***Eligibility**: Those students who passed 10+2 school examination (Biology Group) with a minimum of 50% marks**. The candidates from outside the state of Rajasthan should possess a minimum of 60% marks to seek admission. Candidates with Agriculture / Horticulture / Biotechnology at 10+2 level will be considered, provided that they also had Chemistry as an optional subject at 10+2 level.

Department of Biotechnology

Mohanlal Sukhadia University

Syllabus and Scheme of Examination

For

B.Sc. CBCS Program Biotechnology

Type of course	Course code	Title of the Course	L-T-P/Week	No. of credits	University exam	Internal assessment	Total
Semester I							
Core course 1	B1CT01BOT01	Botany-I	3-1-0	4	80	20	100
Core course 2	B1 CT02BT01	Biotechnology-I	3-1-0	4	80	20	100
Core course 3	B1 CT03CHE01	Chemistry-I	3-1-0	4	80	20	100
Ability Enhancement Compulsory Course (AECC)	B1AECC01EC	English Communication	1-0-2	2	80	20	100
Core course practical 1	B1CP01BOT01	Practical Botany-I	0-0-4	2	80	20	100
Core course practical 2	B1 CP02BT01	Practical Biotechnology-I	0-0-4	2	80	20	100
Core course practical 3	B1 CP03CHE01	Practical Chemistry-I	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
Semester II							
Core course 4	B2CT04BOT02	Botany-II	3-1-0	4	80	20	100
Core course 5	B2CT05BT02	Biotechnology-II	3-1-0	4	80	20	100
Core course 6	B2CT06CHE02	Chemistry-II	3-1-0	4	80	20	100
Ability Enhancement Compulsory Course (AECC)	B2AECC02EC	Environmental Science	1-0-2	2	80	20	100
Core course practical 4	B2CP04BOT02	Practical Botany-II	0-0-4	2	80	20	100
Core course practical 5	B2 CP05BT02	Practical Biotechnology-II	0-0-4	2	80	20	100
Core course practical 6	B2 CP06CHE02	Practical Chemistry-II	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
Semester III							
Core course 7	B3CT07BOT03	Botany-III	3-1-0	4	80	20	100
Core course 8	B3CT08BT03	Biotechnology-III	3-1-0	4	80	20	100
Core course 9	B3CT09CHE03	Chemistry-III	3-1-0	4	80	20	100

SEC-I	B3SEC01	Any 1 from given list	1-0-2	2	80	20	100
Core course practical 7	B3CP07BOT03	Botany-III	0-0-4	2	80	20	100
Core course practical 8	B3CP08BT03	Biotechnology-III	0-0-4	2	80	20	100
Core course practical 9	B3CP09CHE03	Chemistry-III	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
Semester IV							
Core course 10	B4CT10BOT04	Botany-IV	3-1-0	4	80	20	100
Core course 11	B4CT11BT04	Biotechnology- IV	3-1-0	4	80	20	100
Core course 12	B4CT12CHE04	Chemistry- IV	3-1-0	4	80	20	100
SEC-II	B4SEC02	Any 1 from given list	1-0-2	2	80	20	100
Core course practical 10	B4CP10BOT04	Botany- IV	0-0-4	2	80	20	100
Core course practical 11	B4CP11BT04	Biotechnology- IV	0-0-4	2	80	20	100
Core course practical 12	B4CP12CHE04	Chemistry- IV	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
Semester V							
DSE 1	B5ET01BOT01	Botany-I	3-1-0	4	80	20	100
DSE 2	B5ET02BT01	Biotechnology- I	3-1-0	4	80	20	100
DSE 3	B5ET03CHE01	Chemistry- I	3-1-0	4	80	20	100
SEC-III	B5SEC03	Any 1 from given list	1-0-2	2	80	20	100
DSE Practical 1	B5EP01BOT01	Botany-I	0-0-4	2	80	20	100
DSE Practical 2	B5EP02BT01	Biotechnology- I	0-0-4	2	80	20	100
DSE Practical 3	B5EP03CHE01	Chemistry- I	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
Semester VI							
DSE 4	B6ET04BOT02	Botany-II	3-1-0	4	80	20	100
DSE 5	B6ET05BT02	Biotechnology- II	3-1-0	4	80	20	100
DSE 6	B6ET06CHE02	Chemistry- II	3-1-0	4	80	20	100
SEC-IV	B6SEC04	Any 1 from given list	1-0-2	2	80	20	100
DSE Practical 4	B6EP04BOT02	Botany-II	0-0-4	2	80	20	100
DSE Practical 5	B6EP05BT02	Biotechnology- II	0-0-4	2	80	20	100
DSE Practical 6	B6EP06CHE02	Chemistry- II	0-0-4	2	80	20	100
				20	**560**	**140**	**700**
GRAND TOTAL				**120**	**3360**	**840**	**4200**
				TOTAL CREDIT = 120			

Core Course Theory

S.No.	Type of course	Semester	Course code	Title of the Course
1.	Core course 1	I	B1CT01BOT01	Botany-I
2.	Core course 2	I	B1 CT02BT01	Biotechnology-I
3.	Core course 3	I	B1 CT03CHE01	Chemistry-I
4.	Core course 4	II	B2CT04BOT02	Botany-II
5.	Core course 5	II	B2CT05BT02	Biotechnology-II
6.	Core course 6	II	B2CT06CHE02	Chemistry-II
7.	Core course 7	III	B3CT07BOT03	Botany-III
8.	Core course 8	III	B3CT08BT03	Biotechnology-III
9.	Core course 9	III	B3CT09CHE03	Chemistry-III
10.	Core course 10	IV	B4CT10BOT04	Botany-IV
11.	Core course 11	IV	B4CT11BT04	Biotechnology-IV
12.	Core course 12	IV	B4CT12CHE04	Chemistry-IV

Core Course practical

1.	Core course 1	I	B1CP01BOT01	Botany-I
2.	Core course 2	I	B1 CP02BT01	Biotechnology-I
3.	Core course 3	I	B1 CP03CHE01	Chemistry-I
4.	Core course 4	II	B2CP04BOT02	Botany-II
5.	Core course 5	II	B2CP05BT02	Biotechnology-II
6.	Core course 6	II	B2CP06CHE02	Chemistry-II
7.	Core course 7	III	B3CP07BOT03	Botany-III
8.	Core course 8	III	B3CP08BT03	Biotechnology-III
9.	Core course 9	III	B3CP09CHE03	Chemistry-III
10.	Core course 10	IV	B4CP10BOT04	Botany-IV
11.	Core course 11	IV	B4CP11BT04	Biotechnology-IV
12.	Core course 12	IV	B4CP12CHE04	Chemistry-IV

Discipline Specific Electives Theory

S.NO.	Type of course	Semester	Course code	Title of the Course
1.	DSE 1	V	B5ET01BOT01	Botany-I
2.	DSE 2	V	B5ET02BT01	Biotechnology- I
3.	DSE 3	V	B5ET03CHE01	Chemistry- I
4.	DSE 4	VI	B6ET04BOT02	Botany-II
5.	DSE 5	VI	B6ET05BT02	Biotechnology- II
6.	DSE 6	VI	B6ET06CHE02	Chemistry- II

Discipline Specific Electives Practical

S.NO.	Type of course	Semester	Course code	Title of the Course
1.	DSE 1	V	B5EP01BOT01	Botany-I
2.	DSE 2	V	B5EP02BT01	Biotechnology- I
3.	DSE 3	V	B5EP03CHE01	Chemistry- I
4.	DSE 4	VI	B6EP04BOT02	Botany-II
5.	DSE 5	VI	B6EP05BT02	Biotechnology- II
6.	DSE 6	VI	B6EP06CHE02	Chemistry- II

Skill Enhancement Courses (Any four)

Botany	Biotechnology	Chemistry
1. Biofertilizers	1. Probiotic Technology	1. IT Skills for Chemists
2. Herbal Technology	2. Animal Cell Sciences	2. Basic Analytical Chemistry
3. Nursery and Gardening	3. Microbiological Analysis of Air and Water	3. Chemical Technology & Society
4. Floriculture	4. Techniques in Biotechnology	4. Chemoinformatics
5. Medicinal Botany	5. Techniques in Plant Tissue Culture	5. Business Skills for Chemists
6. Plant Diversity and Human Welfare		6. Intellectual Property Rights
7. Ethnobotany		7. Analytical Clinical Biochemistry
8. Mushroom Culture Technology		8. Green Methods in Chemistry
		9. Pharmaceutical Chemistry
		10. Chemistry of Cosmetics & Perfumes
		11. Pesticide Chemistry
		12. Fuel Chemistry

Ability Enhancement Course

S.NO.	Type of course	Semester	Course code	Title of the Course
1.	Ability Enhancement Compulsory Course (AECC)	I	B1AECC01EC	English Communication
2.	Ability Enhancement Compulsory Course (AECC)	II	B2AECC02EC	Environmental Science

NOTE:

1. In the 5^{th} or 6^{th} semester students also have an alternative option of taking one in-house minor research project within the department or in sister departments of this University in lieu of one DSE. Such students will also have to submit a dissertation report as per the prescribed format for the training. (Annexure 1)
2. The total credits and marks for minor research project will be the same as for any other DSE and Evaluation of the minor research project will be done as per the prescribed scheme. (Annexure 1)
3. The total contact hrs. for minor research project will be 8 hrs./week. The student who opts for industrial training will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 2)
4. Students can choose skill courses from the list provided in the syllabi of B. Sc. CBCS Biotechnology, M.Sc. Biotechnology, M. Sc. Botany, M. Sc. Microbiology or any other subject from the faculty of Science. The student also has the choice of choosing any general skill courses offered by College of Science
5. Students can also earn extra credits by taking addition skill courses during entire program period.

ANNEXURE 1

MARKING SCHEME FOR MINOR RESEARCH PROJECT

B. Sc. Biotechnology semester V/VI

S. No.		Maximum Marks	Marks Obtained
1	**Dissertation Report** a. Review of Literature b. Methodology c. Outcome	 15 10 15	
2	Seminar	25	
3	Viva – voce	15	
4	Continuous Assessment	20	
	TOTAL MARKS	**100**	

ANNEXURE 2

CONTINUOUS ASSESSMENT SHEET

B. Sc. Biotechnology semester V/VI : Minor Research Project

Name of Student's :

Technical Competence	Maximum Marks	Minimum Marks
• Review of Literature	5	
• Experimental Design & Skills	5	
• Data Interpretation/ Result Analysis	5	
• Attendance	5	
GRAND TOTAL	**20**	

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name :

Designation : E-mail…….

Ph. No.

Organization:

Date: Signature with seal

Details of Courses

Core Courses –Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

Core Courses: Biotechnology

1. Introduction to Microbiology
2. Animal Biotechnology
3. Plant Biotechnology
4. Recombinant DNA Technology

Core Courses-Chemistry

1. Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons
2. Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I
3. Conductance, Electrochemistry & Functional Group Organic Chemistry-II
4. Chemistry of s- and p-block elements, States of matter and Chemical Kinetics

Discipline Specific Electives-Botany (Any two)

1. Economic Botany and Biotechnology
2. Cell and Molecular Biology
3. Analytical Techniques in Plant Sciences
4. Bioinformatics
5. Research Methodology
6. Dissertation

Discipline Specific Electives: Biotechnology (Any two)

1. Environmental Biotechnology
2. Applied Plant Biotechnology
3. Microbial Technology
4. Immunology and Enzymology
5. Project

Discipline Specific Electives-Chemistry (Any two)

1. Applications of Computers in Chemistry
2. Analytical Methods in Chemistry
3. Molecular Modelling & Drug Design
4. Novel Inorganic Solids
5. Polymer Chemistry
6. Research Methodology for Chemistry
7. Green Chemistry
8. Industrial Chemicals & Environment
9. Inorganic Materials of Industrial Importance
10. Instrumental Methods of Chemical Analysis
11. Chemistry of d-block elements, Quantum Chemistry and Spectroscopy
12. Organometallics, Bioinorganic chemistry, Polynuclear hydrocarbons and UV, IR Spectroscopy
13. Molecules of Life
14. Dissertation

Ability Enhancement Compulsory Courses

1. English/MIL Communication

2. Environmental Science

Skill Enhancement Courses (Any four)

Botany

1. Biofertilizers
2. Herbal Technology
3. Nursery and Gardening
4. Floriculture
5. Medicinal Botany
6. Plant Diversity and Human Welfare
7. Ethnobotany
8. Mushroom Culture Technology

Biotechnology

1. Probiotic Technology
2. Animal Cell Sciences
3. Microbiological Analysis of Air and Water
4. Techniques in Biotechnology

5. Techniques in Plant Tissue Culture

Chemistry

1. IT Skills for Chemists
2. Basic Analytical Chemistry
3. Chemical Technology & Society
4. Chemoinformatics
5. Business Skills for Chemists
6. Intellectual Property Rights
7. Analytical Clinical Biochemistry
8. Green Methods in Chemistry
9. Pharmaceutical Chemistry
10. Chemistry of Cosmetics & Perfumes
11. Pesticide Chemistry
12. Fuel Chemistry

Scheme of B.Sc. Programme (Life Sciences)/ B.Sc. Medical under CBCS

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	**Ability Enhancement Compulsory Course-I**	English communications/ Environmental Science	2
	Core course Botany I	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
	Core Course Botany I Practical	Biodiversity-Practical	2
	Core course Biotechnology I	Introduction to Microbiology	4
	Core Course Biotechnology I Practical	Introduction to Microbiology	2
	Core course Chemistry I	Atomic Structure, Bonding, General Organic Chemistry Aliphatic & Hydrocarbons	4
	Core Course Chemistry I Practical	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons -Lab	2

II	**Ability Enhancement Compulsory Course-II**	English communications/ Environmental Science	2
	Core course Botany II	Plant Ecology and Taxonomy	4
	Core Course Botany -II Practical	Plant Ecology and Taxonomy- Practical	2
	Core course Biotechnology II	Animal Biotechnology	4
	Core Course Biotechnology II Practical	Animal Biotechnology Practical	2
	Core course Chemistry II	Chemical Energetics, Equilibria & Functional Group Organic Chemistry-I	4
	Core Course Chemistry II Practical	Chemical Energetics, Equilibria &	2

			Functional Group Organic Chemistry-I -Lab	
III	**Core course Botany III**		Anatomy and Embryology of Angiosperms	4
	Core Course Botany -III Practical		Anatomy and Embryology of Angiosperms- Practical	2
	Core course Biotechnology III		Plant Biotechnology`	4
	Core Course Biotechnology Practical	**III**	Plant Biotechnology Practical	2
	Core course Chemistry III		Conductance, Electrochemistry & Functional Group Organic Chemistry- II	4
	Core Course Chemistry Practical	**III**	Conductance, Electrochemistry & Functional Group Organic Chemistry- II- Lab	2
	Skill Enhancement Course-I		SEC-I	2
IV	**Core course Botany IV**		Plant Physiology and Metabolism	4
	Core Botany	**–IV**	Plant Physiology And metabolism Practical	2

	Core course Biotechnology IV	Recombinant DNA Technology	4
	Core Course Biotechnology IV Practical	Recombinant DNA technology	2
	Core course Chemistry IV	Chemistry of s- And p-block elements of matter and States Chemical Kinetics	4
	Core Course Chemistry IV Practical	Chemistry of s- and p- block elements, States of matter and Chemical Kinetics-Lab	2
	Skill Enhancement Course-II	SEC-II	2
V	**Discipline Specific Elective Botany –I**	DSE Botany 1	4
	Discipline Specific Elective Botany I Practical		2
	Discipline Specific Elective Biotechnology I	DSE Biotechnology I	4
	Discipline Specific Elective Biotechnology I Practical		2
	Discipline Specific Elective Chemistry I	DSE Chemistry I	4
	Discipline Specific Elective Chemistry I Practical		2
	Skill Enhancement Course -III	SEC-III	2

VI	**Discipline Specific Elective Botany –II**			DSE Botany II	4
	Discipline Specific Elective Botany II Practical				2
	Discipline Specific Elective Biotechnology II			DSE Biotechnology II	4
	Discipline Specific Elective Biotechnology II Practical				2
	Discipline Specific Elective Chemistry III			DSE Chemistry II	4
	iscipline Specific Elective Chemistry III Practical				2
	Skill Enhancement Course –IV			SEC-IV	2
				Total: 120	

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –I (2016-17)

Paper I: *Core Course1 (B1CT01BOT01)*: *Botany I*
Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Theory)
(Credits: Theory-4, Practicals-2)
Credit hours: 60

Unit 1: Microbes **10 Credit hours**

Viruses – Discovery, general structure, replication (general account), Economic importance; Bacteriophage, Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae **10 Credit hours**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria, Fucus, Polysiphonia*. Economic importance of algae

U nit 3: Fungi **10 Credit hours**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; life cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

U nit 4: Bryophytes **10 Credit hours**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5: Pteridophytes and Gymnosperms **20 Credit hours**

General characteristics, classification, Early land plants (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella* and *Equisetum* (Developmental details not to be included). Heterospory and seed habit, stelar evolution.

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pears Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –I (2016-17)

Paper II: *Core Course 2 (B1CT02BT01): Biotechnology I*
Introduction to Microbiology (Theory)
(Credits: Theory-4, Practicals-2)
Credit hours: 60

UNIT-I **15 Credit hours**

Bacteriology: Modern systems of classification of bacteria. General features, distribution, cell size, shape and arrangement, structure of bacterial cell capsule, flagella, pilli, cell wall – chemical composition and wall characteristics, plasma membrane, mesosomes, cytoplasm, nucleoids.

Unit-II **15 Credit hours**

Virology – virus classification, phylogeny, general features, structure, replication in bacteriophages. Transmission of plant and animal viruses and diseases caused by them. Viroids, virusoids and prions: general features and diseases caused by them.

Unit-III **10 Credit hours**

Mycoplasma – history, ultrastructure, nutrition, classification, phylogeny, reproduction and methods of cultivation. Elementary account of most common human /animals diseases (Pulmonary pneumonia, urethritis) caused by mycoplasma.

Brief account of phytoplasma and important diseases caused by them (Sesame phyllody, little leaf of brinjal, grassy shoot of sugarcane).

Unit-IV **10 Credit hours**

Methods in microbiology – microbial cultures, physical conditions for growth , methods for culturing aerobic and anaerobic bacteria. Culture media – selective and differential media nutrient agar, nutrient Broth, enrichment media and other media.

Unit-V **10 Credit hours**

Plant-microbe interaction: bacterial (associative symbiont, PGPR, *Rhizobium*, fungal symbiosis-mycorrhiza), symbiotic association (bacteria and fungi, microbe-microbe interactions-symbiosis between algae and fungi : lichens) : Antagonistic interactions – amensalism, competition, parasitic and predation.

Recommended Books

1. Pelczar and Krieg. Microbiology. McGraw Hill.
2. Prescot, H. and Klein. 2000. Microbiology. McGraw Hill.
3. Tortora. Microbiology : An Introduction. Pearson Education.
4. Stainer, R.Y., Ingrahm, J.L., Wheelis, M.L. and Painter, P.R. General Microbiology. The MacMillian Press Ltd.

5. Madigan, M.T., Martinko, J.M. and Parker, J. B. Biology of Microorganism. Prentice-Hall.
6. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –I (2016-17)

Paper III: *Core Course 3(B1CT03CHE01): Chemistry I*
Atomic Structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons (Theory)

(CREDITS: THEORY-4, PRACTICALS-2)

Credit hours: 60

UNIT I **15 Credit hours**

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de- Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT II **10 Credit hours**

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s, s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd Credit hours (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

UNIT III **15 Credit hours**

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

UNIT IV **10 Credit hours**

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L;

cis - *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT V **10 Credit hours**

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes : (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B.
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
- T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
- E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
- I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –I (2016-17)

Ability Enhancement Compulsory Courses

AECC: B1AECC01EC: English Communication

English Communication Credits: 2

Preamble:

The purpose of this course is to introduce students to the theory,fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

The present course hopes to address some of these aspects through an interactive mode of teaching-learning process and by focusing on variousdimensions of communication skills. Some of these are:Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, notetaking etc.

While, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.

The recommended readings given at the end are only suggestive; the students and teachers have the freedom to consult other materials on various units/topics given below. Similarly, the questions in the examination will be aimed towards assessing the skills learnt by the students rather than the textual content of the recommended books.

Unit-1. Introduction: Theory of Communication, Types and modes of Communication

Unit -2. Language of Communication:
Verbal and Non-verbal
(Spoken and Written)
Personal, Social and Business
Barriers and Strategies
Intra-personal, Inter-personal and Group communication

Unit-3. Speaking Skills:
Monologue
Dialogue
Group Discussion
Effective Communication/ Mis- Communication
Interview
Public Speech

Unit 4. Reading and Understanding
Close Reading
Comprehension
Summary Paraphrasing
Analysis and Interpretation
Translation(from Indian language to English and vice-versa)
Literary/Knowledge Texts

Unit-5. Writing Skills
Documenting
Report Writing
Making notes
Letter writing

Recommended Readings:
1. *Fluency in English* - Part II, Oxford University Press, 2006.
2. *Business English*, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. *Language through Literature* (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –II (2016-17)

Paper I*: Core Course 4 (B2CT04BOT02): Botany -II*

Plant Ecology and Taxonomy (Theory)

(Credits: Theory-4, Practicals-2)

Credit hours: 60

Unit 1: Ecological factors **10 Credit hours**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

U nit 2: Plant communities, Ecosystem and Phytogeography **15 Credit hours**

Characters; Ecotone and edge effect; Succession; Processes and types. Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous, Principle biogeographical zones; Endemism

Unit 3 Introduction to plant taxonomy **15 Credit hours**

Taxonomic hierarchy -Ranks, categories and taxonomic groups; Botanical nomenclature, Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations. Functions of Herbarium, important herbaria and botanical gardens of the world and India.

Unit 4 Taxonomic evidences Classification, Biometrics and numerical taxonomy

10 Credit hours

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series). Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Unit 5 Study of selected angiospermic families 10 Credit hours

Technical description of a plant, systematic study, affinities, distinguishing characters of the following families of angiosperms with special reference to Cruciferae, Malvaceae, Leguminoseae, Compositae, Solanaceae, Lililaceae

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –II (2016-17)

Paper II: *Core Course 5 (B2CT05BT02): Biotechnology II*

Animal Biotechnology (*Theory)*

Credit hours: 60

(Credits: Theory-4, Practicals-2)

Unit-I 15 Credit hours

Animal cell culture : History, techniques, methods , culture media (natural and artificial media). Balanced salt solutions and simple growth medium: composition, types and preparation. Role of CO_2, serum and Growth factors in culture media . Serum and protein-free defined media and their applications.

Unit-II **10 Credit hours**

Primary cultures, Secondary cultures. anchorage dependent growth, non-anchorage dependent cells and their growth. Characterization of cultured cells. test of viability, cytotoxicity and measurement of growth.

Unit-III **15 Credit hours**

Animal cell lines: origin ,characteristics, nomenclature and maintenance. Transformed animal cells and cell lines, measurement of cell death (apoptosis). Stem cell cultures, scaling-up of animal cell cultures and production of recombinant gene products.

Unit-IV **10 Credit hours**

Organ culture: various techniques, applications and limitations. Whole embryo culture, transfection of animal cells : selectable markers, HAT selection, Somatic cell fusion, hybridoma technology and production of monoclonal antibodies.

Unit-V **10 Credit hours**

Growth kinetics of cells in culture, Applications of animal cell culture. Three-dimensional culture and tissue engineering (artificial skin and artificial cartilage), *In vitro* fertilization in humans, super ovulation, embryo transfer in humans and livestock.

Suggested Readings

1. Masters, J. Animal Cell Culture. Panima.
2. Freshney, I. Culture of Animal Cell. John Wiley.
3. Martin, C. (Ed). Animal Cell Culture Techniques. Springer.
4. Mather and Barnes. (Ed). Methods in Cell Biology. Vol. 5-7, Animal Cell Culture Method. Academic Press.
5. Paul, J. Animal Tissue Culture.
6. Butler, M. and Dawson, M. Lab Fax : Cell Culture. Bios Scientific Publications.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –II (2016-17)

Paper III: *Core Course 6 (B2CT06CHE02): ChemistryII*
Chemical Energetics, Equilibria & Functional Organic Chemistry-I
(Theory)
(Credits: Theory-4, Practicals-2)
Credit hours: 60

UNIT I **10 Credit hours**

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

UNIT II **20 Credit hours**

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and G^{o}, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Ionic Equilibria:

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. Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT III **8 Credit hours**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

UNIT IV **8 Credit hours**

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

UNIT V **14 Credit hours**

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: *Preparation:* Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with H

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.
- G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
- R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –II (2016-17)

Ability Enhancement Compulsory Course
AECC: B2AECC02EC: Environmental Science

Unit 1: Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems (2 lectures)

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(6 lectures)

Unit 3: Natural Resources : Renewable and Non-renewable Resources

- Land resources and landuse change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water : Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources : Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

(8 lectures)

Unit 4: Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: Environmental Pollution (8 lectures)

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

(8 lectures)

Unit 6: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

(7 lectures)

Unit 7: Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management : floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8: Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment*, London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36-37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.

.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –III (2016-17)

Paper I: *Core Course 7 (B3CT07BOT03) Botany-III*
Plant Anatomy and Embryology (Theory)
(Credits: Theory-4, Practicals-2)
Credit hours: 60

Unit 1: Meristematic and permanent tissues **10 Credit hours**

Root and shoot apical meristems; Simple and complex tissues. Structure of dicot and monocot root stem and leaf.

Unit 2: Secondary Growth **15 Credit hours**

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood). Adaptive and protective systems- Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 3: Structural organization of flower **15 Credit hours**

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 4: Pollination and fertilization **10 Credit hours**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 5: Embryo and endosperm **10 Credit hours**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship. Apomixis and polyembryony

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –III (2016-17)

Paper II: *Core Course 8 (B3CT08BT03): Biotechnology III*

Plant Biotechnology (Theory)

(Credits: Theory-4, Practicals-2)

Credit hours: 60

Unit-I **15 Credit hours**

Plant tissue culture- History, contribution of Indian Scientists. Concept of cellular totipotancy and differentiation, laboratory facilities and supplies, asepsis and methods of sterilization. Culture medium- composition and methods of preparation. Role of plant growth regulators, vitamins and other adjuvants.

Unit-II **15 Credit hours**

Pathways of micropropagation- axillary bud proliferation, adventitious shoot bud proliferation, Callus organogenesis, Somatic embryogenesis, Steps of micropropagation-management of donor plants, culture establishment, shoot multiplication, rooting, hardening and acclimatization.

Unit-III **10 Credit hours**

Protoplast isolation, culture and Somatic hybridization, production of haploids -Anther and pollen culture, ovary culture. Embryo and endosperm culture. Embryo rescue. Production of synthetic seeds.

Unit-IV **10 Credit hours**

.*In vitro* fertilization, Methods of cryopreservation for germplasm conservation. Somaclonal and gametoclonal variation. Meristem tip culture for elimination of viruses in plants. Commercialization of plant tissue culture- Global scenario and plant tissue culture industries in India.

Unit-V **10 Credit hours**

Cell culture and *in vitro* production of secondary metabolites. Important alkaloids and factors affecting their production. Hairy root culture, elicitation and biotransformation, Bioreactors – their types, construction and use in secondary metabolite production.

Suggested Readings

1. Robert Smith. Plant tissue culture : Techniques and Experiments. South Asia Edition.
2. Gamborg and Phillip. Plant Cell, Tissue and Organ Culture. Narosa.
3. Dixon and Gonzales. Plant Cell Culture. Panima.
4. Narayanswamy. Plant Cell and Tissue Culture. McGraw Hill.
5. Bhojwani, S.S. and Rajdan, M.K. Plant Tissue Culture : Theory and Practices a revised Edition. Elsevier.
6. Razdan, M.K. Introduction to plant tissue culture. Oxford & IBH Publishers.
7. Chawla, H.S. Introduction to Plant Biotechnology. Oxford & IBH Publishers.
8. Dey, K.K. Plant Tissue Culture.
9. Purohit, S.D. Introduction to Plant Cell Tissue and organ culture.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –III (2016-17)

Paper III: *Core Course 9 (B3CT09CHE03): Chemistry III*

Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry-II (Theory)

(Credits: Theory-4, Practicals-2)
Credit hours: 60

UNIT I **10 Credit hours**

Solutions

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.

Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H2O and Na-K only).

UNIT II **10 Credit hours**

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving

boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

UNIT III **10 Credit hours**

Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: *G*, *H* and *S* from EMF data.

Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode.

Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

UNIT IV **10 Credit hours**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic)

Preparation: Acidic and Alkaline hydrolysis of esters.

Reactions: Hell – Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Upto 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.

Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

UNIT V **20 Credit hours**

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines.

Reactions: conversion to benzene, phenol, dyes.

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Reference Books:

1. G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).

2. G. W. Castellan: *Physical Chemistry* 4th Ed. Narosa (2004).
3. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).

4. B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).
5. R. H. Petrucci, *General Chemistry*, 5th Edn., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

7. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
10. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –IV (2016-17)

Paper I: *Core Course 10 (B4CT10BOT04) Botany -IV*
Plant Physiology and Metabolism (Theory)
(Credits: Theory-4, Practicals-2)
Credit hours: 60

Unit 1: Plant-water relations **10 Credit hours**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition **10 Credit hours**

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Photosynthesis and Respiration **15 Credit hours**

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration. Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 4: Enzymes and Nitrogen metabolism **10 Credit hours**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 5: Plant growth regulators and Plant response **15 Credit hours**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –IV (2016-17)

Paper II: *Core Course 11 (B4CT11BT04): Biotechnology IV Recombinant DNA Technology (Theory)*

(Credits: Theory-4, Practicals-2)

Credit hours: 60

Unit-I **12 Credit hours**

Genetic Engineering : definition, scope and importance, molecular tools for genetic engineering. Restriction endonucleases- types, nomenclature, recognition sequences, cleavage pattern. Vectors – general characteristics of vectors, desirable characters such as size, ori site, selection/ markers gene, restriction sites and MCS, cloning and expression vectors.

Unit-II **12 Credit hours**

Plasmid vectors: pBR-322, pUC vectors, Ti-plasmid,. M13 derived pUC vectors, bacteriophage λ vectors, cosmids, YAC and BAC. Creation of recombinant DNA: cloning and selection of individual gene.

Transformation techniques: preparation of competent cells of bacteria, physical and chemical methods of gene tranfer in plant and animal cells.

Unit-III **12 Credit hours**

Genomic library and cDNA library, reverse transcriptase, Colony hybridization, screening by DNA hybridization, labelling of DNA, RNA and proteins: use of radioactive isotopes, non-radioactive labelling, relative advantages, *in vivo* labelling, nick translation, random primer labelling, autoradiography. Blotting techniques southern,northern, western and eastern.

Unit-IV **12 Credit hours**

Protein profiling: SDS PAGE, 2D gel electrophoresis and its significance, gel retardation assay, T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, DNA microarray.

Unit-V **12 Credit hours**

Antisense RNA technology, Ribozyme: biochemistry, hammerhead, hair pin and other ribozymes, strategies for designing ribozymes, application of antisense and ribozyme technologies.

Suggested Readings

1. Christopher, H. Gene cloning and Manipulation. Cambridge University, Press.
2. Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press.
3. Sambrook, Russell and Maniatis. Molecular Cloning : A Laboratory Manual (Vol. I, II and III). Cold Spring Harber Laboratory.
4. Glover, D.M. and Hames, B.D. DNA Cloning : A practical approach. IRL Press. Oxford.
5. Brown, T.A. Gene cloning. Blackwell Publisher.
6. Kreuzar, H. and Massey, A. Recombinant DNA technology. A.S.M. Press, Washington.
7. Llibelli, Lanza and Campbell. Principles of Cloning. Academic Press.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –IV (2016-17)

Paper III: *Core Course 12 (B4CT12CHE04): Chemistry IV Chemistry of S- and P-Block Elements, States Of Matter & Chemical Kinetics (Theory)*

(Credits: Theory-4, Practicals-2)

Credit hours: 60

UNIT I **15 Credit hours**

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon as reducing agent.
Hydrometallurgy, Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn): electrolytic, oxidative refining, Kroll process, Parting process, van Arkel-de Boer process and Mond's process.

***s*- and *p*-Block Elements**

Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity (Pauling, Mulliken, and Alfred-Rochow scales). Allotropy in C, S, and P.

Oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides), inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

UNIT II **10 Credit hours**

Compounds of *s*- and *p*-Block Elements

Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements.
Concept of multicentre bonding (diborane).
Structure, bonding and their important properties like oxidation/reduction, acidic/basic nature of the following compounds and their applications in industrial, organic and environmental chemistry.
Hydrides of nitrogen (NH_3, N_2H_4, N_3H, NH_2OH)
Oxoacids of P, S and Cl.
Halides and oxohalides: PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2

UNIT III

15 Credit hours

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation.

Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO_2.

Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance.

Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

UNIT IV **10 Credit hours**

Liquids

Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Solids

Forms of solids. Symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

UNIT V

10 Credit hours

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular

reactions. Comparison of the two theories (qualitative treatment only).

Reference Books:

1. G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
5. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
8. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg: *Inorganic Chemistry*, Viva Books Pvt. Ltd.

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –V & VI (2016-17)

Discipline Specific Elective Courses
Two (2) be selected from each of the three disciplines

Discipline Specific Elective Botany

1. Cell and Molecular Biology

(Credits: Theory-4, Practicals-2)

THEORY

Credit hours: 60

Unit 1: Techniques in Biology **10 Credit hours**

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life **20 Credit hours**

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes: Structures and roles.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 3: Cell Membrane and Cell Wall **10 Credit hours**

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall. Overview of Cell cycle, Mitosis and Meiosis; Molecular contro

Unit 4: Genetic material **15 Credit hours**

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication , semi–conservative, semi discontinuous RNA priming , Ø (theta) mode of replication , replication of linear , ds-DNA, replicating the 5′end of linear chromosome including replication enzymes.

Unit 5: Transcription (Prokaryotes and Eukaryotes) **5 Credit hours**

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Discipline Specific Elective Botany
2. Economic Botany and Biotechnology
(Credits: Theory-4, Practicals-2)
THEORY
Credit hours: 60

Unit 1: Origin of Cultivated Plants **5 Credit hours**

Concept of centres of origin, their importance with reference to Vavilov's work

Unit 2: Cereals **10 Credit hours**

Wheat -Origin, morphology, uses , Legumes-General account with special reference to Gram and soybean, Spices- General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 3: Beverages **10 Credit hours**

Tea (morphology, processing, uses) Oils and Fats, General description with special reference to groundnut Fibre Yielding Plan-General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 4: Introduction to biotechnology and Plant tissue culture **15 Credit hours**

Introduction to biotechnology, Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications

Unit 5: Recombinant DNA Techniques **20 Credit hours**

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Discipline Specific Elective Botany
3. Analytical Techniques in Plant Sciences
(Credits: Theory-4, Practicals-2)
THEORY
Credit hours: 60

Unit 1: Imaging and related techniques **15 Credit hours**

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation **10 Credit hours**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes **10 Credit hours**

Radioisotope-Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 4: Characterization of proteins and nucleic acids **10 Credit hours**

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 5:Biostatistics **15 Credit hours**

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of

dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Discipline Specific Elective Botany
4. Bioinformatics

(Credits: Theory-4, Practicals-2)
Credit hours: 60

Unit 1: Introduction to Bioinformatics **10 Credit hours**

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Unit 2: Databases in Bioinformatics

10 Credit hours

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3 : Biological Sequence Databases **20 Credit hours**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4: Sequence Alignments

10 Credit hours

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny

10 Credit hours

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummin

Discipline Specific Elective Botany

5.Research Methodology

(Credits: Theory-4, Practicals-2)

Credit hours: 60

Unit 1: Basic concepts of research **10 Credit hours**

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: General laboratory practices **15 Credit hours**

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions.

Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data collection and documentation of observations **10 Credit hours**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.

Unit 4: Overview of Biological Problems **10 Credit hours**

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit 5: **Methods to study plant cell/tissue structure** **15 Credit hours**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

Discipline Specific Elective Botany

6.Dissertation

Discipline Specific Elective Biotechnology

1. Environmental Biotechnology

(Credits: Theory-4, Practicals-2)

THEORY

Credit hours: 60

Unit-I **12 Credit hours**

Natural resources: Energy resources (renewable and non-renewable), conventional and non-conventional sources of energy, forest resources, fish resources, water resources. Conservation of natural resources- *ex situ* and *in situ* conservation strategies, wildlife management,

Unit – II **15 Credit hours**

Waste water and its treatment- small scale and large scale sewage treatment, BOD and COD. Ground water remediation, water softening, water demineralization, desalination, ion-exchange and reverse osmosis, disinfection of water; ozonation and chemo-sterilization of water.

Unit – III **15 Credit hours**

Solid waste and their treatment- organic compost and process of composting, vermi-culture technology. Microbial degradation of xenobiotics, microorganism in abatement of heavy metal pollution, aeromicrobiology: aeroallergens and aeroallergy.

Unit – IV **8 Credit hours**

Biogas, biogas production- Solubilization, acetogenesis and methanogenesis, mechanism of methane formation. Microbes and their genetic engineering for degradation of pollutants.

Unit – V **10 Credit hours**

application of microbes - biofertilizer, biopesticides, microbial leaching, biomining, biohydrometallurgy and biomineralization. Principles and applications of biosensors for detection of pollutants, Oil spills- Causes and recovery, use of super bugs for removal of oil spills.

Recommended books

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.

Discipline Specific Elective Biotechnology

2.Applied Plant Biotechnology

THEORY

Credit hours: 60

(Credits: Theory-4, Practicals-2)

UNIT I **12 Credit hours**

Role of micropropagation in silviculture, horticulture, agriculture, and conservation of biodiversity and threatened plant species. Somatic embryogenesis with special reference to production of synthetic seeds, Application of plant biotechnology in plant pathology with special reference to culture of obligate parasites.

UNIT-II **12 Credit hours**

Screening of germplasm and cell line selection. Application of somaclonal variation with special reference to development of disease resistant cell lines. Applications of plant biotechnology in breeding and crop improvement with special reference to production of haploids and triploids.

UNIT-III **12 Credit hours**

Role of tissue culture in genetic engineering for crop improvement – *Agrobacterium* mediated gene transfer in plants and development of genetically modified organisms with special reference to drought and salinity, insect and virus resistance .

UNIT-IV **12 Credit hours**

Bioreactors for production of secondary metabolites. Introduction types : stirred-tank type, air-lift type, membrane type bioreactor, packed bed reactor. Modes of culture applied in bioreactors – batch culture, fed-batch culture, semi-continuous culture, continuous culture.

UNIT-V **12 Credit hours**

Secondary products in tissue cultures – production of alkaloids, phenols, steroids, lignins, coumarins, flavonoids, anthroquinones and naphthoquinones, isoprenoids, Plant cell immobilization, gel entrapment, applications of immobilization techniques. Secondary metabolite production using immobilized cells.

Recommended books

1. Primrose, S.B. Molecular Biotechnology. Panima.
2. Watson and Zoller. Recombinant DNA. Panima.
3. Winnacker. An introduction to Gene Technology – From genes to clones. VCH.
4. Boylan, M. Genetic engineering – science and ethics on new frontier. Pearson Edu.
5. Glick and Pasternak. Molecular Biotechnology. ASM Press Washington, USA.

Discipline Specific Elective Biotechnology

3.Microbial Technology

(Credits: Theory-4, Practicals-2)

Credit hours: 60

Unit-I **12 Credit hours**

Introduction to industrial biotechnology, basic principles of fermentation technology, fermentation media – natural and synthetic media, fermenters and bioreactors – construction, design and operation. Process of aeration, agitation, temperature regulation, Types of fermentation – solid state, submerged, batch and continuous fermentation.

Unit-II **12 Credit hours**

Process development – Shake flask fermentation, downstream processing: disintegration of cells, separation, extraction, concentration and purification of products, quality control, standard operating procedures and good manufacturing practices.

Unit-III **12 Credit hours**

Brief account of the following products obtained by industrial microbiological fermentation – Alcohol, Alcoholic Beverage-Beer, Organic acid – Citric acid, Antibiotic – Penicillin, Amino acids – Glutamic acid, Vitamin-B12.

Unit-IV **12 Credit hours**

Food spoilage – bacterial, fungal and yeast; food preservation – principles and general methods, elementary idea of canning and packing; sterilization and pasteurization of food products; technology of fermented foods – Yoghurt, Buttermilk, Idli, Dosa, Cheese.

Unit-V **12 Credit hours**

Microbial foods – Single Cell Proteins (SCP), Single Cell Oils (SCO); Hazard Analysis and Critical Control (HACCP) concept; Techniques of mass culture of Algae-spirulina;

Microbial polysaccharides and polyesters; production of xanthaim gum and polyhydroxyalkaloides.

Suggested Reading

1. Waites, Morgan, Rockey. Industrial Microbiology. Blackwell Science.
2. Saha, B.D. Fermentation Biotechnology. American Chemical Society.
3. Demain and Davies . Industrial Microbiology and Biotechnology. A.S.M. Press Washington.
4. Glazer, A.N. and Nikaido, H. Microbial Biotechnology : Principle and application of applied microbiology. W.H. Freeman and com.
5. Stanbary, Whitaker and Hall. Principles of Fermentation Technology.
6. Shuler and Kargi. Bioprocess Engineering. Pearson.
7. Mukherji, K.G. Microbial Technology. APH. Pub. Corp.
8. Ray. Fundamental Food Microbiology. CBH Pub.
9. Bell, Neaves and Williams. Food Microbiology and Laboratory Practice. Panima.

Discipline Specific Elective Biotechnology

4.Immunology and Enzymology

(Credits: Theory-4, Practicals-2)

THEORY

Credit hours: 60

Unit-I **10 Credit hours**

Immune system and immunity; history of immunology; innate and acquired immunity; structure, composition and functions of cells involved in immune system: T cells, B-cells, macrophages, eosinophils, neutrophils, mast cells and natural killer Cells. Structure, composition and functions of Organs involved in immune system: thymus gland, bone marrow, spleen and lymph nodes.

Unit-II **15 Credit hours**

Antigens – structure and properties, types (iso and alloantigens), haptens, adjuvants; antigen specificity. Immunoglobulins – structure, heterogeneity, types and subtypes, properties (physico-chemical and biological). complement – structure, components, properties and functions of complement; complement pathways and biological consequences of complement activation.

Unit-III **10 Credit hours**

Antigen antibody reactions – agglutination, precipitation, complement fixation, immunofluorescence, immuneoelectrophoresis, Applications of these methods in diagnosis of microbial infections. Major histocompatibility complex – structure and functions of MHC.

Unit-IV **15 Credit hours**

History and introduction to enzymes, Classification of enzymes, IUBMB system of nomenclature, E.C. numbers, Introduction to coenzyme, cofactors and prosthetic groups. Enzyme kinetics (Michaelis-Menten laws), importance and determination of V_{max} and K_m values, catalytic mechanisms of enzymes, acid-base, covalent, metal ion and electrostatic catalysis.

Unit-V **10 Credit hours**

Regulation of enzyme activity: metabolic compartmentation, covalent modification, feedback regulation. Enzyme inhibition: competitive and non competitive. Multienzyme complexes: structure and significance. Isolation and purification of enzymes: salt precipitation, gel filteration, ion exchange and affinity chromatography.

Suggested Readings

1. Coico R, Sunshine, Benjamin E. Immunology : A short course. John Wiley and Sons.
2. Roitt, Brostoff, Male and Mosby. Immunology.

3. Kuby *et al.* Immunology. W.H. Freeman and Company.
4. Rao, C.V. An Introduction to Immunology. Narosa Pub. House.
5. Coleman, R.M. Fundamental Immunology. McGraw Hill.
6. Paul, W.E. Fundamentals of Immunology. Raven Press New York
7. Palmer, T. Understanding Enzymes.
8. Price and Stevenson. Fundamentals of Enzymology. Oxford University Press.
9. Dixon and Webb. The Enzymes. Academic Press, London.
10. Foster, F.L. The nature of Enzymology. John Wiley and Sons

Discipline Specific Elective Biotechnology

5.Project

Discipline Specific Elective Chemistry

1.Applications Of Computers In Chemistry

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **15 Credit hours**

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

UNIT II **10 Credit hours**

Numerical methods:

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

UNIT III **15 Credit hours**

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

UNIT IV **10 Credit hours**

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.

Interpolation, extrapolation and curve fitting: Handling of experimental data.

UNIT V **10 Credit hours**

Conceptual background of molecular modelling: Potential energy surfaces. Elementary

ideas of molecular mechanics and practical MO methods.

Reference Books:

1. *chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
2. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
3. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

Discipline Specific Elective Chemistry

2.Analytical Methods In Chemistry

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **5 Credit hours**

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

UNIT II **5 Credit hours**

Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

UNIT III **25 Credit hours**

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

UNIT IV **10 Credit hours**

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation.

Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values.

UNIT V **15 Credit hours**

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from

aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/ diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC).

Role of computers in instrumental methods of analysis

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

9. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
10. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
11. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
12. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
13. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009
14. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
15. Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. Lond.

Discipline Specific Elective Chemistry

3.*Molecular Modelling & Drug Design*

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **10 Credit hours**

Introduction to Molecular Modelling:

Introduction. Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

UNIT II **14 Credit hours**

Force Fields:

Fields. Bond Stretching. Angle Bending. Introduction to nonbonded interactions. Electrostatic interactions. van der Waals Interactions. Hydrogen bonding in Molecular

Mechanics. Force Field Models for the Simulation of Liquid Water.

UNIT III **12 Credit hours**

Energy Minimization and Computer Simulation:

Minimization and related methods for exploring the energy surface. Non- derivative method, First and second order minimization methods. Computer simulation methods. Simple thermodynamic properties and Phase Space. Boundaries. Analyzing the results of a simulation and estimating Errors.

UNIT IV **12 Credit hours**

Molecular Dynamics & Monte Carlo Simulation:

Molecular Dynamics Simulation Methods. Molecular Dynamics using simple models. Molecular Dynamics with continuous potentials. Molecular Dynamics at constant temperature and pressure. Metropolis method. Monte Carlo simulation of molecules. Models used in Monte Carlo simulations of polymers.

UNIT V **12 Credit hours**

Structure Prediction and Drug Design:

Structure prediction - Introduction to comparative Modeling. Sequence alignment. Constructing and evaluating a comparative model. Predicting protein structures by 'Threading', Molecular docking. Structure based de novo ligand design, Drug Discovery – Chemoinformatics – QSAR.

Reference Books:

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.
4. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
5. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John

Wiley and Sons, 1997.

6. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Discipline Specific Elective Chemistry

4.Novel Inorganic Solids

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **20 Credit hours**

Synthesis and modification of inorganic solids:

Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

Inorganic solids of technological importance:

Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments.

Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.

UNIT II **10 Credit hours**

Nanomaterials:

Overview of nanostructures and nanomaterials: classification.

Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.

UNIT III **10 Credit hours**

Introduction to engineering materials for mechanical construction:

Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets and composite materials.

UNIT IV **10 Credit hours**

Composite materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal- matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

UNIT V **10 Credit hours**

Speciality polymers:

Conducting polymers-Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

Reference Books:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
3. Frank J. Ovens, Introduction to Nanotechnology
4. Fahan, *Materials Chemistry*, Springer (2004).

Discipline Specific Elective Chemistry

5.Polymer Chemistry

(Credits: Theory-06, Practicals-02)

Theory: 60 Credit hours

UNIT I **12 Credit hours**

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

UNIT II **12 Credit hours**

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT III **12 Credit hours**

Nature and structure of polymers-Structure Property relationships.

Determination of molecular weight of polymers (M_n, M_w, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

UNIT IV **14 Credit hours**

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

UNIT V **10 Credit hours**

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene).

Reference Books:

1. *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers

Discipline Specific Elective Chemistry

6.Research Methodology For Chemistry

(Credits: Theory-05, Tutorials-01)

Theory: 60 Credit hours

UNIT I **10 Credit hours**

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

UNIT II **15 Credit hours**

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

UNIT III **15 Credit hours**

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiaris

UNIT IV **10 Credit hours**

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

UNIT V **10 Credit hours**

Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011)
2. *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
3. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
4. Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
5. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.
7. Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
8. OSU safety manual 1.01.

Discipline Specific Elective Chemistry

7.Green Chemistry

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **10 Credit hours**

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups;

UNIT II **5 Credit hours**

Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

UNIT III **20 Credit hours**

Examples of Green Synthesis/ Reactions

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral,

ibuprofen, paracetamol, furfural.

2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).
3. Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.
4. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles.

UNIT IV **20 Credit hours**

Examples of Green Synthesis/ Reactions

1. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.
2. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

UNIT V **5 Credit hours**

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

Reference Books:

1. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry,
2. Anamalaya Publishers (2005).
3. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
4. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
5. M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
6. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).
7. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
8. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
9. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
10. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
11. Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
12. Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society (2008).
13. Pavia, D. L. Lamponan, G. H. &Kriz, G.S. *W B Introduction to organic laboratory*

Discipline Specific Elective Chemistry

8.Industrial Chemicals And Environment

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **10 Credit hours**

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permangana.

UNIT II **10 Credit hours**

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

UNIT III **20 Credit hours**

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases. Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global

warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

UNIT IV **10 Credit hours**

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

UNIT V **10 Credit hours**

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E. Manahan, Environmental Chemistry, CRC Press (2005).
8. G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
9. A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).
10. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
11. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
12. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
13. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
14. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
15. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

Discipline Specific Elective Chemistry

9.Inorganic Materials Of Industrial Importance

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **16 Credit hours**

Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

UNIT II **8 Credit hours**

Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

UNIT III **10 Credit hours**

Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco- friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

UNIT IV **6 Credit hours**

Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

UNIT V **20 Credit hours**

Alloys:

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Phase transfer catalysts, application of zeolites as catalysts.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
4. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut
8. E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.

9. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
10. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
11. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
12. P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
13. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
14. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

Discipline Specific Elective Chemistry

10.Instrumental Methods Of Chemical Analysis

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **20 Credit hours**

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

Molecular spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluorescent tags).

UNIT II **16 Credit hours**

Separation techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

UNIT III **8 Credit hours**

Elemental analysis:

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence.

Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

UNIT IV **8 Credit hours**

NMR spectroscopy: **P**rinciple, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications.

Electroanalytical Methods: Potentiometry & Voltammetry

UNIT V **8 Credit hours**

Radiochemical Methods

X-ray analysis and electron spectroscopy (surface analysis)

Reference books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. P.W. Atkins: Physical Chemistry.
4. G.W. Castellan: Physical Chemistry.
5. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
6. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
7. W.J. Moore: Physical Chemistry.
8. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
9. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.

Discipline Specific Elective Chemistry

11. Chemistry of D-Block Elements, Quantum Chemistry & Spectroscopy

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **12 Credit hours**

Transition Elements (3d series)

General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu.

Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).

UNIT II **8 Credit hours**

Coordination Chemistry

Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

Drawbacks of VBT. IUPAC system of nomenclature.

UNIT III **10 Credit hours**

Crystal Field Theory

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry.

Jahn-Teller distortion, Square planar coordination.

UNIT IV **15 Credit hours**

Quantum Chemistry & Spectroscopy

Spectroscopy and its importance in chemistry. Wave-particle duality. Link between spectroscopy and quantum chemistry. Electromagnetic radiation and its interaction with matter. Types of spectroscopy. Difference between atomic and molecular spectra. Born-Oppenheimer approximation: Separation of molecular energies into translational, rotational, vibrational and electronic components.Postulates of quantum mechanics, quantum mechanical operators.

Free particle. Particle in a 1-D box (complete solution), quantization, normalization of wavefunctions, concept of zero-point energy.

Rotational Motion: Schrödinger equation of a rigid rotator and brief discussion of its results (solution not required). Quantization of rotational energy levels.

Microwave (pure rotational) spectra of diatomic molecules. Selection rules. Structural information derived from rotational spectroscopy.

UNIT V **15 Credit hours**

Vibrational Motion: Schrödinger equation of a linear harmonic oscillator and brief discussion of its results (solution not required). Quantization of vibrational energy levels. Selection rules, IR spectra of diatomic molecules. Structural information derived from vibrational spectra. Vibrations of polyatomic molecules. Group frequencies. Effect of hydrogen bonding (inter- and intramolecular) and substitution on vibrational frequencies.

Electronic Spectroscopy: Electronic excited states. Free Electron model and its application to electronic spectra of polyenes. Colour and constitution, chromophores, auxochromes, bathochromic and hypsochromic shifts.

Photochemistry

Laws of photochemistry. Lambert-Beer's law. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions. Photoelectric cells.

Reference Books:

1. G. M. Barrow: *Physical Chemistry* Tata McGraw Hill (2007).
2. G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
3. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
4. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
5. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
6. J. D. Lee: *A New Concise Inorganic Chemistry*, E.L.B.S.
7. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
8. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press.
9. Gary Wulfsberg: *Inorganic Chemistry*, Viva Books Pvt. Ltd.

Section B: Physical Chemistry

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).

II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.

III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration

II. Analyse the given vibration-rotation spectrum of HCl(g)

Reference Books:

1. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.

2. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

Discipline Specific Elective Chemistry

12.Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and Uv, Ir Spectroscopy

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

UNIT I **6 Credit hours**

Chemistry of 3d metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co.

A study of the following compounds (including preparation and important properties);

Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

UNIT II **12 Credit hours**

Organometallic Compounds

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

UNIT III **12 Credit hours**

Bio-Inorganic Chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions

in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones)

UNIT IV **6 Credit hours**

Polynuclear and heteronuclear aromatic compounds:

Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene , Furan, Pyrrole, Thiophene, and Pyridine.

UNIT V **24 Credit hours**

Active methylene compounds:

Preparation: Claisen ester condensation. Keto-enol tautomerism. *Reactions:* Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).

Application of Spectroscopy to Simple Organic Molecules

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Reference Books:

1. James E. Huheey, Ellen Keiter & Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
2. G.L. Miessler & Donald A. Tarr: *Inorganic Chemistry,* Pearson Publication.
3. J.D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley & Sons.
5. I.L. Finar: *Organic Chemistry* (Vol. I & II), E.L.B.S.

6. John R. Dyer: *Applications of Absorption Spectroscopy of Organic Compounds,*
7. Prentice Hall.
8. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of Organic Compounds,* John Wiley & Sons.
9. R.T. Morrison & R.N. Boyd: *Organic Chemistry*, Prentice Hall.
10. Peter Sykes: *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
11. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand.

Discipline Specific Elective Chemistry

13. Molecules Of Life

(Credits: Theory-04, Practicals-02)

Theory: 60 Credit hours

Unit 1: Carbohydrates **10 Credit hours**

Classification of carbohydrates, reducing and non reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof).

Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Unit 2: Amino Acids, Peptides and Proteins **12 Credit hours**

Classification *of Amino Acids,* Zwitterion structure and Isoelectric point.

Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

Unit 3: Enzymes and correlation with drug action **12 Credit hours**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action(Including stereospecifity) , Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Non competitive inhibition including allosteric inhibtion). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring,

Unit 4: Nucleic Acids **18 Credit hours**

Components of Nucleic acids: Adenine, guanine ,thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA(**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Lipids

Introduction to lipids, classification.

Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Unit 5: Concept of Energy in Biosystems **8 Credit hours**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.

Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy,

ATP hydrolysis and free energy change.

Conversion of food into energy. Outline of catabolic pathways of Carbohydrate-Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Recommended Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.*, W. H. Freeman.
6. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
7. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press.

Discipline Specific Elective Chemistry

15.Dissertation

MOHANLAL SUKHADIA UNIVERSITY, UDAIPUR

B. Sc. BIOTECHNOLOGY SEMESTER –III, IV, V & VI (2016-17)

Skill Enhancement Course (Any Four)

BOTANY:

1. Biofertilizers

(Credits 2)

Credit hours: 30

Unit 1 **4 Credit hours**

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2 **8 Credit hours**

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit 3 **4 Credit hours**

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit 4 **8 Credit hours**

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5 **6 Credit hours**

Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

Skill Enhancement Course

2.Herbal Technology

(Credits 2)

Credit hours: 30

Unit 1 **6 Credit hours**

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2 **6 Credit hours**

Pharmacognosy - systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3 **6 Credit hours**

Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

Unit 4 **8 Credit hours**

Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

Unit 5 **4 Credit hours**

Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy)

Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

Skill Enhancement Course

3.Nursery and Gardening

(Credits 2)

Credit hours: 30

Unit 1 **4 Credit hours**

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit 2 **6 Credit hours**

Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit 3 **6 Credit hours**

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Unit 4 **8 Credit hours**

Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

Unit 5 **6 Credit hours**

Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots

- Storage and marketing procedures.

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

Skill Enhancement Course

4.Floriculture

(Credits 2)

Credit hours: 30

Unit 1 **5 Credit hours**

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Unit 2 **5 Credit hours**

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 3 **5 Credit hours**

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 4 **5 Credit hours**

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

Unit 5 **10 Credit hours**

Landscaping Places of Public Importance: Landscaping highways and Educational institutions. Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold,Rose, Lilium, Orchids).

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

Skill Enhancement Course

5.Medicinal Botany

(Credits 2)

Credit hours: 30

Unit 1 **5 Credit hours**

History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments,

Unit-2 **5 Credit hours**

Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 3 **5 Credit hours**

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation:

Unit-4 **5 Credit hours**

Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 5 **10 Credit hours**

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study

ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

2.Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios,

Skill Enhancement Course

6.Plant Diversity and Human Welfare

(Credits 2)

Credit hours: 30

Unit 1 **6 Credit hours**

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at theecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

Unit 2 **6 Credit hours**

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss.

Unit -3 **6 Credit hours**

Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 4 **6 Credit hours**

Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

Unit 5 **6 Credit hours**

Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

Skill Enhancement Course

7. Ethnobotany

(Credits 2)

Credit hours: 30

Unit 1 **6 Credit hours**

Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2 **5 Credit hours**

Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3 **10 Credit hours**

Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b)

Ocimum sanctum c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia,Withania*.

Unit-4 **3 Credit hours**

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5 **6 Credit hours**

Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.

2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981

3. Lone et al,. Palaeoethnobotany

4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.

6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur- 1996 9)

Skill Enhancement Course

8.Mushroom Culture Technology

(Credits 2)

Credit hours: 30

Unit 1 **5 Credit hours**

Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*

Unit 2 **5 Credit hours**

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

Unit-3 **8 Credit hours**

Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

Unit 4 **8 Credit hours**

Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 5 **4 Credit hours**

Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad,Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Skill Enhancement Courses

BIOTECHNOLOGY

1: Probiotic Technology

TOTAL HOURS: 30

CREDITS: 2

Unit-I

Credit hours: 5

Enumeration of probiotic bacteria, Isolation: Pour plate technique. Streaking four way, Zig Zaq, and linear. Spreading, Slant, Stab culture.

Unit-II **Credit hours: 5**

Morphological and cultural Characterization: Colony characteristics, Simple staining, Gram's staining, Negative staining.

Unit-III **Credit hours: 10**

Biochemical characterization: Catalase test, Growth in litmus milk, Growth on BCP-MRS agar, nitrate reduction, arginine hydrolysis, Esculin hydrolysis. Voges Proskauer's test.

Unit-IV **Credit hours: 5**

Carbohydrate fermentation: Arabinose, Cellobinose, Galactose, Maltose, Mannose, Mannitol, Raffinose, Rahmanose. PCR based identification.

Unit V **Credit hours: 5**

Screening of probiotic properties: Antibiotic resistance, Bile tolerance, BSH activity, Antibacterial activity, preparation of skim milk and viability testing.

Skill Enhancement Course

2: Animal Cell Sciences

TOTAL HOURS: 30

CREDITS: 2

Unit I **Credit hours: 4**

Microtomy: Principles & types, sample preparation & sectioning parameters.

Unit II **Credit hours: 6**

Immunological Techniques:- antigen- antibody reactions, Radial Immuno diffusion, ELISA.

Unit III **Credit hours: 6**

Animal Tissue culture : Design, Layout and Equipment . Media: preparation and metaphase chromosome preparation .

Unit IV **Credit hours: 4**

Histochemical techniques : principle and types , various enzymatic anlysisand cryosectioning.

Unit V **Credit hours: 10**

Marketing & management of animal biotechnology : Effective advertising and marketing, technology decision making, and resource decision-making etc., Product marketing decision.

Skill Enhancement Course

3: Microbiological Analysis Of Air And Water

TOTAL HOURS: 30

CREDITS: 2

Unit 1 Aeromicrobiology

Credit hours: 4

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health
and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air sample collection and analysis

Credit hours: 7

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi,
Identification characteristics

Unit 3 Control measures

Credit hours: 4

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology

Credit hours: 5

Water borne pathogens, water borne diseases

Unit 5 Microbiological analysis of water

Credit hours: 10

Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of
water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests Precipitation, chemical disinfection, filteration, high temperature, UV light

Skill Enhancement Course

4: Techniques In Biotechnology

TOTAL HOURS: 30

CREDITS: 2

Unit-I (GeneralInstruments) **Credit hours: 6**

Principles, working and applications of- Autoclave, Laminar Airflow, Hot Air Oven, UV and Visible Spectrophotometer.

Unit-II (Microscopy) **Credit hours: 6**

Microscopy: Principles and applications of Simple, compound, Phase contrast. Micrometry.

Unit-III (Centrifugation) **Credit hours: 5**

Centrifugation: Rotors, Bench top, Low Speed, High Speed, Cooling Centrifuge. Principles and Application of Ultracentrifugation.

Unit-IV (Electrophoresis) **Credit hours: 10**

Agarose gel electrophoresis, Native and SDS PAGE analysis, PCR, Molecular, biochemical and cytological markers.

Unit-V (Chromatography) **Credit hours: 3**

Principals and applications of Paper and thin layer chromatography.

Skill Enhancement Course

5: Techniques In Plant Tissue Culture

TOTAL HOURS: 30

CREDITS: 2

Unit –I (Introduction to Plant Tissue culture) **Credit hours: 6**

Introduction to Plant Tissue culture, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it's control and measures.

Unit-II (Media and Culture Preparation) **Credit hours: 7**

Role of Micro and macro nutrients, Vitamins and carbon source in tissue culture, Media preparation- pH, Temprature, Solidifying agents, Various media preparations, Slant Preparations etc. Maintenance of cultures, Environmental Conditions,.

Unit-III (Culture techniques) **Credit hours: 5**

Explants selection, explants characteristics, sterilization and inoculation for culture establishment

Unit-IV (Initiation of Cultures) **Credit hours: 6**

Induction and growth parameters; Culture initiation, Callus culture., Micropropagation through various explants (Leaf, Stem, Axillary bud).

Unit-V **Credit hours: 6**

Meristem tip culture and its application.Techniques and significance of Androgensis and Gynogenesis (anther and pollen, ovary and ovule culture). Production of Synthetic seeds.

Skill Enhancement Course

Chemistry

1. It Skills for Chemists

(Credits: 02)

30 Credit hours

Mathematics

Fundamentals, mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.

Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities.

Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms).Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas,

equilibrium constant expressions).

Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

Computer programming:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

BASIC programs for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

HANDS ON

Introductory writing activities: Introduction to word processor and structure drawing (ChemSketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.

Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure- volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

Numeric modelling: Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration-time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pK_a of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).

Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The *t* test. The *F* test.

Presentation: Presentation graphics

Reference Books:

1. McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
2. Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
3. Steiner, E. The Chemical Maths Book Oxford University Press (1996).
4. Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
5. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
6. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
7. Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
8. Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

Skill Enhancement Course

2.*Basic Analytical Chemistry*

(Credits: 02)

30 Credit hours

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.

b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

b. To compare paint samples by TLC method. **Ion-exchange:** Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.
b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.
b. To analyze arson accelerants.
c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by

flame photometry.

b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Reference Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry* 6^{th} *Ed.,*

   Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2^{nd} *Ed.,* W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis* 7^{th} *Ed.,* Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis* 6^{th} *Ed.,* Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis* 5^{th} *Ed.,* Marcel Dekker, Inc., New York (1995).

Skill Enhancement Course

3. *Chemical Technology & Society*

(Credits: 02)

Theory: 30 Credit hours

Chemical Technology

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.

Society

Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants); energy from natural sources (i.e. solar and renewable forms), from fossil fuels and from nuclear fission; materials like plastics and polymers and their natural analogues, proteins and nucleic acids, and molecular reactivity and interconversions from simple examples like combustion to complex instances like genetic engineering and the manufacture of drugs.

Reference Book:

John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.

Skill Enhancement Course

4. *Chemoinformatics*

(Credits: 02)

Theory: 30 Credit hours

Introduction to Chemoinformatics: History and evolution of chemoinformatics, Use of chemoinformatics, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.

Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Searching chemical structures: Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.

Applications: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand-Based and Structure Based Drug design; Application of Chemoinformatics in Drug Design.

Hands-on Exercises

Reference Books:

1. Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics.* Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book.* Wiley-VCH.
3. Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi.

Skill Enhancement Course

5. *Business Skills for Chemists*

(Credits: 02)

Theory: 30 Credit hours

Business Basics

Key business concepts: Business plans, market need, project management and routes to market.

Chemistry in Industry

Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies.

Making money

Financial aspects of business with case studies

Intellectual property

Concept of intellectual property, patents.

Reference

www.rsc.org

Skill Enhancement Course

6. *Intellectual Property Rights (Ipr)*

(Credits: 02)

Theory: 30 Credit hours

In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.

Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights

Introduction, How to obtain, Differences from Patents.

Trade Marks

Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.

Differences from Designs.

Patents

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs

Definition, How to obtain, features, International design registration.

Layout design of integrated circuits

Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Different International agreements

(a) Word Trade Organization (WTO):

(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement

(ii) General Agreement on Trade related Services (GATS)

(iii) Madrid Protocol

(iv) Berne Convention

(v) Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible

assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Reference Books:

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
5. Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

Skill Enhancement Course

7. *Analytical Clinical Biochemistry*

(Credits: 02)

THEORY: 30 Credit hours

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Review of concepts studied in the core course:

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.

Isolation and characterization of polysachharides.

Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications.

Lipoproteins.
Properties, functions and biochemical functions of steroid hormones.

Biochemistry of peptide hormones.

Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.

Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

Practicals

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Determination of the iodine number of oil.
4. Determination of the saponification number of oil.
5. Determination of cholesterol using Liebermann- Burchard reaction.
6. Proteins – qualitative.
7. Isolation of protein.
8. Determination of protein by the Biuret reaction.
9. Determination of nucleic acids

Reference Books:

1. T.G. Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.
5. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
6. G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
7. A.L. Lehninger: Biochemistry.
8. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

Skill Enhancement Course

8. Green Methods In Chemistry

(Credits: 02)

Theory: 30 Credit hours

Tools of Green chemistry, Twelve principles of Green Chemistry, with examples.

The following Real world Cases in Green Chemistry should be discussed:

1 A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy).
2 Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
3 Environmentally safe antifoulant.
4 CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
5 Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.
6 A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
7 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
8 Development of a fully recyclable carpet: cradle to cradle carpeting.

Reference Books:

1. Manahan S.E. (2005) Environmental Chemistry, CRC Press
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New

Skill Enhancement Course

9. Pharmaceutical Chemistry

(Credits: 02)

Theory: 30 Credit hours

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Practicals

1. Preparation of Aspirin and its analysis.
2. Preparation of magnesium bisilicate (Antacid).

Reference Books:

1. G.L. Patrick: Introduction to *Medicinal Chemistry*, *Oxford University* Press, UK.
2. Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.
3. William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

Skill Enhancement Course

10. Chemistry of Cosmetics & Perfumes

(Credits: 02)

30 Credit hours

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Practicals

1. Preparation of talcum powder.
2. Preparation of shampoo.
3. Preparation of enamels.
4. Preparation of hair remover.
5. Preparation of face cream.
6. Preparation of nail polish and nail polish remover.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

Skill Enhancement Course

11. Pesticide Chemistry

(Credits: 02)

30 Credit hours

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

Practicals

2 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.

3 Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

1. R. Cremlyn: *Pesticides*, John Wiley.

Skill Enhancement Course

12. Fuel Chemistry

(Credits: 02)

30 Credit hours

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.