BACHELOR OF SCIENCE(HONS.)

CHEMISTRY

Programme Code: CHYB
Duration: 3 Years

Detailed Syllabus with Scheme of Examination

FROM SESSION: 2019-2020 Onwards

Department of Chemistry
Faculty of Science

CHHATRAPATI SHIVAJI MAHARAJ UNIVERSITY
PANVEL, NAVI MUMBAI

Chhatrapati Shivaji Maharaj University
NAVI, MUMBAI
Private University Estab. under act XXXII- 2018 of Govt. of Mah.

B. Sc. I Semester I

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	CHYB1010	Inorganic Chemistry-I	4	0	0	30	70	100	4
DSC	CHYB1020	Physical Chemistry-I	4	0	0	30	70	100	4
GE	**	General Elective - I	4	0/1	4/0	30	70	100	4
AECC	ENGG1000	English Communication	2	0	0	15	35	50	2
DSC	CHYB1011	Inorganic Chemistry-I Lab	0	0	4	15	35	50	2
DSC	CHYB1021	Physical Chemistry-I Lab	0	0	4	15	35	50	2
GE	**	General Elective - I Lab	0	1/0	0/4	15	35	50	2
		Total	**14**	**0**	**12**	**150**	**350**	**500**	**20**

CHYB1010	**Inorganic Chemistry-I**	**4L:0T:0P**	**4 Credits**

Course Objectives:

1. Know the discovery of electron, proton and neutron and their characteristics. 00
2. To understand the nature electromagnetic radiation and quantum theory.
3. To understand the periodic law and significance of atomic no and electronic configuration as the basic for periodic classification.
4. To understand Chemical Bonding and Nature of Chemical Bonding

UNIT-1: Atomic Structure and Periodicity of Elements(15L)

1.1 Bohr's theory and its limitations. atomic spectrum of hydrogen atom.

1.2 Wave particle duality, Heisenberg uncertainty principle.

1.3 Schrödinger's wave equation, significance of ψ and ψ.

1.4 Quantum numbers and their significance.Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves.

1.5 Shapes of s, p and d atomic orbitals,

1.6 Electrons filling rules in various orbitals: a)Aufbau's principle b)Hund's rule of Maximum multiplicity c) Pauli's exclusion principleelectonic configuration of Elements, Stability of empty, half filled and completely filled orbitals

1.7 Periodicity of the elements: General discussion of elements:a) Electronic configuration b) atomic radii d) ionization energy e) Electron Affinity f) Electronegetivity g) Mettalic Characterh)Reactivity i) Oxidation State j) Melting and Boiling Points

UNIT-2:Chemical Bonding and Molecular structure (VBT) (15L)

2.1 Valence Bond Theory(VBT)

2.2 Concept of Hybridization, Different types of Hybridization

2.3 Geometry of the MoleculesLinear geometry- $BeCl_2$ (sp hybridization),Planer trigonal geometry- BF_3 (sp^2 hybridization), Tetrahedral geometry- $SiCl_4$ (sp^3 hybridization), Trigonal bipyramidal geometry- PCl_5 (sp^3d hybridization), Octahedral geometry- SF_6 (sp^3d^2 hybridization) Pentagonal bipyramidal geometry -IF_7 (sp^3d^3 hybridization)

2.4Shapes of Molecules:Hybridization of orbitals and directional nature of covalent bond. Sidgwick – Powell theory. Valence Shell Electron Pair Repulsion (VSEPR) theory, shapes of inorganic molecules and anions such as $BeCl_2$, BF_3, SiF_4 , NH_3 , H_2O, OF_2 , Cl_2O, ClO_2, PCl3 , PCl_5 , SF_4 , ClF_3 , ICI_3 , PPh_3 , BrF_5 , IF_7 , XeF_4 , XeF_6 , CO^{2-}_3 , NO_3 , PO^{3-}_4 ,ClO_4 , SbF4 , SbF2- 5 , TeF5 ,XeF.+ 5 , l - 3 and l + 3 related species.

UNIT-3:Chemical Bonding and Molecular structure (MOT) (15L)

3.1 Molecular orbital theory (MOT)

3.2 LCAO method, formation of bonding , anti bonding and nonbonding molecular orbitals.

3.3 Conditions for successful overlap, Types of overlaps - S-S ,S-px, Px-Px, Py-Py and Pz-Pz overlaps.

3.4 Bond order and its significance.

3.5 Energy level sequence for molecular orbital when n=1&2.

3.6 MO diagrams for homonuclear diatomic molecule of 1st& 2nd period Elements (He_2, Li_2, B_2, N_2, O_2).

3.7 Molecular orbital diagrams for heteroatomic diatomic molecules. (CO, NO)

UNIT4:Crystal field Theory (15L)

4.1 Introduction

4.2 Assumption of Crystal Field Theory

4.3 Crystal Field Splitting

4.4 CFSE, Calculation of CSFE

4.5 Factors affecting on CFSE

4.6 Magnetic Properties

4.7 Jahn Teller Distortion

Course Outcomes:

1. Apply the fundamental principles of measurement, matter, atomic theory, chemical
2. periodicity, chemical bonding
3. Apply the chemical Bonding theories to understand the bonding in compounds
4. 3)Apply the VSEPR theory to predict the Structures of Molecules

Reference Books:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.

3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry:

CHYB1011	**Inorganic Chemistry-I LAB.**	**0L:0T:4P**	**2 Credits**

1. To prepare standard 0.1 N $KMnO_4$ solution and to determine the strength of given oxalic acid solution.
2. To standardize supplied EDTA solution by titrating with 0.01 M $ZnSO_4$ solution and to estimate amount of calcium from given solution by using Eriochrome Black-T as an indicator.
3. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
4. To determine unknown concentration of Hydrochloric acid conductometrycally.
5. To determine unknown concentration of acid mixtures by conductometrycally

CHYB1020	**Physical Chemistry-I**	**4L:0T:0P**	**4 Credits**

Course Objectives:

1. To apply gas laws in various real life situations.
2. To explain the behaviour of real and ideal gas.
3. To differentiate between gaseous state and vapour.
4. Explain the properties of liquids.
5. To understand Kinetics of reactions
6. To write the expressions for equilibrium constants
7. To understand the concept of ionic equillibria

UNIT-1: Chemical Energetics(15L)

1.1 Introduction, Basic concepts of thermodynamics

1.2 First law of thermodynamics Spontaneous and non-spontaneous process with examples.

1.3 Statements of second law of thermodynamics, Carnot's cycle and its efficiency. (Numericals)

1.4 Entropy, Physical Significance of entropy, Statement of Third Law of thermodynamics and calculation of absolute entropies of substances(Numerical)

UNIT-2: Chemical Equilibrium(15L)

2.1 Chemical Equilibrium: Free energy change in a chemical reaction.

2.2 Thermodynamic derivation of the law of chemical equilibrium.

2.3 Distinction between ΔG and ΔGo , Le Chatelier's principle.

2.4 Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT-3:Ionic equilibria(15L)

3.1 Strong, moderate and weak electrolytes, degree of ionization.

3.2factors affecting degree of ionization, ionization constant and ionic product of water.

3.3 Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono

and diprotic acids.

3.4 Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications.

3.5 Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages).

3.6 Theory of acid– base indicators; selection of indicators and their limitations.

UNIT-4: Chemical Kinetics(15L)

4.1 Introduction, Rate of reaction, Definition and units of rate constant.

4.2 Factors affecting rate of reaction. (Nature of reactant, Concentration, pressure, temperature and catalyst.)

4.3 Order and Molecularity of reaction, Zero order reaction, First order reaction, Characteristics of first order reaction.examples, Pseudo-unimolecular reactions,examples.

4.4 Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Characteristics of Second order reaction.

4.5 Determination of order of reaction by i) integration method ii) graphical method iii)Half life method.

4.6 Effect of temperature on rate of reaction, Arrhenius equation, Concept of energy of activation.

4.7 Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Numerical problems.

Course Outcome (COs):

Upon successful completion students should be able to:

1. State and apply the laws of thermodynamics; perform calculations with ideal and real gases; design practical engines by using thermodynamic cycles; predict chemical equilibrium and spontaneity of reactions by using thermodynamic principles.
2. To apply the concepts of colloids and gels
3. To learn depth knowledge about liquid states

Reference Books

1. Principles of Physical Chemistry Puri, Sharma and Pathania, Vishal Publishing House,44th Edition
2. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition
3. Essentials of Physical Chemistry,Bahl , Tuli and Bahl
4. Text Book of Physical Chemistry, Soni and Dharmarha
5. Essentials of Nuclear Chemistry by H J Arnikar, New Age, 4th edition.

CHYB1012	**Physical Chemistry-I**	**0L:0T:4P**	**2 Credits**

(Perform any six experiments)

1. Determination of equivalent weight of Mg by Eudiometer.
2. Study of specific reaction rate of hydrolysis of methyl acetate in presence of HCl.
3. Determination of heat of ionization of weak acid by using polythene bottle.

4. Determination of heat capacity of calorimeter for different volumes.
5. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
6. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
7. Determination of enthalpy of hydration of copper sulphate.
8. Study of the solubility of benzoic acid in water and determination of ΔH.

Reference Books

1. Experimental Physical Chemistry: A. Findlay.
2. Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar. (Anjali Publication.)
3. Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata Mc Graw Hill)
4. Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)

ENGG1000	**English Communication**	**4L:0T:0P**	**2 Credits**

Course Objectives.

1. To acquaint the students with appropriate language skills with the purpose of improving the existing ones – LSRW.
2. To make the learners understand the importance and effective use of non-verbal communication.
3. To make the learner proficient in public speaking and presentation skills.
4. To guide and teach the students to utilize the principles of professional business and technical writing for effective communication in the global world.
5. To deploy technology to communicate effectively in various situations.

Unit-1: Communication and Communication Process:

1.1 Introduction to Communication, Forms and functions of Communication,
1.2 Barriers to Communication ((linguistic and semantic, psychological, physical, mechanical, cultural), and overcoming them, Types of communication: verbal and non-verbal communication.
1.3 Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.
1.4 Listening:Importance of Listening, Types of Listening, Barriers to Listening.

Unit- 2:Writing Skills, Reading Skills & Listening Skills

2.1 Features of Good Language, Technical Style of writing, Writing Emails and it's etiquettes,
2.2 Technical Reports: Report Writing: Types, Format and Structure of reports.

Unit-3:Letter Writing

3.1 Types of letters: Job application letter, complaint letter, enquiry letter, reply to enquiry, sales letter.
3.2 Essential and non-essential parts of letters, formats of letters.

Unit-4:Grammar

4.1 Types of sentences, Antonyms and Synonyms,

4.2 Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Pairs of confused words, Common Errors in sentences.

Unit- 5:Soft Skills

5.1 Body language, Team work and skills, Decision making ability, Negotiation skills and

5.2 Interview skills.

Unit-6: Dialogues Writing and Speaking

6.1 Greeting someone and responding to greet, Thanking someone and responding to thanks,

6.2 Making inquiry and responding to enquiry on telephone, Making request and responding to request.

Course Outcomes.

The students will be able to-

1.Understand and evaluate information they listen to and express their ideas with greater clarity.

2.Speak and respond effectively along the various channels of communication in a business organization.

3.Speak convincingly before an audience with the help of an expanded vocabulary and enhanced digital content.

4.Communicate through result oriented writing both within and outside the organization.

5.Write a set of effective and easy to understand technical description, instructions.

References:

1. Communication in Organizations by Dalmar Fisher, Jaico Publishing House
2. Communication Skills by Meenakshi Raman & Sangeeta Sharma,
3. Oxford University Press.
4. Business Correspondence & Report-writing by R.C. Sharma& Krishna Mohan, Tata McGraw-Hill Education.
5. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
6. Technical Writing & Professional Communication for non-native speakers of English by Thomas N. Huckin & Leslie A. Olsen, McGraw –Hill.
7. Mastering Communication by Nicky Stanton, Palgrave Master Series
8. www.buisnesscommunicationskills.com
9. www.kcitraing.com
10. www.mindtools.com

SEMESTER II

	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	CHYB2010	Organic Chemistry-1	4	0	0	30	70	100	4
DSC	CHYB2020	Analytical Chemistry-I	4	0	0	30	70	100	4
GE	**	General Elective - II	4	0	4/0	30	70	100	4
AECC	EVSG2000	Environmental Science	2	0	0	15	35	50	2
DSC	CHYB2011	Organic Chemistry-I Lab	0	0	4	15	35	50	2
DSC	CHYB2021	Analytical Chemistry-I Lab	0	0	4	15	35	50	2
GE	**	General Elective - II Lab	0	1/0	0/4	15	35	50	2
		Total	**14**	**0**	**12**	**150**	**350**	**500**	**20**

CHYB2010	**Organic Chemistry-I**	**4L:0T:0P**	**4 Credits**

Course Objectives:

1. Difference between activating and deactivating groups.
2. Correlate the preparation of types of Cycloalkanes, Cycloalkenes.
3. Understand the Concept of stereochemistry
4. Study about the chemistry of Aromatic aldehyde, aromatic ketones and acids.
5. Study about the chemistry of aromatic sulphonic acid and Nitro compounds.

UNIT-1: Fundamentals of Organic Chemistry (15L)

1.1 Introduction, Curved arrow notations,
1.2 Cleavage of Bonds: Homolysis and Heterolysis.
1.3 Organic molecular species: Nucleophiles and electrophiles.
1.4 Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation effect,
1.5 Reactive Intermediates: Generation, Structure, Stability and Reactions of Carbocations, Carbanions and carbon free radicals.

UNIT-2:Streochemistry (15L)

2.1 Introduction, Types of Stereoisomerism, Optical Isomerism.
2.2 Concept of Chirality, Elements of Symmetry, Optical Isomerism in tartaric acid, 2, 3 Dihydroxybutanoic acid.
2.3 Enantiomerism, Diastereomerism and Meso compounds, Geometrical isomerism in C=C, C=N and alicyclic compounds.
2.4 Nomenclature of stereoisomers: D and L, erythro and threo, R and S, E and Z.

UNIT-3:Aromaticity (15L)

3.1 Introduction, Characteristics properties of organic compounds.
3.2 Meaning of terms: Aromatic, Non aromatic, Antiaromatic, Pseudoaromatic.
3.3 Structure of Benzene: Kekule structure, Resonance structure, M.O. picture,
3.4 Modern theory of Aromaticity,
3.5 Mechanism of Electrophilic substitution reactions: Nitration, Sulphonation, Halogenation and Friedel craft reaction.

UNIT-4: Cycloalkanes, cycloalkenes and alkadienes(15L)
4.1 Cycloalkanes: - Introduction. Method of formation -
a. By addition of carbene to alkene
b. Action of metallic sodium on dihaloalkane c) Diels - Alder reaction d) By reduction of aromatic compounds,
4.2 Chemical properties- a) Photohalogenation b) Catalytic halogenations c) Catalytic hydrogenation d) Effect of heat e) Reaction with hydrogen halide.
4.3 Cycloalkenes : Introduction, Method of formation from cyclic compounds, Chemical Properties - a) Hydrogenation b) Addition of Halogens and halogen acids, c) Allylic halogenations

Course Outcomes:
1. Working through this course, students are expected to apply their knowledge to problem-solve, deduce structures, and synthesize simple organic molecules using the studied reactions.
2. Relationships between organic chemistry and other disciplines are noted.

Reference Books
1. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
2. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
3. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
4. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
5. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
6. D.Nasipuri :Stereochemistry of Organic compounds

CHYB2011	**Organic Chemistry-Ilab**	**0L:0T:4P**	**2 Credits**

Estimations (any two):
1. Estimation of aniline. (by bromination method)
2. Estimation of acetamide.
3. Estimation of Aspirin.

Organic Qualitative Analysis:
1.Detection of physical constant, type, functional group, elements, and Confirmatory test.
2.Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl. Br, I)Acids: Oxalic acid, Benzoic acid, cinnamic acidPhenols: Beta-Naphthol, ResorcinolBase: Aniline, p-NitroanilineNeutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, BromobenzenePurification of organic compounds by crystallization (from water and alcohol) and distillation.

Reference Books

1. Vogel's Text Book of Quantitative Chemical Analysis. (Longmann) ELBS Edition.
2. Vogel's Text Book of Qualitative Chemical Analysis. (Longmann) ELBS Edition.
3. Hand book of Organic Qualitative Analysis : Clarke.

CHYB2020	Analytical Chemistry-I	4L:0T:0P	4 Credits

Course Objectives:

1. To provide a basic knowledge and understanding of essential chemical and physical principles for analytical chemistry.
2. To introduce basic analytical techniques and practical aspects of classical chemicalanalysis.
3. To solve problems related to chemical analysis and interpret analytical results.

UNIT-1: Introduction to analytical Chemistry (20L)

1.1 Importance of analysis
1.2 Analytical processes (Qualitative and Quantitative)
1.3 Methods of analysis (Only classification)
1.3 Sampling of solids, liquids and gases
1.4 Errors, types of errors (determinate and indeterminate).
1.5 Accuracy (Absolute and relative error)(Numericals)
1.6 Significant figures, mean, median, standard deviation (Numerical problems expected)

UNIT-2: Chromatography (20L)

2.1 Introduction to Basic principles of Chromatography, Basic terms, Classification of Chromatography
2.2 Paper chromatography- Principle, Methodology- types of paper and treatment, Sample loading, choice of solvent, development of ascending, descending, circular location of spots, determination of R_f value.
2.3 Thin layer chromatography; principle ,solvent system, stationary phases, preparation of TLC plate
2.4 Preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot, Rf value, Applications, advantages and disadvantages
2.5 Comparison of paper chromatography & TLC

UNIT-3: Theory of titrimetric Analysis (20L)

3.1 Acid-base indicators,Theory of indicators w.r.t. Ostwald's ionization theory and quinoid theory.
3.2 Neutralization curves and choice of indicators for Strong acid-strong base, Strong acid-weak base, Strong base-weak acid.
3.3 Complexometric titrations: Introduction, Types EDTA titrations, Metallochromic indicators- Eriochrome black- T, Indicator Action of Eriochrome black- T.
3.4 Physical analysis of water – pH, Conductance, Colour, odour, Turbidity and taste.
3.5 Chemical Analysis – Total Dissolved solids , Hardness, Salinity, Alkalinity, Acidity, Sulphates, Nitrates,Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand

Course Outcome (COs):

After examination the student should be able to:

1. Explain the theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration).

2. Various techniques within gravimetric and coulometric methods.
3. Explain the theoretical principles of selected instrumental methods within electroanalytical and spectrometric/spectrophotometric methods, and main components in such analytical instruments.

Reference Books

1. Textbook of quantitative Inorganic analysis-A.I. Vogel
2. Instrumental methods of Chemical analysis-H. Kaur
3. Instrumental methods of Chemical analysis-B.K. Sharma
4. Instrumental methods of Chemical analysis-Chatwal Anand

CHYB2021	Analytical Chemistry-I lab	0L:0T:4P	2 Credits

I. Separation Techniques by: Chromatography

(a) Separation and identification of the monosaccharide present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

(b)Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC Solvent Extractions: To separate a mixture of Ni2+& Fe2+ by complexation with DMG and extracting the Ni2+-DMG complex in chloroform, and determine its concentration by pectrophotometer.

II. Analysis of soil:

(i) Determination of pH of soil.

(ii) Estimation of calcium, magnesium, phosphate

III. Ion exchange: Determination of exchange capacity of cation exchange resins and anion exchange resins.

IV. Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometer.
2. Determination of chemical oxygen demand (COD).

SEMESTER III

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	CHYB3010	Organic Chemistry-II	4	0	0	30	70	100	4
DSC	CHYB3020	Analytical Chemistry-II	4	0	0	30	70	100	4
DSC	CHYB3030	Physical Chemistry-II	4	0	4	30	70	100	4
GE	**	Generic Elective -III	4	0	4	30	70	100	4
SEC	**	Skill Enhancement Courses -1	2	0	0	15	35	50	2
DSC	CHYB3011	Organic Chemistry-II Lab	0	0	4	15	35	50	2

DSC	CHYB3021	Analytical Chemistry-II Lab	0	0	4	15	35	50	2
DSC	CHYB3031	Physical Chemistry-II Lab	0	0	4	15	35	50	2
GE	**	Generic Elective -III Lab	0	0	4	15	35	50	2
		Total	**18**	**0**	**16**	**195**	**455**	**650**	**26**

CHYB3010	**Organic Chemistry-II**	**4L:0T:0P**	**4 Credits**

Course Objective:

1. To know about the concepts of stereochemistry.
2. To understand the difference between configuration and conformation.
3. To describe the structure and properties of various types of heterocyclic Compounds.
4. To describe the structure and properties of various types of Aromatic compounds Compounds

UNIT 1: Stereochemistry **(15L)**

1.1 Conformational isomerism – Introduction.

1.2 Representation of conformations of ethane by using Saw- Horse, Fischer (dotted linewedge) and Newmann's projection formulae.

1.3 Conformations and conformational analysis of ethane and n-butane by Newmann'sProjectionformula with the help of energy profile diagrams.

1.4 Cycloalkanes relative stability - Baeyer's strain theory, Theory of strainless rings.

1.5 Conformations and stability of cyclohexane and monosubstituted cyclohexane.

1.6 Locking of conformation in t-butyl cyclohexane.

1.7 Stereoselective and stereospecific reactions:

i)Stereochemistry of addition of halogens to alkenes: syn and anti addition.Example- Addition of bromine to 2-butene. (mechanism not expected) ii) Stereochemistry ofelimination reaction: syn and anti elimination.Example-Dehydrohalogenation of 1-bromo-1,2-diphenylpropane. (mechanism not expected)

UNIT 2: Polynuclear Hydrocarbons (15L)

2.1Napthalene - Source, synthesis from benzaldehyde and ethyl succinate (Fitting and Erdmann Synthesis), Haworth synthesis, structure of naphthalene, chemical reactions-Reduction,Oxidation, Sulphonation, Nitration, Halogenation, Chloromethylation, Friedel craft acylation, Friedel craft alkylation, preparation of naphthalene derivative, α-napthylamine, β- napthylamine, α-napthols, β-napthols.

2.2Anthracene :-Source and extraction,structure of Anthracene, synthesis from(a) benzene and methylene dibromide& acetylene tetrabromide (b) From napthaquinone and 1,3-butadiene Chemical reaction :- Reduction, Oxidation, Sulphonation, Nitration, Halogenation, Friedel craft acylation, Formylation by Vilsmeier – Hack method, Diels-Alderreaction,

2.3Phenanthrene – Synthesis of Phenanthrene 1) Haworth synthesis 2) Bardhan – Sengupta synthesis 3) Bogert – cook synthesis 4) pschorr synthesis

Unit 3: Study of Heterocyclic compounds. **(15L)**

3.1 Introduction and classification.

3.2Pyrrole :

Methods of synthesis from acetylene, from furan, from succinamide.

Physical properties; Reactivity of pyrrole -Basic character, Acidic character, Electrophilic substitution with general mechanism, Chemical reactions – Reduction, Oxidation, Nitration, sulphonation and halogenations, Friedel Craft's reaction, Coupling reaction.

3.3Pyridine :

Methods of synthesis- From acetylene and hydrogen cyanide, from piperidine; Physical properties; Chemical reactions - Basic character, Electrophilic substitution (Nitration, sulphonation & bromination)reactions, Nucleophilic substitution – General mechanism. Reactions with sodamide, sodium hydroxide and n-Butyl lithium.

3.4Quinoline:

Synthesis - Skraup's synthesis; Physical properties; Reactions of quinoline - Electrophilic substitution reactions - Nitration and sulphonation; Nucleophilic substitution reactions - Reactions with sodamide, alkylation and arylation; Reduction.

3.5 Indole:

Synthesis - Fischer Indole Synthesis; Physical properties; Chemical reactions- Elecrophilic substitution reactions (Nitration, bromination, Friedel Craft's acylation), diazo coupling, Mannich reaction, oxidation and reduction.

UNIT 4: Name Reactions

(15L) Introduction, Statement, General reaction, Important features, Mechanism and two Synthetic applications of following reactions.

4.1 Claisen Condensation
4.2 Perkin reaction
4.3 Mannich Reaction
4.4 Knoevengel Condensation
4.5 Reformatsky Reaction
4.6 Reimer-Tiemann Reaction
4.7 Clemmensen Reduction
4.8 Pinacol –Pinacolone rearrangement
4.9 Benzilic acid rearrangement
4.10 Benzidine rearrangement
4.11 Cannizzaro reaction

UNIT 5: Green Chemistry (15L)

5.1 Introduction
5.2 12 principles of green chemistry
5.3 Goals of green chemistry
5.4 Green chemicals - Green reagents, green catalyst , green solvents.
5.5 Green organic synthesis - Use of Zeolites , Natural catalysts, Biocatalysts.
5.6 Emerging green technologies-Microwave chemistry, Sonochemistry , Photochemistry,

Electrochemistry. Mechanochemistry.

5.7 Green synthesis – Polycarbonate , Carbaryl pesticide, Ibuprofen.

References :

1. Environmental chemistry by Dr.H.Kaur , 6th edition , page no. 669-691
2. Advances in green chemistry: chemical synthesis using MW irradiation by R.S.Varma
3. Green chemistry: Environment friendly alternatives by Rashmi Sanghi and M.M.Srivastava
4. Mechanism and Structure in Organic Chemistry. April,1963 By Edwin S. Gould
5. A text book of Organic Chemistry –Arun Bahl , B.S.Bhal 18th Revised edition 2006 .
6. A guidebook to mechanism in Organic Chemistry sixth Edition by Peter Sykes.
7. Advanced Organic Chemistry : Reactions, Mechanisms and structure by Jerry March.

Course Outcomes:

Students will gain an understanding of:

1. Reactivity patterns of conjugated and aromatic molecules
2. The fundamental electronic structure and bonding in carbonyl compounds
3. The fundamental electronic structure and bonding in Aromatic & Heterocyclic compounds

CHYB3011	**Organic Chemistry-IIlab**	**0L:0T:4P**	**2 Credits**

1. **Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.**

2. **Organic preparations:**

i. **Acetylation of one of the following compounds:** amines (aniline, o-, m-, ptoluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: a. Using conventional method. b. Using green approach

ii**. Benzolyation of one of the following amines** (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, pcresol) by Schotten-Baumann reaction.

iii. **Oxidation of ethanol/ isopropanol** (Iodoform reaction).

iv. **Bromination of any one of the following**: a. Acetanilide by conventional methods b. Acetanilide using green approach (Bromate-bromide method)\

v. **Nitration of any one of the following**: a. Acetanilide/nitrobenzene by conventional method b. Salicylic acid by green approach (using ceric ammonium nitrate). vi. Selective reduction of meta dinitrobenzene to m-nitroaniline. vii. Reduction of p-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides and esters.

ix. **Semicarbazone of any one of the following compounds**: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi. Aldol condensation using either conventional or green method. xii. Benzil-Benzilic acid rearrangement.

CHYB3020	Analytical Chemistry-II	4L:0T:0P	4 Credits

Course Objectives:

1. To introduce basic analytical techniques and practical aspects of classical chemical analysis.
2. To solve problems related to chemical analysis and interpret analytical results.
3. To understand the theory of gravimetric analysis
4. To learn quantitative analysis of Inorganic compounds.
5. To understand the theory conduct metric titration.

UNIT 1: Gravimetry **(15L)**

1.1 Introduction
1.2 precipitation
1.3 nucleation
1.4 crystal growth
1.5 digestion
1.6 Optimum conditions for good precipitation
1.7 Physical nature of precipitate
1.8 Co-precipitation
1.9 Post-precipitation
1.10 Role of organic precipitant in gravimetric analysis e.g. DMG, 8-hydroxy quinolone

UNIT 2: Inorganic qualitative analysis (15L)

2.1 Theoretical principles involved in qualitative analysis.
2.2 Applications of solubility product and common ion effect in separation of cations into groups.
2.3 Application of complex formation in

1. Separation of II group into IIA and IIB sub-groups.
2. Separation of Copper from Cadmium.
3. Separation of Cobalt from Nickel.
4. Separation of Cl-, Br –, I –.
5. Detection of NO_2^-, NO_3^- (Brown ring test).

2.4 Application of oxidation and reduction in

1. Separation of Cl^-, Br^-, I^- in mixture
2. Separation of NO_2^- and NO_3^- in mixture.

2.5 Spot test analysis.

UNIT 3: Conducto metric Titration (15L)

3.1 Introduction
3.2 Definition

3.3 Measurement of conductance by whistone bridge method
3.4 Direct reading
3.5 General procedure of conductometric titration
3.6 Different types of titrations
3.7 Strong acid vs strong base
3.8 Strong acid vs weak base
3.9 Weak acid vs strong base
3.10 Weak acid weak base
3.11 Cell constant
3.12 Types of cells

UNIT 4: Analysis of fertilizer(15L)
4.1 Introduction
4.2 Sampling and sample preparation
4.3 Analysis of nitrogen , phosphorous and potassium
4.4 Nitrogen : Determination of nitrogen by total Kjeldals method and Urea nitrogen method
4.5.Phosphrous: Total phosphrous available and non available alkalimetric ammonium molybdenum phosphate by sodium tetraphenyl borate method
4.6 Potassium: Potassium by sodium tetra phenyl borate method
4.7 To understand the theory fertilizer analysis.

Course Outcome:

1. Performing risk assessment of chemical experiments and chemical analytical activity.
2. Performing classical analytical experiments, and make observations and assessments of important factors that could affect the analytical result.
3. Be familiar with calculations in analytical chemistry, be able to calculate titration errors for method evaluation, and perform statistical evaluation of results from classical and instrumental chemical experiments and analyses.
4. Make scientific reports from chemical experiments and present the results in a transparent manner.

List of references:

1. Vogel's Text book of qualitative analysis, Revised edition by J. Barret
2. Instrumental methods of Chemical Analysis by H.Kaur 7th edition,
3. Analytical Chemistry, 6th edition by D. Cristen
4. Instrumental Methods of Chemical Analysis,(Recent edition 2012) by Gurudeep R. Chatawal .
5. Fundamentals of Analytical Chemistry , 6th edition , by D.A. Skoog
6. Basic Concept of Analytical Chemistry, 3rd edition, by S.M. Khopakar
7. A text Book of macro and Semi-micro Qualitative Analysis 5th edition by by A.I. Vogel's .
8. Essentional of Physical Chemistry, Revised edition 2012, by Bhal and Tuli,
9. Analytical Chemistry by B.K.Sharma , Krishna Prakashan Media Ltd, Meerut, edition3rd , 2011
10. Industrial Chemistry By R.K.Das, Part-II, Kalyani Publisher, Ludhiana ,New Delhi
11. Vogel's Text Book of Quantitative Analysis. By J Mendham, R.C. Denney,
12. J.D.Brames,M.Thomous,B.Sivasankar.
13. Industrial chemistry by B.K.Sharma , Goel Publishing Housing, 16th edition 2011

14. Progressive Inorganic Chemistry, 4th edition by T.S. Suratkar, M.M.Thatte and B.R.Pandit
15. Soil and Plant Testing by A. Cottenie

CHYB3021	Analytical Chemistry-IIlab	0L:0T:4P	4 Credits

I. Separation Techniques

1. Chromatography: (a) Separation of mixtures (i) Paper chromatographic separation of Fe3+, Al3+, and Cr3+. (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

(b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC II. Solvent Extractions:

(i) To separate a mixture of Ni2+ & Fe2+ by complexation with DMG and extracting the Ni2+- DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Solvent extraction of zisconium with amberliti LA-1, separation from a mixture of irons and gallium.

2. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

3. Determination of Na, Ca, Li in cola drinks and fruit juices using fame photometric techniques.

4. Analysis of soil: (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate

IIIon exchange:

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.

2 Structural characterization of compounds by infrared spectroscopy.

3 Determination of dissolved oxygen in water.

4 Determination of chemical oxygen demand (COD).

5 Determination of Biological oxygen demand (BOD).

6 Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

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. • Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

3) Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

4)Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.

5) Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.

6) Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London

CHYB3030	Physical Chemistry-II	4L:0T:0P	4 Credits

Course Objectives:

1. To understand laws of thermodynamics.
2. To know about the acid bases concept of Arrhenius, Lowry and Bronsted.
3. To discuss the conductance and transferences
4. To understand concepts about electrochemistry

UNIT 1: Electrochemistry (15L)

1.1: Introduction, Conduction of electricity, Types of conductors: Electronic and Electrolytic.

1.2: Explanation of the terms: Specific, equivalent and molar conductance, relation between specific and equivalent conductance, variation of conductance with dilution, equivalent conductance at infinite dilution.

1.3: Debye-Huckel theory of conductance of strong electrolytes, (relaxation effect, electrophoretic effect , Derivation not expected) Debye-Huckel limiting law (only equation and explanation of terms in it)

1.4: Migration of ions, Hittorf's rule, Transport number, Determination of transport number by moving boundary method, Factors influencing transport number (Nature of electrolyte, Concentration, Temperature, Complex formation, Abnormal transport number, Degree of hydration.)

1.5: Kohlrausch law and its applications: (i) Relationship between ionic conductance, ionic mobility and transport number. (ii) Determination of equivalent / molar conductance at infinite dilution for weak electrolytes. (iii) Determination of degree of dissociation.(iv) Determination of ionic product of water. (v) Determination of solubility and solubility product of sparingly soluble salts.

1.6: Buffer solution, acidic and basic buffers, Henderson's equation.

1.7: Numerical problems.

UNIT 2: Thermodynamics (15L)

2.1: Concept of entropy: Introduction, Definition, Mathematical expression, Unit, Physical significance of entropy.

2.2: Entropy changes for reversible and irreversible processes in isolated systems.

2.3: Entropy changes for an ideal gas as a function of V & T and as a function of P & T

2.4: Entropy change in mixing of gases.

2.5: Entropy change accompanying phase transitions: (i) Solid to liquid (ii) Liquid to vapor (iii) One crystalline form to another.

2.6: Third law of thermodynamics: statement, absolute entropy, determination of absolute entropy, entropy change in chemical reactions, standard entropy.

2.7: Numerical problems.

UNIT 3: Chemical Kinetics (15L)

3.1: Introduction, Third order reactions – derivation of rate constant, characteristics and examples of third order reaction.

3.2: Methods to determine order of reaction: i) Van't Hoff differential method ii) Integral rate expression method iii) Half life method

3.3: Effect of temperature on the rate of reaction: (i) Temperature coefficient, (ii) Arrhenius equation, (iii) Energy of activation.

3.4: Theories of reaction rate: (i) Collision theory, (only quantitative aspect, derivation not expected.) (ii) Transition state theory.

3.5: Numerical problems and NH4

UNIT 4: Physical properties of liquids(15L)

4.1: Classification of physical properties.

4.2: Surface tension and Chemical constitution, use of parachor in elucidating molecular structure.

4.3: Viscosity, coefficient of viscosity, determination of viscosity by Ostwald's Viscometer.

4.4: Refractive index, measurement of refractive index by Abbe's refractometer, specific and molecular refraction, molecular refractivity.

4.5: Numerical problems.

Course Outcome (COs):

Students will gain an understanding of:

1. The application of mathematical tools to calculate thermodynamics.
2. The relationship between microscopic properties of molecules with macroscopic thermodynamic observables
3. The derivation of rate equations from mechanistic data
4. The use of simple models for predictive understanding of physical phenomena associated to chemical thermodynamics and kinetics
5. The limitations and uses of models for the solution of applied problems involving chemical thermodynamic and kinetics.
6. Students learn depth concepts about electrochemistry.

Reference Books :

1. Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).

4. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
6. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010)

CHYB3031	Physical Chemistry-IIlab.	0L:0T:4P	2 Credits

1. Surface tension measurements. a. Determine the surface tension by (i) drop number (ii) drop weight method. b. Study the variation of surface tension of detergent solutions with concentration.
2. Viscosity measurement using Ostwald's viscometer. a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. b. Study the variation of viscosity of sucrose solution with the concentration of solute.
3. Indexing of a given powder diffraction pattern of a cubic crystalline system.
4. pH metry a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. b. Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide c. pH metric titration of
(i) strong acid vs. strong base,
(ii) weak acid vs. strong base.
5. Determination of dissociation constant of a weak acid.

Reference Books

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

SEMESTER IV

Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
CHYB4010	Inorganic Chemistry-II	4	0	0	30	70	100	4
CHYB4020	Physical Chemistry-III	4	0	0	30	70	100	4
CHYB4030	Organic Chemistry-III	4	0	0	30	70	100	4
**	Generic Elective -IV	4	0	0	30	70	100	4
**	Skill Enhancement Courses -2	2	0	0	15	35	50	2
CHYB4011	Inorganic Chemistry-II Lab	0	0	4	15	35	50	2
CHYB4021	Physical Chemistry-III Lab	0	0	4	15	35	50	2

CHYB4031	Organic Chemistry-III Lab	0	0	4	15	35	50	2
**	Generic Elective -IV Lab	0	0	4	15	35	50	2
	Total	**16**	**0**	**16**	**180**	**420**	**650**	**24**

CHYB4010	**: INORGANIC CHEMISTRY-II**	**4L:0T:0P**	**4 Credits**

Course Objectives:

1. To understand the key features of coordination compounds, including: - the variety of structures. - oxidation numbers and electronic configurations. - coordination numbers. - ligands, chelates. - bonding, stability of complexes.
2. To be able to use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds.
3. To be able to describe the shapes and structures of coordination complexes with coordination numbers ranging from 4 to 12.
4. To be able to describe the stability of metal complexes by the use of formation constants and to calculate thermodynamic parameters from them.

UNIT 1. Study d Block Elements **(15L)**

1.1 Introduction of'd' block elements

1.2 Study of transition elements with respect to electronic structure, coloured ions, magnetic properties character, oxidation states, and complex formation.

1.3 Chemistry of d block elements

UNIT 2: Study of 'f' block elements **(15L)**

A)Study of lanthanides.

2.1 Introduction

2.2 Properties of lanthanides with respect to

i.Electronic configuration.

ii.Oxidation state.

iii.Colour and spectra.

iv.Lanthanide contraction.

2.3 Methods of separation of lanthanides.

(Mention name only, separation of lanthanides by ion exchange method).

2.4 Isolation of f Block elements

UNIT 3: Co-ordination chemistry(15L)

3.1 Definition and formation of co-ordinate covalent bond in BF3 - NH3 and [NH4]*

3.2 Distinguish between double salt and complex salt

3.3 Werner's theory-

i.Postulates

ii.The theory as applied to cobalt amines viz. CoCl3.6H2O, CoCl3.5H2O, CoCl3. 4H2O, CoCl3. 3H2O

3.4 Description of the terms- ligands, co-ordination compounds

3.5 IUPAC nomenclature of coordination compound.

3.6 Valance bond theory of transition metal complex with respect to, C.N. = 4, C.N. = 6.

3.7 A brief introduction with respect to ligands, chelating agent chelation and metal chelate

3.8 Structural requirements of chelate formation

3.9 Difference between metal chelate and metal complex
3.10 Classification of chelating agents (with specific illustration of bidentate chelating agents)
3.11 Application of chelating with respect to chelating agents EDTA and DMG

UNIT 4: Catalysis(15L)
4.1 Introduction
4.2 Classification of catalytic reaction- Homogenous and Heterogeneous
4.3 Types of Catalysis
4.4 Characteristics of catalytic reactions
4.5 Mechanism of catalysis
i.Intermediate compound formation
ii.Adsorption
4.6 Industrial application of catalysts

Course Outcome
Students will gain an understanding of:

1. Predicting geometries of simple molecules
2. The fundamentals of the chemistry of the main group elements, and important real world applications of many of these species
3. The use of group theory to recognize and assign symmetry characteristics to molecules and objects, and to predict the appearance of a molecule's vibrational spectra as a function of symmetry
4. The bonding models, structures, reactivity's, and applications of coordination complexes, boron hydrides, metal carbonyls, and organometallics

References:

1. Inorganic Chemistry, Principles of structure and reactivity J. E. Huheey & etal.
2. Inorganic Chemistry-Shriver and Atkns, 5th Edition
3. Principles of Inorganic Chemistry by Puri, Sharma, Kalia
4. Advance Inorganic Chemistry by Agrawal, Keemtilal (Pragati Edition)
5. Theoretical Inorganic Chemistry 2nd Edition by C. Day and J. Selbin
6. Principles of Inorganic Chemistry by Puri, Sharma, Jauhar
7. Chemistry in Non – Aqueous Solvents by H. H. Sisler (Chapman and Hall Ltd.)
8. Modern Inorganic Chemistry by R. D. Madan (S. Chand)
9. Inorganic Chemistry by J. D. Lee
10. Basic Inorganic Chemistry by F. A. Cotton, G. Wilkinson and B. L. Gaus Wiley.
11. Concept and Models of Inorganic Chemistry by B. Douglas. D. Mc. Daniel and J. Alexander, John Wiley.

CHYB4011	INORGANIC CHEMISTRY-II lab.	0L:0T:4P	2 Credits

(A) Iodo / Iodimetric Titrations
(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.
(B) Inorganic preparations (i) Cuprous Chloride, Cu2Cl2 (ii) Preparation of Manganese(III) phosphate,

$MnPO_4.H_2O$ (iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

Reference Books:

1)Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS. 1978

CHYB4020	**Physical Chemistry-III**	**4L:0T:4P**	**4 Credits**

Course Objectives:

1. To understand the concept of black body radiations.
2. To understand the concept of wave functions.
3. To understand different properties of molecular structure.
4. To understand the basic principles of spectroscopy
5. To understand the basic features of spectroscopy.
6. To understand the Harmonic Oscillator

UNIT-1. Quantum Theory. (10L)

1.1 Introduction
1.2 Duel nature of matter and energy:- De Broglie hypothesis.
1.3 The Heisenberg's uncertainty principle.
1.4 Concept of energy operators (Hamiltonian).
1.5 Derivation of Schrodinger wave equation.
1.6 Physical interpretation of the ψ and $\psi 2$.
1.7 Particle in a one dimensional box.
1.8 Schrodinger wave equation for hydrogen atom.
1.9 Concept of Quantum numbers.

UNIT2: Spectroscopy (12L)

2.1 Introduction
2.2 Electromagnetic radiation.
2.3 Electromagnetic spectrum, Energy level diagram.
2.4 Rotational spectra of diatomic molecules: Rigid rotor model; moment of inertia (derivation expected); energy levels of rigid rotor, selection rules; spectral intensity; distribution using population distribution (Maxwell – Boltzman distribution),
2.5 vibration Spectroscopy
2.6 raman Specrtoscopy

UNIT– 3 Photochemistry (12L)

3.1 Difference between thermal and photochemical processes.
3.2 Laws of photochemistry :

1. Grotthus - Draper law,
2. Lambert law,
3. Lambert – Beer's law (with derivation),
4. Stark - Einstein law.

3.3 Quantum yield, Reasons for high and low quantum yield.

3.4 Factors affecting Quantum yield.
3.5 Photosensitized reactions – Dissociation of H2, Photosynthesis.
3.6 Photodimerisation of anthracene, decomposition of HI and HBr.
3.7 Photophysical and photochemical processes.
3.8 Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence.
3.9 Chemiluminescence, Electroluminescence.
3.10 Numerical problems.

UNIT 4.SOLUTIONS (12L)

4.1 Introduction
4.2 Ideal solutions, Raoult's law, vapour pressure of ideal and non ideal solutions of miscible liquids.
4.3 Composition of liquid and vapour, vapour pressure and boiling point diagrams of miscible liquids.
***Type I* :** Systems with intermediate total vapour pressure. (i.e. System in which b.p. increases regularly – Zeotropic)
***Type II* :** Systems with a maximum in the total vapour pressure. (i.e. System with a b.p. minimum – Azeotropic)
***Type III* :** Systems with a minimum in the total vapour pressure. (i.e. System with a b.p. Maximum – Azeotropic) Distillation of miscible liquid pairs.
4.4 Solubility of partially miscible liquids.
(i)Maximum solution temperature type : Phenol – water system.
(ii)Minimum solution temperature type : Triethyl amine – water system.
(iii)Maximum and minimum solution temperature type : Nicotine – water system.
Distillation of partially miscible liquid pairs.
4.5 Vapour pressure and distillation of immiscible liquids, steam distillation.

UNIT – 5. Electromotive force.(14L)

5.1 Introduction
5.2 Thermodynamics of electrode potentials, Nernst equation for electrode and cell potentials in terms of activities.
5.3 E.M.F. series.
5.4 Types of electrodes : Description in terms of construction, representation, half cell reaction andemf equation for
i. Metal – metal ion electrode.
ii. Amalgam electrode.
iii. Metal – insoluble salt electrode.
iv. Gas – electrode.
v. Oxidation – Reduction electrode.
5.5 Reversible and Irreversible cells.
i. Chemical cells without transference.
ii. Concentration cells with and without transference.
iii. Liquid – Liquid junction potential : Origin, elimination and determination.
5.6 Equilibrium constant from cell emf, Determination of the thermodynamic parameters such as G, H and S.
5.7 Applications of emf measurements :
i. Determination of pH of solution using Hydrogen electrode.
ii. Solubility and solubility product of sparingly soluble salts (based on concentration cell).

5.8 Numerical problems.

Course Outcomes:

1. 1.Able to recognize different regions for different spectroscopy.
2. Able to explain the concept of Electromagnetic Waves.
3. Able to explain the concept use in Black Body Radiation.
4. Able to calculate dipole moment in given molecules.
5. Able to use concept of polarizability.

Reference Books :

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton.
6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.

CHYB4021	**Physical Chemistry-IIILab.**	**0L:0T:4P**	**2 Credits**

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
2. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.
3. Distribution of acetic/ benzoic acid between water and cyclohexane.
4. Study the equilibrium of at least one of the following reactions by the distribution method: (i) I2 (aq) + I - → I3 - (aq)2+ (ii) Cu2+(aq) + nNH3 → Cu(NH3) n
5. Study the kinetics of the following reactions. 1. Initial rate method: Iodide-persulphate reaction 2. Integrated rate method: a. Acid hydrolysis of methyl acetate with hydrochloric acid. b. Saponification of ethyl acetate. 3. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.
6. Adsorption I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

CHYB4030	**Organic Chemistry-III**	**4L:0T:0P**	**4 Credits**

Course Objectives:

1. To understand the concept of Streochemistry
2. To understand the nomenclature.
3. To understand the reactivity of alcohols and phenols.
4. To understand the basic reactions of Nitrogen containing compounds.

UNIT 1 : Stereochemistry (12L)

1.1 Introduction, Geometrical isomerism in aldoximes and ketoximes. Configuration of ketoximes– Beckmann Transformation (Mechanism and proof not expected), configuration of aldoximes.
1.2 Conformational isomerism – Introduction, representation of conformations of ethane by using Saw-Horse, Fischer (dotted line wedge) and Newmann's projection formulae.
1.3 Conformations and conformational analysis of ethane and n-butane by Newmann's projection formula with the help of energy profile diagrams.
2.4 Nomenclature – D and L, R and S, E and Z systems.

UNIT 2 : Alcohols and Phenols (16L)

2.1 Alcohols : Introduction. 1) Dihydric alcohols : Nomenclature, methods of formation of (a) Ethylene glycol – from ethylene, ethylene dibromide and ethylene oxide.
2.2 Physical properties. Chemical reactions of ethylene glycol – acidic nature, reaction with hydrogen halide, Oxidation – Lead tetraacetate, HIO4 and Nitric acid. Uses of ethylene glycol.
2.3 Pinacol formation, Pinacol – pinacolone rearrangement and its mechanism. 2) Trihydric alcohols Nomenclature, methods of formation of glycerol – from fats and oils. Synthesis from elements carbon and hydrogen. Physical properties.
2.4 Chemical reactions of glycerol – reaction with electropositive metals, reaction with hydrogen halides (HCl & HI) Reaction with conc. Nitric acid in presence of conc. Sulphuric acid. Reactions with potassium hydrogen sulphate, Esterification and oxidation with Fenton's reagent. Uses of glycerol.
2.5 Phenols : Introduction, comparative acidic strength of alcohol and phenol. Reactions of phenol (carbolic acid) : (i) Acylation and Fries rearrangement, (ii) Ether formation and Claisen rearrangement (iii) Gatterman synthesis (iv) Carboxylation – Kolbe's reaction (v) Reimer – Tiemann reaction and its mechanism
2.6 Alcohol Introduction, Manufacture of ethyl alcohol from molasses.
2.7 Rectified spirit, Denatured spirit, absolute alcohol and power alcohol. By-products of alcohol industry

UNIT 3 : Aldehydes and Ketones (08L)

3.1 Introduction, Nomenclature, structure and reactivity of the carbonyl group.
3.2 Aldol condensation (base–catalysed) (with mechanism).
3.3 Perkin reaction, Mannich reaction, Cannizzaro reaction, Knoevengel condensation, Reformatsky reaction.

UNIT 4 : Ethers, Epoxides (12L)

4.1 Ethers : Introduction, Nomenclature, methods of formation of anisole by Williamson's synthesis and from diazomethane, chemical reactions of anisole with HI, Gravimetric estimation of –OCH3 group by Ziesel's method (Related problems are expected based on % of –OCH3 and no. of –OCH3 groups)

4.2 Crown ethers : Introduction and application.
4.3 Epoxides : Introduction, Nomenclature, commercial method of preparation of ethylene oxide. Acid and Base catalysed ring opening of ethylene oxide. Reactions of Grignard and organolithium reagents with ethylene oxide.

UNIT 5 : Nitrogen containing compounds (12L)

Aliphatic - Nitrogen containing compounds
5.1 Nitriles : Introduction. Method of preparations of alkanenitriles i) haloalkane ii) From alkali salts of sulphonic acid iii) From aldoxime iv) From Grignard reagent Chemical properties – i) Hydrolysis ii) Reduction iii) Addition of hydrogen halide iv) Reaction with Grignard reagent.
5.2 Isonitriles : Introduction. Method of preparations of alkaneisonitriles i) From haloalkane ii) From amine, Chemical properties – i) Hydrolysis ii) Reduction iii) Addition of hydrogen halide iv) Reaction with Grignard reagent.
5.3 Isocyanates : Introduction. Method of preparations of methylisocyanate from potassium cyanate and from phosgene. Chemical properties – i) Hydrolysis ii) Reaction with alcohol & phenol. iii) Reaction with NH3 iv) Trimerization.
5.4 Isothiocyanates : Introduction. Method of preparations of methylisothiocyanate From Hoffmann's mustard oil test and from sulphur and isonitrile Chemical properties – i) Hydrolysis ii) Halogenation iii) Reaction with amines. Aromatic - Nitrogen containing compounds
5.5 Introduction – Groups activating and deactivating Benzene ring.
5.6 Mechanism of electrophilic substitution reactions with respect to halogenation of nitrobenzene & aniline
5.7 Mechanism of nucleophilic substitution reactions with respect to alkylation of nitrobenzene & aniline.

Course Outcomes:

1. 1.Able to write streochemistry nomenclature.
2. Able to explain reactivity of alcohols & phenols.
3. Able to explain reactivity of ethers 5 epoxides.

Reference Books : Latest editions of following reference books.

1. Organic Chemistry. Volume 1 – The fundamental principles by I. L. Finar.
2. Organic Chemistry. Volume 2 – Stereochemistry and the chemistryof natural. Products by I. L. Finar, Low-priced Edn. ELBS - Longman
3. Organic Chemistry. Volume I, II, III by S.M. Mukharjee, S. P. Singh and R. P. Kapoor. Wiley
4. Eastern Limited.
5. Advanced Organic Chemistry, by B. S. Bahl, Arun Bahl. S. Chand & Company, Ltd.
6. Organic Chemistry by Morrison – Boyd.
7. A Text Book of Organic Chemistry by K. S. Tiwari. S. N. Meharotra. N. K. Vishnoi. Vikas Publication, Meerut.
8. Spectroscopic methods in Organic Chemistry by Williams and Fleming. Mc-Graw Hill.
9. Stereochemistry of Organic Compounds by E. L. Eliel. Orient Longman.
10. Stereochemistry of Organic Compounds by P. S. Kalsi. New Age International Ltd.
11. Shreve's Chemical Process Industries by George T Austin. Mc Graw Hill International Edn. 11.
12. Industrial Chemistry by Reigel. Asta Publishing House, Mumbai.

CHYB4031	Organic Chemistry-III lab.	0L:0T:4P	2 Credits

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books

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

B.Sc Chemistry Part-III
SEMESTER V

Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
CHYB5010	Inorganic Chemistry-III	4	0	0	30	70	100	4
CHYB5020	Physical Chemistry-IV	4	0	0	30	70	100	4
**	DSE-I	4	0	0	30	70	100	4
**	DSE-II	4	0	0	30	70	100	4
CHYB5011	Inorganic Chemistry-III Lab	0	0	4	15	35	50	2
CHYB5021	Physical Chemistry-IV Lab	0	0	4	15	35	50	2
**	DSE-I Lab	0	0	4	15	35	50	2
**	DSE-II Lab	0	0	4	15	35	50	2
	Total	16	0	16	180	420	600	22

CHYB5010	Inorganic Chemistry-III	4L:0T:0P	4Credits

Objectives.Course

To understand the concepts of metal ligand bonding in transition complex compounds

1. To understand the concepts of soft & hard acids & Bases.
2. To understand the thermodynamics and kinetic aspects of metal complexes.
3. To understand the nomenclature, classification, properties and preparations of coordination compounds.
4. To understand the chemistry of organometalic compounds, homogenous hydrogenation and carbonyls.

5. To understand the bioinorganic chemistry of hemoglobin, myoglobin etc.
6. 6.To understand the difference between conductor, semiconductor & superconductor.

UNIT 1.Hard and Soft Acids and Bases (HSAB).(12L)
1.1 Classification of acids and bases as hard and soft.
1.2 Theoretical bases of hardness and softness
1.3 Pearson's HSAB concept.
1.4 Acid – Base strength and hardness and softness.
1.5 Application and limitations of HSAB principle.

UNIT 2. Metal ligand bonding in Transition metal complexes (12L)
2.1 Isomerism in complexes with C.N.-4 and 6 2.1.1 Geometrical Isomerism
2.1.2 Optical Isomerism
2.1.3 Structural Isomerism-Ionisation Isomerism,Hydrate Isomerism, Coordination Isomerism,Linkage Isomerism and Co-ordination position Isomerism
2.2 Molecular orbital theory (MOT).
2.2.1 Introduction.
2.2.2 MOT of octahedral complexes with sigma bonding such as [Ti(H2O)6]3+, [Ni(NH3)6]2+, [CoF6]3–, [Co(NH3)6]3+.
2.2.3 Merits and demerits of MOT

UNIT 3. Inorganic Polymers. (12L)
3.1 Introduction.
3.2 Basic concept and definition.
3.3 Classification of polymers - Organic and Inorganic polymers.
3.4 Comparison between organic and inorganic polymers.
3.5 Polymer back bone.
3.6 Homoatomic polymer containing – (i) Phosphorus. (ii) Fluorocarbons.
3.7 Heteroatomic polymers -
(i) Silicones (ii) Phosphonitrilic compounds.

UNIT 4. Metals, Semiconductors and Superconductors.(12L)
4.1 Introduction.
4.2 Properties of metallic solids.
4.3 Theories of bonding in metal. i) Free electron theory.
ii) Molecular orbital theory (Band theory).
4.4 Classification of solids as conductor, insulators and semiconductors on the basis of band theory.
4.5 Semiconductors. Types of semiconductors - intrinsic and extrinsic semiconductors. Applications of semiconductors.
4.6 Superconductors: Ceramic superconductors - Preparation and structures of mixed oxide YBa2Cu3O7 – *x*
4.7 Applications of superconductors.

UNIT 5. Organometallic Chemistry. (12L)
5.1 Definition, Nomenclature of organometallic compounds.

5.2 Synthesis and structural study of alkyl and aryl compounds of Li, Be and Al.
5.3 Mononuclear carbonyl and nature of bonding in simple metal carbonyls.
5.4 Carbonyl Clusters, Metal carbonyls of Fe,Co,Rh,Os etc

Course Outcomes

After the completion of the course, Students will be able to

1. Recognize the bonding in transition compounds by VBT and CFST theories.
2. Able to predict the geometry of coordination compounds and type of hybridization.
3. Able to determine the properties and preparations of Li, Al, Hg, Sn, Ti etc. metal compounds.
4. Able to recognize the biological reaction alkali and alkaline earth metals, nitrogen fixation, hemoglobin and myoglobin.

Reference Books

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4th Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3rd Edition. John Wiley publication.
6. Fundamental concepts of Inorganic Chemistry by E. S. Gilreath.
7. Structural principles in inorganic compounds. W. E. Addison.
8. T. B. of Inorganic analysis – A. I. Vogel.
9. Theoretical principles of Inorganic Chemistry – G. S. Manku.
10. Theoretical Inorganic Chemistry by Day and Selbine.

CHYB5011	Inorganic Chemistry-III	0L:0T:4P	2 Credits

1) Gravimetric Analysis

a. Gravimetric estimation of iron as Fe_2O_3 from a solution containing Ferrous ammonium sulphate and free sulphuric acid.
b. Gravimetric estimation of barium as $BaSO_4$ from a solution containing barium chloride and free hydrochloric acid.

2) Titrimetric Analysis :

(Calibration of burette, pipette and volumetric flask is essential)

a. Fertilizer analysis : To determine percentage of nitrogen in the given sample of a nitrogenous fertilizer (ammonium sulphate). Known weight of the sample to be taken by the student. For preparing its solution which is to be refluxed with known excess of alkali. Standard HCl solution to be supplied.
b. Quality control : To determine percentage purity of a given sample of soda ash. Standard HCl solution to be supplied. Known weight of the sample to be taken by the student for preparing its solution.
c. Determination of total hardness of water using 0.01M EDTA solution.
d. (Students should standardise the given EDTA solution by preparing 0.01M $CaCl_2$ solution. using $CaCO_3$ salt.)

e. Determination of alkali content of antacid tablet using HCl.(Note : These experiments are performed by preparing calibrated sets of burettes, pipettes and volumetric flasks.)

3) Inorganic Preparations

a. Preparations of Ferrous ammonium sulphate (Mohr's salt)
b. Preparation of Tetrammine copper (II) sulphate.

4) Semi-micro qualitative analysis

Analysis of binary mixtures with non interfering cations and anions (at least 6 mixtures to be analyzed)
i. Following anions are to be given :
Cl–, Br–, I–, NO3–, CO3– –, SO4– – (Only insoluble carbonates are to be given)
ii.Following cations are to be given : Cu+2, Cd+2Al+3, Fe+3, Cr+3.Zn+2, Mn+2, Ni+2, Co+2. Ca+2, Ba+2.Mg+2. NH4+, K+ .
Note:-Use of spot tests to be made whenever possible.

Reference Books :

1. Qualitative Inorganic Chemistry by A. I. Vogel.
2. Quantitative Inorganic Chemistry by A. I. Vogel.
3. Physical Chemistry of Inorganic qualitative analysis by Kuricose & Rajaram.
4. Practical manual in water Analysis by Goyal & Trivedi.
5. Basic Concepts in Analytical Chemistry by S. M. Khopkar. Wiley Eastern Ltd.
6. Practical Chemistry, Physical – Inorganic – Organic and Viva voce by Balwant Rai Satija. Allied Publishers Private Limited.
7. College Practical Chemisty by H. N. Patel, S. R. Jakali, H. P. Subhedar, Miss. S. P. Turakhia. Himalaya Publishing House, Mumbai.
8. College Practical Chemistry by Patel, Jakali, Mohandas, Israney, Turakhia.
9. Himalya Publishing house.
10. Experiments in General Chemistry by C. N. R. Rao. Affiliated East –West Press Private Ltd., Delhi.

CHYB5020	**Physical Chemistry-IV**	**4L:0T:4P**	**6 Credits**

Course Objectives:

1.To understand thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials.
2. To understand Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law
3. To understand the concept of equilibrium constant, free energy, chemical potential
4. To understand the Nernst distribution law – its thermodynamic derivation, modification of distribution law when solute undergoes dissociation, association and chemical combination. Applications of distribution law
5. To understand the determination of degree of hydrolysis and hydrolysis constant of aniline hydrochloride

UNIT 1. Phase Equilibria.(12L)

1.1 Introduction
1.2 Gibbs phase rule : Phase rule equation and explanation of terms involved in the
1.3 Phase diagram, true and metastable equilibria.
1.4 One component systems: (i) Water system (ii) Sulphur system with explanation for polymorphism.

1.5 Two component systems:

(i) Eutectic system: (Ag – Pb system); Desilverisation of lead,

(ii) Freezing mixture: (KI –H_2O system),

(iii) Formation of compound with congruent melting point (FeCl3 – H2O)

1.5 Three component solid-liquid system:

Development of triangular phase diagram: (Acetic acid – Chloroform –water system).

UNIT 2. Thermodynamics. **(12L)**

2.1 Introduction

2.2 Free energy : Gibbs function (G) and Helmholtz function (A), Criteria for thermodynamic equilibrium and spontaneity.

2.3 Relation between _G and _H : Gibbs Helmholtz equation.

2.4 Phase equilibria : Clapeyron – Clausius equation and its applications.

2.5 Thermodynamic derivation of law of mass action, van't – Hoff isotherm and isochore.

2.6 Fugacity and activity concepts.

2.7 Partial molar quantities, Partial molar volume, Concept of chemical potential, Gibbs-Duhem equation.

2.8 Numerical problems.

UNIT 3. The solid state(12L)

3.1 Introduction,Space lattice, lattice sites, Lattice planes, Unit cell.

3.2 Laws of crystallography :

(i)Law of constancy of interfacial angles

(ii)Law of rational indices

(iii)Law of crystal symmetry.

3.3 Weiss indices and Miller indices.

3.4 Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacing of lattice planes.

3.5 Diffraction of X-rays, Derivation of Bragg's equation.

3.6 Determination of crystal structure by Bragg's method.

3.7 Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation.

3.8 Numerical problems.

UNIT 4. Radioactivity **(12L)**

4.1 Introduction.

4.2 Detection and measurement of nuclear radiation by Scintillation and Geiger Muller counter methods.

4.3 Radioactive equilibrium and range of α - particles.

4.4 Geiger – Nuttal relation, Determination of radioactive constant (decay constant).

UNIT 5. Chemical Kinetics(12L)

5.1 Introduction

5.2 Simultaneous reactions such as

i)opposing reaction: (Derivation of rate equation for first order opposed by first order expected, Numerical problems expected),

ii)side reaction:,

iii)consecutive reactions: (Derivation of rate equation and Numerical problems are not

expected).

Course Outcomes:

After the completion of the course, Students will be able to

1. Recognize the basic terms of thermodynamic.
2. Able to predict the energy change in heat capacities at constant volume and pressure and their relationship.
3. Able to drive Joule's law and its application.
4. Able to derive relationship between modification of distribution law when solute undergoes dissociation
5. Able to recognize the degree of hydrolysis and hydrolysis constant of aniline hydrochloride.

Reference Books: (Use recent editions)

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
6 Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition

CHYB5021	**Physical Chemistry-IV**	**0L:0T:4P**	**2 Credits**

[A]Instrumental

1. Viscosity :

To determine the percentage composition of a given liquid mixture by viscosity method. (Density data to be given).

2. Refractometry :

To determine the specific and molar refractions of benzene, toluene and xylene by Abbe's refractometer and hence determination of the refraction of -CH2- group (Methylene group). (Densities should be determined by students.)

3. Polarimetry :

To determine the specific rotation and unknown concentration of sugar solution.

4.Conductometry:

(i)To determine degree of dissociation and dissociation constant of acetic acid at various dilutions and to verify Ostwald's dilution law conductometrically.

(ii)To determine the normality of the given strong acid by titrating it against strong alkali conductometrically.

(iii)To determine equivalent conductance at infinite dilution of strong electrolyte (any one from KCl, NaCl, KNO3 and HCl) and verify Onsager equation. (Taking five different dilutions)

5.Surface Tension:

To determine surface tension of a liquid by using stalagmometer.

[B]Non - Instrumental 1. Chemical Kinetics

1.To study the hydrolysis of methyl acetate in presence of HCl and H2SO4 and to determine the relative strength of acids.
2.To study the effect of acid strength (0.5 M and 0.25 M HCl) on hydrolysis of an ester.
3.To study the reaction between K2S2O8 and KI (unequal concentrations)

Reference Books:

1. Experimental Physical Chemistry by A. Findlay.*(Longman.)*
2. Advanced Practical Physical Chemistry by J.B. Yadav.*(Goel Publishing house, Meerut.)*
3. Experiments in Physical Chemistry by R. C. Das and B. Behra.*(Tata Mc Graw Hill.)*
4. Advanced experimental Chemistry Vol. I. Physical by J. N. Gurtu and R. Kapoor.
1. Practical book of Physical Chemistry – by Nadkarni Kothari & Lawande. (Bombay Popular
2. Prakashan.)
3. Systematic Experimental Physical Chemistry – by S. W. Rajbhoj, Chondhekar.*(Anjali Publication.)*
4. Practical Physical Chemisty – by B. D. Khosala & V. C. Garg. R.*(S.Chand & Sons.)*
5. Experiments in Chemistry by D. V. Jagirdar.
6. Practical Chemistry, Physical – Inorganic – Organic and Viva – voce by Balwant*Rai Satija.(Allied*
7. *Publishers Pvt. Ltd.)*
8. College Practical Chemistry by Patel, Jakali, Mohandas, Israney, Turakhia. (Himalaya Publishing
9. Housing, Mumbai.)

Teaching & Evaluation Scheme
SEMESTER VI

Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
CHYB6010	Inorganic Chemistry-IV	4	0	0	30	70	100	4
CHYB6020	Organic Chemistry-IV	4	0	0	30	70	100	4
**	DSE-III	4	0	0	30	70	100	4
**	DSE-IV	4	0	0	30	70	100	4
CHYB6011	Inorganic Chemistry-IV Lab	0	0	4	15	35	50	2
CHYB6021	Organic Chemistry-IV Lab	0	0	4	15	35	50	2
**	DSE-III Lab	0	0	4	15	35	50	2
**	DSE-IV Lab	0	0	4	15	35	50	2
	Total	16	0	16	180	420	600	22

CHYB6010	**Inorganic Chemistry-IV**	**4L:0T:0P**	**4 Credits**

Course objectives

1. To understand the role of metal ions in biological system.
2. To understand the role of metal ions in oxygen transport.
3. To understand the concept of acid and bases.

4. To understand the uses of inorganic polymers.
5. To understand the nature of bonding of different metals with carbon atom.

UNIT-1: Inorganic Reaction Mechanism(12L)

1.1 Introduction
1.2 Classification of Mechanism,Association, dissociation, interchange and the rate determining steps
1.3 SN1 and SN2 reaction for inert and labile complexes
1.4 Mechanism of substitution in cobalt (III) octahedral complexes
1.5 Trans effect and its theories
1.6 Applications of trans effect in synthesis of Pt (II) complexes.

UNIT 2. Thermodynamic and Kinetic aspects of metal complexes.(12L)

2.1 Introduction
2.2 Thermodynamic stability
2.3 Kinetic Stability
2.4 Relation between thermodynamic and kinetic stability
2.5 Step wise stability constant
2.6 Factor affecting the stability of complexes

UNIT 3. A. Nuclear Chemistry (16L)

3..1 Nuclear reactions and energetic of nuclear reactions.
3.2 Types of nuclear reactions-
1. Artificial transmutation.
2. Artificial radioactivity.
3. Nuclear fission and its application in Heavy water nuclear reactor.
4. Nuclear fusion.

3.3 Applications of radio-isotopes as tracers.
1. Chemical investigation – Esterification.
2. iStructural determination – Phosphorus pentachloride.
3. Analytical Chemistry – Isotopic dilution method for determination of volume of blood.
4. Age determination – Dating by C14.

B. Actinides

3.4 Position in periodic table.
3.5 Electronic configuration.
3.6 General methods of preparation of Transuranic elements.
1. Neutron capture – followed by β decay.
2. Accelerated projectile bombardment.
3. Heavy ion bombardment.

3.7 IUPAC nomenclature of the super heavy elements with atomic number (Z) greater than 100.

UNIT 4. Iron and Steel (8L)

4.1 Occurrence,Extraction of iron by Blast furnace,Steel: Definition and types.
4.2 Conversion of cast iron into steel byi)Bessemer process.ii)L.D. process.

4.3 Heat treatment on steel.

UNIT 5. Bio-inorganic Chemistry **(12L)**

5.1 Introduction.
5.2 Essential and trace elements in biological process.
5.3 Metalloporphyrins with special reference to hemoglobin and myoglobin.
5.4 Biological role of alkali and alkaline earth metal ions with special reference to Na+, K+ and Ca2+

Course Outcomes

1. Students are able to describe role of different metal ions in biological system.
2. Students are able to recognize role of porphyrin ring in haeomoglobin.
3. Students are able to count total of electrons in organometallic compound.
4. Students come to know about uses of different inorganic polymers in making of tyres, toys, plastics bags.
5. Students are able to name different organometallic compounds.

Reference Books: (Use recent editions)

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Lang Ford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4th Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3rd Edition. John Wiley publication.
6. Structural principles in inorganic compounds. W. E. Addison.
7. Theoretical principles of Inorganic Chemistry – G. S. Manku.
8. Theoretical Inorganic Chemistry by Day and Selbine.
9. Co-ordination compounds. SFA Kettle.
10. Essentials of Nuclear Chemistry by H. J. Arnikar.
11. Nuclear Chemistry by M. N. Sastri
12. Organometallic Chemistry by R. C. Mahrotra A. Sing, Wiley Eastern Ltd. New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addision – Wisley Longman – Inc.
14. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
15. 15.Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing

CHYB6011	Inorganic Chemistry-IV lab	0L:0T:4P	2Credits

1) Gravimetric Analysis

c. Gravimetric estimation of iron as Fe2O3 from a solution containing Ferrous ammonium sulphate and free sulphuric acid.
d. Gravimetric estimation of barium as BaSO4 from a solution containing barium chloride and free hydrochloric acid.

2) Titrimetric Analysis :

(Calibration of burette, pipette and volumetric flask is essential)

f. Fertilizer analysis : To determine percentage of nitrogen in the given sample of a nitrogenous fertilizer (ammonium sulphate). Known weight of the sample to be taken by the student. For preparing its solution which is to be refluxed with known excess of alkali. Standard HCl solution to be supplied.
g. Quality control : To determine percentage purity of a given sample of soda ash. Standard HCl solution to be supplied. Known weight of the sample to be taken by the student for preparing its solution.
h. Determination of total hardness of water using 0.01M EDTA solution.
i. (Students should standardise the given EDTA solution by preparing 0.01M $CaCl_2$ solution. using $CaCO_3$ salt.)
j. Determination of alkali content of antacid tablet using HCl.(Note : These experiments are performed by preparing calibrated sets of burettes, pipettes and volumetric flasks.)

3) Inorganic Preparations

c. Preparations of Ferrous ammonium sulphate (Mohr's salt)
d. Preparation of Tetrammine copper (II) sulphate.

4) Semi-micro qualitative analysis

Analysis of binary mixtures with non interfering cations and anions (at least 6 mixtures to be analyzed)
i. Following anions are to be given :Cl^-, Br^-, I^-, NO_3^-, CO_3^{--}, SO_4^{--} (Only insoluble carbonates are to be given)
ii.Following cations are to be given : Cu^{+2}, Cd^{+2}.Al^{+3}, Fe^{+3}, Cr^{+3}.Zn^{+2}, Mn^{+2}, Ni^{+2}, Co^{+2}. Ca^{+2}, Ba^{+2}.Mg^{+2}. NH_4^+, K^+ .

Note:-Use of spot tests to be made whenever possible.

11. Reference Books :

12. Qualitative Inorganic Chemistry by A. I. Vogel.
13. Quantitative Inorganic Chemistry by A. I. Vogel.
14. Physical Chemistry of Inorganic qualitative analysis by Kuricose & Rajaram.
15. Practical manual in water Analysis by Goyal & Trivedi.
16. Basic Concepts in Analytical Chemistry by S. M. Khopkar. Wiley Eastern Ltd.
17. Practical Chemistry, Physical – Inorganic – Organic and Viva voce by Balwant Rai Satija. Allied Publishers Private Limited.
18. College Practical Chemisty by H. N. Patel, S. R. Jakali, H. P. Subhedar, Miss. S. P. Turakhia. Himalaya Publishing House, Mumbai.
19. College Practical Chemistry by Patel, Jakali, Mohandas, Israney, Turakhia.
20. Himalya Publishing house.
21. Experiments in General Chemistry by C. N. R. Rao. Affiliated East –West Press Private Ltd., Delhi.

CHYB6020	**Organic Chemistry-IV**	**4L:0T:4P**	**6 Credits**

Course objectives

1. To understand the mechanism of name reactions
2. To understand the role of reagent in chemical synthesis.

3. To understand the mechanisms of electrophilic substitution reactions .
4. To understand the synthesis of Natural products.

UNIT 1. Name reactions (12L)

Statement, General Reaction, Mechanism and Synthetic applicationsDiels -Alder reaction,Oppenauer Oxidation, Meerwein –Pondorff-Verley reduction,Schmidt rearrangement ,Hofmann rearrangement, Wittig reaction,Wagner- Meerwein rearrangement, Favorskii rearrangement,Michael reaction, Dieckmann's reaction or condensation ,Problem based on above reactions.

UNIT 2. Reagents in Organic Synthesis (12L)

Preparation and Applications of following reagents

1. Lithium aluminium hydride LiAlH4
2. Osmium tetraoxide
3. Dicyclohexyl Carbodiimide
4. Raney Nickel
5. 2,3-Dichloro -5,6-dicyano – 1,4-benzoquinone (DDQ)
6. Polyphosphoric acid (PPA)
7. Diazomethane
8. Cerric ammonium nitrate (CAN)
9. N-Bromosuccinamide (NBS)
10. Selenium dioxide (SeO2)

UNIT 3. Electrophilic addition to >C=C< bond and TRIPLE BOND (12L)

3.1 Addition to Carbon-Carbon double bond (>C=C<) : Introduction, Examples of addition reactions, Mechanism of electrophilic addition to >C=C< bond, Hydrohalogenation:-orientation & reactivity, Anti-Markovnikoff's addition (peroxide effect), Rearrangements (support for formation of carbocation), Addition of halogens, Addition of water, Addition of hypohalous acids (HO-X), Hydroxylation (formation of 1,2-diols),
Hydroboration-oxidation (formation of alcohol), Hydrogenation (formation of alkane), Ozonolysis (formation of aldehydes & ketones).
3.2 Addition to Carbon-Carbon triple bond : Introduction, Examples ofaddition reactions, Mechanism of electrophilic addition to bond. Addition of halogens, Addition of halogen acids, Addition of hydrogen, Addition of water, Formation of metal acetylides.

UNIT 4. Natural Products (12L)

A] Terpenoids

1.Introduction, Occurrence, Isolation, General Characteristic, Classification. 2.General Methods for structure determinations
3.Isoprene rule.
4.Analytical evidences and synthesis of Citral and alpha-terpineol.

B] Alkaloid:

1.Introduction, Occurrence, Isolation, Classification, Properties.
2.General Methods for structure determinations
3.Analytical evidences and synthesis of and Nicotine

UNIT 5. Pharmaceuticals **(12L)**

1.Introduction, Classification, Qualities of ideal drug.

2.Synthesis and uses: ethambutal, phenobarbitone, isoniazide, benzocaine, Chloramphenicol, paludrine.

3.Drug action of sulpha drugs.

Course outcomes:

1. students are able to understand mechanisms of the name reactions.
2. students are able to understand the synthesis of Natural products.
3. students are able to understand the synthesis of Pharmaceuticals

References :

1. Organic Chemistry Vol 2, Stereochemistry and the Chemistry of Natural Products (5thed) by I L Finar
2. Organic Chemistry Natural Products Vol I, by O P Agrawal
3. Advanced Organic Chemistry : Reactions, Mechanisms and structure by – Jerry March
4. Reagents for Organic Synthesis by Louis F. Fieser , Mary Fieser - 1967
5. A Text book of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur I Vogel.
6. Mechanism and Structure in Organic Chemistry. April,1963 By Edwin S.Gould
7. A text book of Organic Chemistry by Arun Bahl , B.S.Bhal Eighteenth Revised edition 2006 .
8. A guidebook to mechanism in Organic Chemistry sixth Edition by Peter Sykes.
9. Advanced Organic Chemistry : Reactions, Mechanisms and structure by Jerry March.
10. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut
11. Shreeves chemical process industries 5th Edition, G.T. Oustin, Mc Graw Hill
12. Riegel`s hand book of Industrial chemistry, 9th Edition, Jems A. Kent
13. Industrial chemistry –R.K. Das, 2nd Edition, 1976.

CHYB6021	Organic Chemistry-IV lab	0L:0T:4P	2 Credits

I) Qualitative analysis

Separation of binary mixture and Identification of its components. At least 08 mixtures are to be separated & identified.

Nature 1. Solid – Solid : 4 mixtures
2. Solid – Liquid : 2 mixtures
3. Liquid – Liquid : 2 mixtures

1) Solid – Solid Mixtures:
One mixture from each the following types should be given:
i. Acid + Phenol ii. Acid + Base
iii. Acid + Neutral iv. Phenol + Base
v. Phenol + Neutral vi. Base + Neutral

2) Solid – Liquid Mixtures
Mixture of type Neutral + Neutral or Acid + Neutral should be given.

3) Liquid – Liquid Mixtures
Mixture of type Neutral + Neutral or Base + Neutral should be given.
Following compounds should be used for preparation of mixtures

Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.
Phenols: α-naphthol, β-naphthol
Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, N- dimethyl aniline.
Neutrals: Anthracene, acetanilide, m-dintrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea and thiourea.
NB :
1.For Solid-Liquid and Liquid-Liquid mixtures avoid detection of type of mixture. Instead the weightage is given to detection of nature and separation of mixture.
2.Separation and qualitative analysis of the binary Mixtures should be carried out on microscale using microscale kits.

II)Quantitative analysis: Organic estimations:

1. Estimation of sucrose
2. Saponification value of oil.
3. To determine the amount of acid and ester present in the given mixture of acid and ester.
4. Determination of Molecular weight of monobasic/dibasic acid by volumetric method.
5. Estimation of unsaturation –to estimate the percentage purity of given olefinic compound by bromination method.

Note: Double burette method should be used for titration.

III)Organic Preparations: (Any four)

1.Multicomponent reaction - Preparation of Dihydropyrimidone.
2.Radical coupling reaction - Preparation of 1,1,2 bis-2 naphthol.
3.Base catalyzed Aldol condensation- Preparation of Dibenzalpropanone.
4.Diels Alder reaction- Reaction between Furan and Maleic acid
5.Benzil-Benzilic acid rearrangement reaction.
6.Electrophilic aromatic substitution reaction- Bromination of Acetanilide by KBr and Cerric Ammonium Nitrate.

IV) Preparation of Derivatives:

1. Benzoyl derivative (β-naphthol and aniline).
2. Picrate derivative (anthracene and β-naphthol).
3. Iodoform (Acetone).
4. Osazone of Carbohydrates (Glucose).
5. Oxalate derivative (of Urea).
6. 2,4-Dinitro phenyl hydrazone (carbonyl compounds)

Oxime derivatives (carbonyl compounds)

LIST OF GENERAL ELECTIVE SUBJECTS

List of Generic Electives Available for students of B.Sc. (Hons.) CHEMISTRY

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	Mathematics	MTHB1010	Algebra	5-1-0	6
II	Mathematics	MTHB2010	Differential Calculus & Vector Calculus	5-1-0	6

III	Mathematics	MTHB3010	Differential Equation	5-1-0	6
IV	Mathematics	MTHB4010	Numerical Analysis	4-1-1	6
I	Physics	PHYB1010+PHYB1011	Mechanics	4-0-4	6
II	Physics	PHYB2010+PHYB2011	Thermal Physics	4-0-4	6
III	Physics	PHYB3010+PHYB3011	Waves and Optics	4-0-4	6
IV	Physics	PHYB4010+PHYB4011	Elements of Modern Physics	4-0-4	6
I	Botany	MCRB1010+ MCRB1011	Microbiology and Phycology	4-0-4	6
II	Botany	BOTB2010+ BOTB2011	Diversity of Archaegoniates&Plant Anatomy	4-0-4	6
III	Botany	BOTB3020+ BOTB2021	Economic botany	4-0-4	6
IV	Botany	BOTB4020+ BOTB4021	Phytogeography	4-0-4	6
I	Zoology	ZOOB1010+ ZOOB1011	Non-Chordates	4-0-4	6
II	Zoology	ZOOB2010+ ZOOB2011	Chordates	4-0-4	6
III	Zoology	ZOOB3010+ ZOOB3011	Animal Physiology: Controllong and coordinating system	4-0-4	6
IV	Zoology	BCHB4210+ BCHB4211	Biochemistry of Metabolic Processes	4-0-4	6

MATHEMATICS

MTHB1010	**Algebra**	**5L:1T:0P**	**6 Credits**

Course objectives:

The objectives of this course are

1. To understand the students concept of complex number.
2. To make student learn of set & functions.
3. To familiarize students with system of linear equations.
4. To impart the knowledge of linear transformation& eigen values,eigen vectors .

Unit 1: **Complex Number** L:15

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rationalindices and its applications.

Unit 2:**Set & Functions: L : 20**

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit 3: **Systems of linear equations:** L:20

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence

Unit 4: **Linear transformations:** L: 20

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Text /Reference Books:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**
3. David C. Lay, Linear Algebra and its Applications,3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand and apply the complex number in problems.
2. understand the concept of set & functions & how to solve the problems .
3. How to solve linear equations using matrix.
4. Understand the concept of linear transformations.

MTHB2010	**Differential Equation**	**5L:1T:0P**	**6 Credits**

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of Differential Equations, Mathematical Modeling and their applications.

Unit 1: **Differential Equations and Mathematical Modeling:** L:12

Differential equations and mathematical models, Order and degree of a differential equation, Exact differential equations and integrating factors of first order differential equations, Reducible second

order differential equations, Application of first order differential equations to equations to acceleration-velocity model, Growth and decay model.

Unit 2: **Population Growth Models:** L:16
Introduction to compartmental models, Lake pollution model (with case study of Lake Burley Griffin), Drug assimilation into the blood (case of a single cold pill, case of a course of cold pills, case study of alcohol in the bloodstream), Exponential growth of population, Limited growth of population, Limited growth with harvesting.

Unit 3: **Second and Higher Order Differential Equations:** L:16
General solution of homogeneous equation of second order, Principle of superposition for a homogeneous equation; Wronskian, its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, Method of undetermined coefficients, Method of variation of parameters, Applications of second order differential equations to mechanical vibrations.

Unit 4: **Analysis of Mathematical Models:** L:12
Interacting population models, Epidemic model of influenza and its analysis, Predator-prey model and its analysis, Equilibrium points, Interpretation of the phase plane, Battle model and its analysis.

Course Learning Outcomes: The course will enable the students to:
1. Formulate Differential Equations for various Mathematical models.
2. Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
3. Apply these techniques to solve and analyze various mathematical models.

Text /Reference Books:

1. 1. Barnes, Belinda & Fulford, Glenn R. (2015). *Mathematical Modelling with Case Studies, Using* Maple *and* MATLAB (3rd ed.). CRC Press, Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equation and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
3. Ross, Shepley L. (2004). *Differential Equations* (3rd ed.). John Wiley & Sons. India

MTHB3010	**Partial Differential Equation**	**5L:1T:0P**	**6 Credits**

Course Objectives: The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

Unit 1: **First Order PDE and Method of Characteristics:** L: 16
Introduction, Classification, Construction and geometrical interpretation of first order partial differential equations (PDE), Method of characteristic and general solution of first order PDE, Canonical form of first order PDE, Method of separation of variables for first order PDE.

Unit 2: **Mathematical Models and Classification of 2ndOrder Linear PDE:** L: 12

Gravitational potential, Conservation laws and Burger's equations, Classification of second order PDE, Reduction to canonical forms, Equations with constant coefficients, General solution.

Unit 3: **The Cauchy Problem and Wave Equations:** L: 16
Mathematical modeling of vibrating string, vibrating membrane. Cauchy problem for second order PDE, Homogeneous wave equation, Initial boundary value problems, Non-homogeneous boundary conditions, Finite strings with fixed ends, Non-homogeneous wave equation, Goursat problem.

Unit 4: **Method of Separation of Variables:** L: 12
Method of separation of variables for second order PDE, Vibrating string problem, Existence and uniqueness of solution of vibrating string problem, Heat conduction problem, Existence and uniqueness of solution of heat conduction problem, Non-homogeneous problem.

Course Learning Outcomes: The course will enable the students to:
1. Formulate, classify and transform partial differential equations into canonical form.
2. Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.

Text /Reference Books:

1. 1. Myint-U, Tyn & Debnath, Lokenath. (2007). *Linear Partial Differential Equation for Scientists and Engineers* (4th ed.). Springer, Third Indian Reprint, 2013.
2. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, Dover Publications. Indian Reprint.
3. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). *Partial Differential Equations*: *An Introduction with Mathematica and MAPLE* (2nd ed.). World Scientific.

MTHB4010	**Numerical Analysis**	**4L:1T:0P**	**5 Credits**

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

Unit 1: **Methods for Solving Algebraic and Transcendental Equations:** L:12
Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method.

Unit 2: **Techniques to Solve Linear Systems:** L:12
Partial and scaled partial pivoting, LU decomposition and its applications, Iterative methods: Gauss-Jacobi, Gauss-Seidel and SOR methods.

Unit 3: **Interpolation:** L:16
Interpolation formulae, Newton's forward and backward differences, Stirling's formula,Lagrange's interpolation formula, Piecewise linear interpolation.

Unit 4: **Numerical Differentiation and Integration:** L:16

First order and higher order approximation for first derivative, Approximation for second derivative. Numerical integration by closed Newton-Cotes formula: trapezoidal rule, Simpson's rule and its error analysis. Euler's method to solve ODE's.

Course Learning Outcomes: The course will enable the students to learn the following:

1. Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
2. Interpolation techniques to compute the values for a tabulated function at points not in the table.
3. Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

Text /Reference Books:

1. Bradie, Brian. (2006). *A Friendly Introduction to Numerical Analysis*. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). *Numerical Methods for Scientific and Engineering Computation*. (6th ed.). New Age International Publisher, India, 2016.
3. Gerald, C. F., & Wheatley, P. O. (2008). *Applied Numerical Analysis* (7th ed.). Pearson Education. India.

MTHB4011	**Numerical Analysis Lab**	**0L:0T:2P**	**1 Credits**

Practical/Lab work to be performed in Computer Lab:

Use of computer algebra software (CAS), for example Mathematica/MATLAB/Maple/ Maxima/Scilab etc., for developing the following numerical programs:

1. Bisection method
2. Newton Raphson method
3. Secant method
4. Regula Falsi method
5. LU decomposition method
6. Gauss-Jacobi method
7. SOR method
8. Gauss-Seidel method
9. Lagrange interpolation
10. Newton interpolation
11. Trapezoidal rule
12. Simpson's rule
13. Euler's method

Note: For any of the CAS: Mathematica /MATLAB/ Maple/Maxima /Scilab etc., data typessimple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

PHYSICS

PHYB1010	**MECHANICS**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of dynamical laws of motion.
2. To impart the knowledge of rotational dynamics, eleasiticity and fluid motion.
3. To make students learn the theory of gravitation and central forces.
4. To make students learn oscillatory motion and non inertial systems.
5. To impart the knowledge of special theory of relativity.

Unit 1: **Fundamentals of Dynamics:** L:13

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy. Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit 2: **Rotational Dynamics, Elasticity and Fluid Motion: L: 17**

Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit 3: **Gravitation and Central Force Motion:** L:16

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Unit 4: **Non-Inertial Systems:** L: 4

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit 5: **Special Theory of Relativity:** L:10

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

Text /Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
9. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
10. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
11. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand concept of centre of mass and different kinds of frames of references.
2. Acquire knowledge of different types of forces of work and energy.
3. Understand the rotational and translational dimensions.
4. Understand the dynamics of oscillations and non inertial systems.
5. Impart the knowledge about theory of relativity and its importance.

PHYB1011	**MECHANICS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Measurements of length (or diameter) using vernier calipers, screw gauge and travellingmicroscope.
2. To study the random error inobservations.
3. To determine the elastic Constants of a wire by Searle'smethod.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Moment of Inertia of aFlywheel.
6. To determine the value of g using BarPendulum.
7. To determine the value of g using Kater'sPendulum.
8. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus ofrigidity.
9. TodeterminetheModulusofRigidityofaWirebyMaxwell'sneedle.
10. Todetermine**g**andvelocityforafreelyfallingbodyusingDigitalTimingTechnique.
11. TodeterminetheYoung'sModulusofaWirebyOpticalLeverMethod.

PHYB2010	**THERMAL PHYSICS**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of the basic laws of thermodynamics
2. To make students learn the concept of entropy and free energies.
3. To impart the knowledge of thermodynamic relations and kinetic theroy of gases.
4. To impart the knowledge of heat through molecular collisions.
5. To convey the basic concepts related to behavior of real gasses.

Unit 1: **Introduction to Thermodynamics:** L:10

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit 2: **Second Law of Thermodynamics:** L:8

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit 3: **Entropy and Thermodynamic Potentials:** L:14

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Unit 4: **Maxwell's Thermodynamic Relations:** L:10

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Unit 5**: Kinetic Theory of Gases:** L:20

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport phenomenon in Ideal Gases. Brownian Motion and its Significance.

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule- Thomson Effect.

Text /Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand different laws of thermodynamics.
2. Understand basic concepts of entropy and enthalpy.
3. Understand the concept of free energies and thermodynamics potential.
4. Understand the kinetic Theory of Gases.
5. Possess sound knowledge of theories for ideal and real gases.

PHYB2011	**THERMAL PHYSICS LAB**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

1. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
2. Newtons law of cooling.
3. Stefan's constant.
4. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
5. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

7. To calibrate a thermocouple to measure temperature in a specified Range using Null Method

PHYB3010	WAVES AND OPTICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of collinear harmonic oscillator and wave motion.
2. To make students learn about superposition of harmonic waves
3. To make students learn the theories of interference and various interferometers.
4. To impart the knowledge of diffraction and diffractometers.
5. To impart the knowledge of holography.

Unit 1: **Superposition of Harmonic oscillations:** L:9

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Unit 2: **Wave Motion:** L:8

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit 3: **Superposition of Two Harmonic Waves:** L:10

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Unit 4: **Interference:** L:13

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Michelson

Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit 5: **Diffraction:** L:20

Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Text /Reference Books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand wave motion and theories of superposition of harmonic oscillations.
2. Understand superposition of harmonic waves and wave optics.
3. Understand theories of interference.
4. Possess sound knowledge of diffraction methods.
5. Understand principle of holography.

PHYB3011	WAVES AND OPTICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine the wavelength of sodium source using Michelson's interferometer.

5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffractiongrating.
9. To study Lissajous Figures.
10. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Take measurements using various optical benches, interferometers, diffractometers.
2. Determine angle, refrective index and dispersive power of a prism using various techniques.
3. Determine wavelength of a light source using various optical techniques.
4. Determine dispersive power and resolving power of diffraction gratings.
5. Study and understand lissajous figures.

PHYB4010	ELEMENTS OF MODERN PHYSICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of quantum theory of radiation
2. To impart the knowledge of basic quantum mechanics
3. To make student learn elements of nuclear physics
4. To impart the knowledge on lasers and their applications

Detailed Syllabus:

Unit 1: **Quantum theory of Radiation:** L:14

Planck's quantum law, Planck's constant and light as a collection of photons; Blackbody, Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.Position measurement- gamma ray microscope thought experiment; Wave-particle duality,

Unit 2: **Quantum Mechanics:** L:19

Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets, impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle-application to virtual particles and range of an interaction. Two slit interference experiment with

photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box-energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

Unit 3: **Nuclear Physics:**L:12

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.Radioactivity**:** stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Unit 4: **Fission and fusion:**L:8

Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit 5: **Lasers:**L:8

Einstein’s A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

Text /Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.

10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand quantum theory of radiation
2. Possess knowledge of introductory quantum mechanics
3. Understand the fundamentals of nuclear physics.
4. Understand the working principle and applications of lasers.

PHYB4011	**ELEMENTS OF MODERN PHYSICS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. To determine the wavelength of laser source using diffraction of single slit.
2. To determine the wavelength of laser source using diffraction of double slits.
3. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
4. Measurement of Planck's constant using black body radiation and photo-detector.
5. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
6. To determine work function of material of filament of directly heated vacuum diode.
7. To determine the Planck's constant using LEDs of at least 4 different colours.
8. To determine the wavelength of H-alpha emission line of Hydrogen atom.
9. To determine the ionization potential of mercury.
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.
11. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
12. To setup the Millikan oil drop apparatus and determine the charge of an electron.
13. To show the tunneling effect in tunnel diode using I-V characteristics.

----------**BOTANY** ----------

MCRB1010	**MICROBIOLOGY AND PHYCOLOGY**	**4L:0T:0P**	**6 CREDITS**

Course objectives:

The objectives of this course are

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Bacteria and algae).

UNIT- 1: Microbial World (Origin and Evolution of Life, Microbial diversity (12Lectures)

1.1. Discovery of microorganisms, origin of life, spontaneous, biogenesis, Pasteur experiments, germ theory of disease.

1.2. Classification of microorganisms – R.H. Whittaker's five kingdom concept, Carl Woese's-Domain system.

1. 3. Brief account of special groups of bacteria- Archaebacteria, Mycoplasma, Chlamydia, Actinomycetes, Rickettsias and Cyanobacteria.

UNIT- 2 : VIRUSES (12 Lectures)

2.1. Viruses- Discovery, general account, structure& replication of –T4 Phage (Lytic, Lysogenic) and TMV, Viroids, Prions.

2.2. Plant diseasescaused by viruses– Symptoms, transmission and control measures (Brief account only).

2.3. Study of Tobacco Mosaic, Bhendi Vein clearing and Papaya leaf curl diseases.

UNIT 3: BACTERIA (12 Lectures)

3. 1. Bacteria: Discovery, General characteristics, cell structure andnutrition.

3.2. Reproduction- Asexual and bacterial recombination (Conjugation, Transformation, Transduction).

3.3. Economic importance of Bacteria.

UNIT –4: ALGAE (12Lectures)

4.1. General account - thallus organization and reproduction in Algae.

4.2. Fritsch classification of Algae (up to classes only) and economic importance.

4.3. Structure, reproduction and life history of Oedogonium, Ectocarpus and Polysiphonia.

UNIT 5: FUNGI (12 Lectures)

5.1. General characteristics and outline classification (Ainsworth).

5.2. Structure, reproduction and life history of Rhizopus (Zygomycota),Penicillium (Ascomycota), and Puccinia (Basidiomycota).

5.3. Lichens-Structure and reproduction; ecological and economic importance.

Text /Reference Books:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw HillInternational.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press,Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, NewDelhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V.,Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, NewDelhi.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

5. Develop understanding on the concept of microbial nutrition
6. Classify viruses based on their characteristics and structures
7. Develop critical understanding of plant diseases and their remediation.
8. Examine the general characteristics of bacteria and their cell reproduction/ recombination
9. Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance
10. Conduct experiments using skills appropriate to subdivisions

MCRB1011	**MICROBIOLOGY AND PHYCOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and LysogenicCycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, rootNodule.
3. Gramstaining.
4. Endospore staining with malachite green using the (endospores taken from soilbacteria).
5. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,Procholoron* through electron micrographs, temporary preparations and permanent slides.

BOTB2010	**DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY**	**4L:0T:2P**	**6 Credits**

Course Objectives:

2. This course aims at making a familiarity with special groups of plants joined together by a common feature of sexual reproduction involving Archegonia.
3. To Create an understanding by observation and table study of representative members of phylogenetically important groups should be able to make students learn the process of evolution in a broad sense.
4. To Study of morphology, anatomy, reproduction and developmental changestherein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants

UNIT – 1: BRYOPHYTES (12L)

1.1 Bryophytes: General characters, Classification (up to classes)

1.2. Structure, reproduction and Life history of Marchantia, and Funaria.

1.3. Evolution of Sporophyte in Bryophytes.

UNIT – 2: PTERIDOPHYTES (12L)

2.1. Pteridophytes: General characters, classification (up to Classes)

2.2. Structure, reproduction and life history of Lycopodium, and Marsilea.

2.3. Heterospory and seed habit.

2.4. Evolution of stele in Pteridophytes.

UNIT – 3: GYMNOSPERMS (12L)

3.1. Gymnosperms: General characters, classification (up to classes)

3.2. Morphology, anatomy, reproduction and life history of Pinus and Gnetum

3.3. Economic importance with reference to wood, essential oils and drugs

UNIT –4: Tissues and Tissue systems (12L)

4.1.Meristems - Root and Shoot apical meristems and their histological organization.

4.2.Tissues – Meristematic and permanent tissues (simple, complex, secretory)

4.3.Tissue systems–Epidermal, ground and vascular.

UNIT – 5. Secondary growth (12L)

5.1. Anomalous secondary growth in Achyranthes, Boerhaavia and Dracaena.

5.2. Study of local timbers of economic importance-Teak, Rosewood, Red sanders and Arjun (Tella maddi).

Course Learning Outcomes:

1. Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms
2. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
3. Understanding of plant evolution and their transition to land habitat.
4. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperm

Text /Reference Books

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press,U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley& Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge UniversityPress, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers IndiaLtd.

Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut,India.

BOTB2011	**DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY LAB**	**0L:0T:2P**	**4 Credits**

LIST OF EXPERIMENTS

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanentslides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanentslides/photographs.
4. *Peziza*: sectioning throughascocarp.
5. *Alternaria:* Specimens/photographs and temporarymounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both thehosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to beshown.
8. Studyof phaneroplasmodium from actual specimens and /or photograph.Studyof *Stemonitis* sporangia.
9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanentslides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza(Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust ofcrucifers.

BOTB3020	**ECONOMIC BOTANY**	**4L:0T:2P**	**6 Credits**

COURSE OBJECTIVES

1. To relate the principles of Economic Botany to other disciplines in biology.
2. To relate useful plants to the affairs of mankind.
3. To relate useful plants to the local and world economy.

Unit 1: Origin of Cultivated Plants (6 lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals and Legumes (6 lectures)

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man
and ecosystem.

Unit 3: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry.
Potato – morphology, propagation & uses.

Unit 4 : Spices and Beverages (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper Tea, Coffee (morphology, processing & uses)

Unit 5 : Sources of oils and fats (10 lectures)

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

COURSE OUTCOME

1. Understand core concepts of Economic Botany and relate with environment,populations, communities, and ecosystems
2. Develop critical understanding on the evolution of concept of organization of apexnew crops/varieties, importance of germplasm diversity, issues related to access andownership
3. Develop a basic knowledge of taxonomic diversity and important families of usefulplants
4. Increase the awareness and appreciation of plants & plant products encountered ineveryday life
5. Appreciate the diversity of plants and the plant products in human use

Text/ Reference Books

1) Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2) Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,
3) The Netherlands.
4) Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & BartlettPublishers.

L

I S T **BOTB3020**	**ECONOMIC BOTANY LAB**	**0L:0T:4P**	**2 Credits**

OF EXPERIMENTS:

1) **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2) **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3) **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests),
4) Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m.starch grains, micro-chemical tests).
5) **Spices:** Black pepper, Fennel and Clove (habit and sections).
6) **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
7) **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
8) **Essential oil-yielding plants**: Habit sketch of *Rosa*, *Vetiveria*, *Santalum* and *Eucalyptus* (specimens/photographs).

BOTB4020	**PHYTOGEOGRAPHY**	**4L:0T:2P**	**5 Credits**

COURSEOBJECTIVE

1. To give a fundamental understanding of the distribution of vascular plants and of the basic models which describe it.
2. To know about the floristic regions and plant formations of the Planet, in the light of previous continental and climatic evolution.
3. To learn floristic recording of specific habitats and the assessment of their naturality on the basis of chorological and life form spectra of the flora.

Unit I: Introduction, soil and water 15 lectures

Basic concepts; Levels of organization. Abiotic and biotic Components and theirinterrelationships and dynamism, homeostasis. Soil: Origin; Types and Formation;Composition; Physical, Chemical and Biological components; Soil profile. Types of soils inIndia. Water: States of water in the environment; Precipitation types (rain, fog, snow, hail,dew); Hydrological Cycle; Atmospheric moisture; Water in soil; Ground water table. Water resources of India

Unit II: Ecological adaptations, Population ecology 15 lectures

Variations in adaptation of plants in relation to light, temperature, water, wind and fire.Biotic interactions: Competition: Inter- and intraspecific competition; Ammensalism,heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation,Population ecology: Characteristics and population growth, population regulation, lifehistory strategies; *r* and *k* selection. Ecological Speciation.

Unit III: Plant Communities and Ecosystem 15 lectures

Community characteristics: analytical and synthetic; Concept of ecological amplitude;Habitat and niche; Ecotone and edge effect; Succession: processes, types; climax concept.Primary vs Secondary succession. Ecosystem: Structure; Processes; Trophic organization;Food chains and Food webs; Ecological pyramids. Ecosystems of India.

Unit IV: Functional Aspects of Ecosystem and Phytogeography15 lectures

Principles and models of energy flow; Production and productivity; Ecological efficiencies;Biogeochemical cycles of carbon, nitrogen and phosphorus. Phytogeography: Principles;Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrialbiomes (one each from tropical, temperate & tundra); Phyto-geographical division of India;Local Vegetation.

Course outcomes

On completion of this course, the students will be able to:

1. Understand core concepts of biotic and abiotic
2. Classify the soils on the basis of physical, chemical and biological components
3. Analysis the phytogeography or phytogeographical division of India
4. Evaluate energy sources of ecological system
5. Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
6. Conduct experiments using skills appropriate to subdivisions

Text/ Reference Books

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems

Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

LIST BOTB4021	**PHYTOGEOGRAPHY LAB**	**4L:0T:2P**	**5 Credits**

LIST OF EXPERIMENTS:

1. Study of instruments used to measure microclimatic variables: Soil thermometer,maximum and minimum thermometer, anemometer, psychrometer/hygrometer, raingauge and lux meter.
2. Determination of pH of various soil and water samples (with pH meter, universalindicator/Lovibond comparator and/or pH paper strip)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and basedeficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid
5. titration method.
6. Comparison of bulk density, porosity and rate of infiltration of water in soils of threehabitats.
7. Determination of dissolved oxygen of water samples from polluted and unpollutedsources.
8. Study of morphological adaptations of hydrophytes and xerophytes (four each).
9. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).
10. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
11. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

----------ZOOLOGY----------

ZOOB1010	**NON-CHORDATES : PROTISTS TO ECHINODERMATA**	**4L:0T:2P**	**5 Credits**

Course Objectives:

1. To understand different levels of biological diversity through the systematic classification of invertebrate fauna
2. To understand the taxonomic position of protozoa to echinodermatas.
3. To understand the general characteristics of animals belonging to protozoa to echinodermatas.
4. To understand the body organization of phylum from protozoa to echinodermatas.
5. To understand the origin and evolutionary relationship of different phylum from protozoa to to echinodermata.

Unit 1: Protista, Parazoa and Metazoa **12 lectures**

1.1. General characteristics and Classification up to classes
1.2. Study of *Euglena*, *Amoeba* and *Paramecium*
1.3. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
1.4. Locomotion and Reproduction in Protista

Unit 2: Porifera and Cnidaria 12 lectures

2.1. General characteristics and Classification up to classes
2.2. Canal system and spicules in sponges
2.3. General characteristics and Classification up to classes and Metagenesis in *Obelia*
2.4. Polymorphism in Cnidaria
2.5. Corals and coral reefs

Unit 3: Helmimthes, Platyhelminthes and Annelida 12 lectures

3.1. General characteristics and Classification up to classes
3.2. Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

Unit 4: Arthropoda 12 lectures

4.1. General characteristics and Classification up to classes
4.2. Type study of palamaneous
4.3. Type study of periplata
4.4. Insect and vectors of human diseases.

Unit 5 Mollusca and Echinodermata 12 lectures

5.1. General characteristics and Classification up to classes
5.2. Mollusca –type study of prawn
5.3. Echinodermata – study of star fish.
5.4. Minor Phyla- Ectophora and rotifera

Course Learning Outcomes: The course will enable the students to learn the following:

4. Student should be able to describe unique characters of protozoa to echinodermata
5. Student should be able to recognize life functions of protozo to echinodermata
6. To recognise the ecological role of phylum protozoa to echinodermata
7. To recognise the diversity from protozoa to echinodermata

Text /Reference Books:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

O2

ZOOB1011	**Non Chordates Lab**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in*Paramecium*
2. Examinationofpondwatercollectedfromdifferentplacesfordiversityinprotista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella,Spongilla*
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina,Madrepora*
5. One specimen/slide of anyctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro-photographs)
7. Studyofadult*Ascarislumbricoides*anditslifestages(Slides/micro-photographs)
8. TosubmitaProjectReportonanyrelatedtopiconlifecycles/coral/coralreefs.

ZOOB2010	CHORDATES	0L:0T:2P	1 Credits

COURSE OBJECTIVES

1. To understand what the chordates are.
2. To understand different categories of chordates.
3. To understand the general characters of chordates.
4. To understands the level of organization in chordate subphylum.
5. To understand the origin and evolutionary relationship in different subphylum of chordates.

UNIT 1:

1.1. General characters of Chordata
1.2 Prochordata
1.2.1 Salient features of Cephalochordata
1.2.2 Structure of Branchiostoma
1.2.3 Affinities of Cephalochordata
1.2.4 Salient features of Urochordata
1.2.5 Structure and life history of Herdmania
1.2.6 Significance of Retrogressive metamorphosis

Unit – 2:

2.1 Cyclostomata
2.1.1 General characters of Cyclostomata
2.1.2 Comparision of the Petromyzon and Myxine
2.2 Pisces
2.2.1 General characters of Fishes
2.2.2 Classification of fishes up to sub - class level with examples
2.2.3 Scoliodon - External features, Digestive system, Respiratory system, Heart, Brain
2.2.4 Migration in Fishes
2.2.5 Types of Scales

Unit – 3:

3.1 Amphibia
3.1.1 General characters of Amphibian
3.1.2 Classification of Amphibia upto orders with examples.
3.1.3 Rana hexadactyla - External features, Digestive system, Respiratory system, Heart, Brain
3.2 Reptilia
3.2.1 General characters of Reptilia
3.2.2 Classification of Reptilia upto orders with examples
3.2.3 Calotes - External features, Digestive system, Respiratory system, Heart, Brain
3.2.4 Identification of Poisonous snakes and Skull in reptiles

Unit :4 Aves

4.1 General characters of Aves
4.2. Classification of Aves upto subclasses with examples.
4.3 Columba livia - External features, Digestive system, Respiratory system, Heart, Brain
4.4 Migration in Birds
4.5 Flight adaptation in birds

Unit -5 Mammalia

5.1 General characters of Mammalia
5.2 Classification of Mammalia upto sub - classes with examples
5.3 Comparision of Prototherians, Metatherians and Eutherians
5.4. Dentition in mammals

COURSE OUTCOME

1. Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
2. Student should be able to recognize life functions of urochordates to fishes.
3. To understand the ecological role of different groups of chordates.
4. To understand the diversity ofchordates

Text Books/ Reference Books

UNIT 1:

1.1. General characters of Chordata
1.2 Prochordata
1.2.1 Salient features of Cephalochordata
1.2.2 Structure of Branchiostoma
1.2.3 Affinities of Cephalochordata
1.2.4 Salient features of Urochordata
1.2.5 Structure and life history of Herdmania
1.2.6 Significance of Retrogressive metamorphosis

Unit – 2:

2.1 Cyclostomata
2.1.1 General characters of Cyclostomata
2.1.2 Comparision of the Petromyzon and Myxine
2.2 Pisces
2.2.1 General characters of Fishes
2.2.2 Classification of fishes up to sub - class level with examples
2.2.3 Scoliodon - External features, Digestive system, Respiratory system, Heart, Brain
2.2.4 Migration in Fishes
2.2.5 Types of Scales

Unit – 3:

3.1 Amphibia
3.1.1 General characters of Amphibian
3.1.2 Classification of Amphibia upto orders with examples.
3.1.3 Rana hexadactyla - External features, Digestive system, Respiratory system, Heart, Brain
3.2 Reptilia

3.2.1 General characters of Reptilia
3.2.2 Classification of Reptilia upto orders with examples
3.2.3 Calotes - External features, Digestive system, Respiratory system, Heart, Brain
3.2.4 Identification of Poisonous snakes and Skull in reptiles

Unit :4 Aves

4.1 General characters of Aves
4.2. Classification of Aves upto subclasses with examples.
4.3 Columba livia - External features, Digestive system, Respiratory system, Heart, Brain
4.4 Migration in Birds
4.5 Flight adaptation in birds

Unit -5 Mammalia

5.1 General characters of Mammalia
5.2 Classification of Mammalia upto sub - classes with examples
5.3 Comparision of Prototherians, Metatherians and Eutherians
5.4. Dentition in mammals

COURSE OUTCOME

5. Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
6. Student should be able to recognize life functions of urochordates to fishes.
7. To understand the ecological role of different groups of chordates.
8. To understand the diversity ofchordates

Text Books/ Reference Books

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

ZOOB2011	**Chordates Lab**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Protochordata : Herdmania, Amphioxus, Amphioxus T.S. through pharynx
2. Cyclostomata : Petromyzon, Myxine
3. Pisces : Pristis, Torpedo, Channapleuronectes, Hippocampus, Exocoetus, Eheneis, Labeo, Catla, Clarius, Auguilla,Protopterus Placoid scale, Cycloid scale, Ctenoid scale
4. Amphibia : Ichthyophis, Amblystoma, Siren, Hyla, Rachophous Axolotl larva
5. Reptilia : Draco, Chemaeleon, Uromastix, Vipera russeli, Naja, Bungarus, Enhydrina, Testudo, Trionyx, Crocodilus
6. Aves : Passer, Psittacula, Bubo, Alcedo, Columba, Corvus, Pavo,
7. Study of different types of feathers : Quill, Contour, Filoplume down
8. Mammalia : Ornithorthynchus, Tachyglossus, Pteropus, Funambulus, Manis, Loris, Hedgehog Osteology :

Appenducular skeletons of Varanus, Pigeon Rabbit - Skull, fore limbs, hind limbs and girdles

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ZOOB3010	**ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM**	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVE

1. To know about the functioning of various system of organisms and their interrelationship for well-coordinated function.
2. To understand structure and functions of different animal tissues and endocrine glands

Unit 1:Tissues

1.1. Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

1.2. Bone and Cartilage Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 2:Nervous System

2.1. Structure of neuron, resting membrane potential,

2.2. Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers;

2.3. Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc;

2.4. Physiology of hearing and vision.

Unit 3:Muscle Histology of different types of muscle;

3.1. Ultra structure of skeletal muscle;

3.2 Molecular and chemical basis of muscle contraction;

3.3. Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 4:Reproductive System

4.1. Histology of testis and ovary;

4.2. Physiology of male and female reproduction; Puberty,

4.3. Methods of contraception in male and female

Unit 5 :Endocrine System

5.1. Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action;

5.2. Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones;

5.3. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones

COURSE OUTCOME

1. Should be able to recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same i.e., should learn about an integrative approach to understand the interactions of various organ

systems resulting in the complex overall functioning of the body. e.g. Cardiovascular and Respiratory systems to meet the oxygen demand of the body.

2. Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances i.e. how physiological mechanisms adapt in response to various external and internal stimuli in order to maintain health.
3. Knowledge of role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes

TEXT / REFERENCE BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

ZOOB3010	**ANIMAL PHYSIOLOGY: CONTROLLONG AND COORDINATING SYSTEM**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues (*Subject to UGC guidelines)

BCHB4210	**BIOCHEMISTRY OF METABOLIC PROCESSES**	**4L:0T:2P**	**6 Credits**

COURSE OBJECTIVES

1. To understand The relationship between the structure and function of specific biological molecules and enzymes are regulated
2. To understand main principles of metabolic biochemistry concepts and homeostasis is controlled in the body
3. To understand function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated
4. To Understand the metabolism of carbohydrates and fates of various intermediate and end products

Unit 1: Overview of Metabolism

1.1 Catabolism vs Anabolism, Stages of catabolism,

1.2. Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions;

1.3. Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

2.1. Sequence of reactions and regulation of glycolysis, Citric acid cycle,

2.2. Phosphate pentose pathway,

2.3. Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

3.1. β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms;

3.2.Biosynthesis of palmitic acid;

3.3. Ketogenesis

Unit 4: Protein Metabolism

4.1. Catabolism of amino acids: Transamination, Deamination,

4.2. Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

5.1.Redox systems; Review of mitochondrial respiratory chain,

5.2.Inhibitors and un-couplers of Electron Transport System

COURSE OUTCOME

1. Students gain knowledge and skill in the interactions and interdependence of physiological and biomolecules and the understand essentials of the metabolic pathways along with their regulation.
2. To understand the principles, instrumentation and applications of bioanalytical techniques.
3. To expose the students to various processes used in industries.
4. Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation and be able to design and conduct scientific experiments and analyze the resulting data.

Text/ Reference Books

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

BCHB4211	**BIOCHEMISTRY OF METABOLIC PROCESSES LAB**	**0L:0T:2P**	**1 Credits**

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue

3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]

To perform the Acid and Alkaline phosphatase assay from serum/ tissue

O3 List of Skill Enhancement Course offered by the Department (any Two 1 in Sem.I and II,Any 1 in each Sem III & Sem IV) (Credit: 02 each)

Semester	Course Code	Course Name	(L-T-P)	Credits
III	CHYB3210	IT Skills for Chemists	2-0-0	2
III	CHYB3220	Chemical Tech & Society	2-0-0	2
III	CHYB3230	Chemo informatics	2-0-0	2
IV	CHYB3240	Fuel Chemistry	2-0-0	2
V	CHYB4210	Analytical Clinical Biochemistry	2-0-0	2
VI	CHYB4220	Green Methods in Chemistry	2-0-0	2
VII	CHYB4230	Pharmaceutical chemistry	**2-0-0**	**2**
VIII	CHYB4240	Pesticide Chemistry	**2-0-0**	**2**

CHYB3210	IT SKILLS FOR CHEMISTS	2L:0T:0P	2 Credits

Lectures 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).

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 concentrationtime data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa 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:

• McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).
• Mortimer, R. Mathematics for Physical Chemistry. 3 rd Ed. Elsevier (2005).
• Steiner, E. The Chemical Maths Book Oxford University Press (1996).
• Yates, P. Chemical calculations. 2 nd Ed. CRC Press (2007).

• Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
• Levie, R. de, How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
• Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
• Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

CHYB3220	CHEMICAL TECHNOLOGY & SOCIETY	2L:0T:0P	2 Credits

Theory: 30 Lectures

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.

CHYB3230	CHEMOINFORMATICS	2L:0T:0P	2 Credits

(Credits: 02) Theory: 30 Lectures

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 basics of computation of physical andchemical 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 drugdesign; 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:

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

CHYB3240	FUEL CHEMISTRY	2L:0T:0P	2 Credits

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:

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

CHYB4210	ANALYTICAL CLINICAL BIOCHEMISTRY	2L:0T:0P	2 Credits

THEORY: 30 Lectures

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:

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.

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.

CHYB4220	GREEN METHODS IN CHEMISTRY	2L:0T:0P	2 Credits

Theory: 30 Lectures

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

CHYB4230	**PHARMACEUTICAL CHEMISTRY**	**2L:0T:0P**	**2 Credits**

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory 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.

CHYB4240	PESTICIDE CHEMISTRY	2L:0T:0P	2 Credits

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

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

2. Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

• R. Cremlyn: Pesticides, John Wiley.

List of discipline Specific Elective Papers offered by the Department for students in B.Sc. (Hons.) Chemistry (4 to be selected, 2 in each of 5th and 6th semester)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	CHYB5310+CHYB5311	Organic Spectroscopy	4-0-4	6
V	CHYB5320+CHYB5321	Industrial Chemistry	4-0-4	6
V	CHYB5330+CHYB5331	Analytical Chemistry-III	4-0-4	6
V	CHYB5340+CHYB5341	Green chemistry	4-0-4	6
VI	CHYB6310	Research Methodology for chemistry	5-1-0	6
VI	CHYB6320+CHYB6321	Polymer Chemistry	4-0-4	6
VI	CHYB6330+CHYB6331	Novel Inorganic Solids	4-0-4	6
VI	CHYB6340+CHYB6341	Application of Computers in Chemistry	4-0-4	6
VI	CHYB6393	Dissertation*	-	6

CHBY5310	Organic Spectroscopy	4L:0T:0P	4 Credits

Course Objectives:

1. In order to study the NMR spectroscopy to understand the important role of nuclear magnetic resonance spectroscopy in the study of the structures of organic compounds.
2. To develop an understanding of the significance of the number, positions, intensities and splitting of signals in nuclear magnetic resonance spectra.
3. To be able to assign structures to simple molecules on the basis of nuclear magnetic resonance spectra.
4. In order to study carbohydrates will develop the skills to recognize and draw particular carbohydrate structures.
5. To know general structural elements of cyclic monosaccharide and disaccharides and their implications for structure and function.

UNIT 1. Introduction to Spectroscopy

1.1 Meaning of spectroscopy,

1.2 Nature of electromagnetic radiation -wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, different regions of electromagnetic radiations

1.3 Regions of electromagnetic radiation.

1.4 Interaction of radiation with matter-absorption, emission, florescence and scattering, Types of spectroscopy and advantages of spectroscopic methods.

1.5 Energy types and energy levels of atoms and molecules.

UNIT 2. UV Spectroscopy(12L)

2.1 Introduction,

2.2 Beer-Lamberts law, absorption of U.V. radiation by organic molecule leading to different excitation.

2.3 Terms used in U.V. Spectroscopy- Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effect.

2.4 Modes of electromagnetic transitions.

2.5 Effect of conjugation on position of U.V. band.

2.6 Calculation of λ-max by Woodward and Fisher rules for dienes and enones systems.

2.7 Colour and visible spectrum.

2.8 Applications of U.V. Spectroscopy-

UNIT 3. IR Spectroscopy

(12L)

3.1 Introduction,

3.2 Principle of I.R. Spectroscopy,

3.3 IR Instrumentation, schematic diagram

3.4 Fundamental modes of vibrations types and calculation –

3.5 Condition for absorption of IR radiations

3.6 Regions of I.R. Spectrum, fundamental group region, finger print region.

3.7 Hooks Law for Calculation of vibrational frequency

3.8 Factors affecting on IR absorption frequency,
3.9 Characteristic of I.R. absorption of following functional groups a) Alkanes alkenes alkynes b) Alcohol and phenols c)Ethers d) Carbonyl compounds e) Amines) f) Nitro compounds g)Aromatic Compounds

UNIT 4. NMR Spectroscopy(12L)
4.1 Introduction,
4.2 Principles of PMR Spectroscopy
4.3 NMR- Instrumentation, Schematic diagram
4.4 Magnetic and nonmagnetic nuclei
4.5 Chemical shift- definition, measurement, calculation, Factors affecting Chemical shift
4.6 Shielding, & deshielding
4.7 Peak Integration
4.8 Merits of TMS as PMR reference compounds
4.9 Coupling Constant
4.10 Types of Coupling Constant
4.11 Spin-spin splitting (n+1 rule).
4.12 Applications

UNIT 5. Mass Spectroscopy
5.1 Introduction
5.2 Principle of mass spectroscopy
5.3 Mass spectrometer - schematic diagram
5.4 Types of ions produced in mass spectrum
5.5 Fragmentation patterns of- alkanes, alkenes, aromatic hydrocarbons, alcohols, phenols, amines and carbonyl compounds
5.6 McLaffrety rearrangement
5.7 Applications-Combined Problems based on UV, IR, NMR and Mass Spectral data

Course outcomes :

1. After study of course students have firm foundations in the fundamentals and application of current chemical and scientific theories.
2. Students are able to identify and solve chemical problems and explore new areas of research.
3. Students are skilled in probling solving ,critical thinking and analytical reasoning.
4. After completion of course students should have the ability to identify organic compounds by analysis and interpretation of spectral data.
5. Students should have the ability to explain common terms in NMR spectroscopy such as chemical shift ,coupling constant and anisotropy and describe how they are affected by molecular structure.
6. Students are skilled to perform the most commonly used NMR experiments and to interpret and document their results.

Reference Books:

1. Absorption Spectroscopy of Organic Molecules by V.M.Parikh .
2. Spectroscopy of Organic compounds by P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy by Y. R. Sharma.
4. Instrumental Methods of Analysis (7th edition) by
5. Willard, Merritt, Dean, Settle.
6. Spectroscopy by G R Chatwal and S K Anand

7. Spectroscopy by Pavia, lampman, Kriz, Vyvyan
8. Organic Spectroscopy (2nd edition) by Jag Mohan
9. Organic Spectroscopy (3rd edition) by William Kemp
10. Instrumental Methods of Chemical Analysis by H Kaur.

CHYB5230	Industrial Chemistry	0L:0T:4P	4 Credits

Course Objectives:

The specific objectives of Industrial Chemistry program are to:

1. Make the students well-grounded in the principles and through knowledge of scientific techniques of industrial Chemistry.
2. Educate and train Chemists to acquire a meaningful picture of Chemical industries.
3. Prepare students for professional participation in Chemical industries so as to adapt themselves to jobs which are problem solving
4. Train students to be result-oriented in the chemical, petrochemical, biochemical and allied technological fields.

UNIT 1. Manufactue of Heavy Chemicals (12L)

1.1 Introduction,Manufacture of Ammonia (NH_3)

i.Physico-chemical principles

ii.Manufacture by Haber's process

1.2 Manufacture of Sulphuric acid (H_2SO_4)

i.Physico-chemical principles

ii.Manufacture by Contact process

1.3 Manufacture of Nitric acid (HNO3)

i.Physico-chemical principles

ii.Manufacture by Ostwald's (Ammonia oxidation process)

1.4 Manufacture of Sodium carbonate (Washing soda) (Na2CO3)

i.Physico-chemical principles

ii.Manufacture by Solvay process

UNIT 2. Corrosion and Passivity (12L)

2.1 Introduction of corrosion,Electrochemical theory of corrosion,Factors affecting on corrosion,

2.2 Passivity-Definition,Types of passivity,Oxide film theory and evidences,Applications of passivity

UNIT 3. Sugar Industry (12L)

3.1 Introduction,Manufacture of cane sugar, extraction, decolourisation, crystallization and other

details of industrial process
3.2 Refining of raw sugar
3.3 Manufacturing of white sugar in India
3.4 Byproducts of sugar industry

UNIT 4. Soaps and Detergents **(12L)**
4.1 Introduction,Soaps,Raw materials,Types of soaps,Cleaning action of soap.
4.2 Manufacture of soap
i.Cold Process
ii.Semi-boiled Process
iii.Boiled or Hot Process
4.3 Detergents
i.Raw Materials
ii.Types of Detergents: Anionic, cationic and amphoteric
4.4 Comparisons between soaps and detergents.

UNIT 5. Nanomaterials **(12L)**
5.1 Terminology and history
5.2 Optical properties of nanomaterials
i.Semiconducting nanoparticle
ii.Metallic nanoparticle
5.3 Characterization and fabrication
i.Characterization methods
a)Scanning electron microscopy
b)Transmission electron microscopy
ii.Top-down, bottom-up fabrication a) Colloidal route
b)Sol-gel method
c)Chemical reduction method
d)Electrochemical method.
5.4 Applications of Nanomaterials

Course Outcome (COs):
1. Industrial Chemistry is designed to provide graduates with the skills, knowledge and learning tools required to carry out professional research.
2. Development and production activities in the field of chemistry, including the following sectors: health, food, cosmetics, the environment and energy.

Reference:

1. Text Book of Quantitative inorganic analysis – A.I.Vogel
2. Instrumental methods of chemical analysis –Willard, Merit & Dean
3. .Principles of electroplating & electroforming – Blum &Hogaboom
4. Instrumentals methods of chemical analysis – Chatwal & Anand
5. Vogel's textbook of qualitative inorganic analysis – Bassett, Denny etc
6. Textbook of qualitative inorganic analysis – Kolthoff and sandel
7. Fundamentals of analytical chemistry – Skoog and West
8. Basic concepts of analytical chemistry – Khopkar
9. Analytical chemistry – Walton
10. Chemical process industries – Shrieve & Brink

11. Industrial chemistry – Kent
12. Industrial chemistry – Rogers
13. .Industrial chemistry – R.K.Das
14. Text book of qualitative organic analysis - Vogel
15. Qualitative organic chemistry – Vogel
16. Hand book of organic analysis – H.T.Clarke
17. Chemistry of pesticides – K.H.Buchel
18. Mechanical chemistry – Burger

Semester-VI

CHYB5330	**Analytical Chemistry-III**	**4L:0T:4P**	**6 Credits**

Course Objectives

1. To provide a basic knowledge and understanding of essential chemical and physical principles for analytical chemistry.
2. To introduce basic analytical techniques and practical aspects of classical chemical analysis.
3. To solve problems related to chemical analysis and interpret analytical results

UNIT 1. Theory of Titrimetric Analysis (12L)

1.1 Introduction
1.2 Neutralization Indicators (Acid-Base Indicators)
1.3 Theory of indicators w.r.t. Ostwald's colour change interval and Ostwald's Quinoid theory
1.4 Neutralization curves and choice of indicators for the following titration,
i.Strong acid-strong base
ii.Strong acid-weak base
iii.Strong base - weak acid
1.5 Complexometric titration
i.General account
ii.Types of EDTA titration
iii. Metallochromic indicators w.r.t. Eriochrom Black-T indicator

UNIT 2. Potentiometric Titrations(12L)

2.1 Introduction
2.2 Determination of pH
2.3 Study of Quinhydrone and Glass electrodes and their use in determination of pH
2.4 Potentiometric titrations: Classical and analytical methods for locating end points
2.5 Acid base titration
2.6 Redox titration
2.7 Advantages of potentiometric titrations
2.8 Precipitation titration
2.9 Basic circuit of direct reading potentiometer

UNIT 3. Colorimetry and Spectrophotometry(12L)

3.1 Theory of Colorimetry and Spectrophotometry
i.Lambert Beer's law
ii.Terms used in Colorimetry and Spectrophotometry
iii.Deviation from Beer's law.

3.2 Classification of methods of 'colour' measurement or comparison
i. Photoelectric Colorimeter method – Single beam photo-electric colorimeter.
ii.Spectrophotometer method – Single beam direct reading spectrophotometer
3.3 Determination of unknown concentration by using Concentration-Absorbance plot.

UNIT 4. Flame Photometry(12L)
4.1 Introduction
4.2 General principles of flame photometry
4.3 Instrumentation
4.4 Effect of solvent in flame photometry
4.5 Instruments
4.6 Application of flame photometry
4.7 Interference in flame photometry
4.8 Factors that influence the intensity of emitted radiation in a flame photometer
4.9 Limitations of flame photometry
4.10 Conclusions

UNIT 5. Chromatography (12L)
5.1 Introduction
5.2 Developments in chromatography
5.3 Advantages of chromatography
5.4 Types of chromatography on the basis of mechanism of interaction of solute with Stationary phase
i)Adsorption ii) Partition iii) Ion Exchange iv) Size exclusion v) Affinity
5.5 Classification of chromatography on the basis of mobile phase and stationary phase
i)Gas Chromatography ii) Liquid Chromatography iii) Supercritical-fluid. Chromatography
5.5 Paper Chromatography and its applications
5.6 Thin layer chromatography and its applications
5.7 Adsorption column chromatography and its applications
5.8 Gas chromatography and its applications.

Course Outcomes:
After examination the student should be able to: -
1. Explain the theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration), and various techniques within gravimetric and coulometric methods.

2. Explain the theoretical principles of selected instrumental methods within electroanalytical and spectrometric/spectrophotometric methods, and main components in such analytical instruments. - Explain the theoretical principles of various separation techniques in chromatography, and typical applications of chromatographic techniques. -

3. Assess and suggest a suitable analytical method for a specific purpose, and evaluate sensitivity, important sources of interferences and errors, and also suggest alternative analytical methods for quality assurance.

References

1. Text Book of Quantitative inorganic analysis – A.I.Vogel
2. Instrumental methods of chemical analysis –Willard, Merit & Dean
3. Principles of electroplating & electroforming – Blum &Hogaboom
4. Instrumentals methods of chemical analysis – Chatwal & Anand
5. Vogel's textbook of qualitative inorganic analysis – Bassett, Denny etc
6. Textbook of qualitative inorganic analysis – Kolthoff and sandel
7. Fundamentals of analytical chemistry – Skoog and West
8. Basic concepts of analytical chemistry – S.M. Khopkar
9. Analytical chemistry – Walton
10. Chemical process industries – Shrieve& Brink
11. Industrial chemistry – Kent
12. Industrial chemistry – Rogers
13. Industrial chemistry – R.K.Das
14. Text book of qualitative organic analysis - Vogel
15. Qualitative organic chemistry – Vogel

CHYB5340	GREEN CHEMISTRY	4L:0T:4P	6 Credits

Course Objectives

1. To provide a basic knowledge of green chemistry and understanding of essential chemical and physical principles of Green Chemistry.
2. To introduce basic analytical techniques and practical aspects of classical chemical analysis.
3. To solve problems related to chemical analysis and interpret analytical results

UNIT:1 Introduction to Green Chemistry **(4L)**

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

UNIT 2.Principles of Green Chemistry and Designing a Chemical synthesis **(24L)**

2.1 Twelve principles of Green Chemistry with their explanations and examples; Designing a
2.2 Green Synthesis using these principles;
2.3 Prevention of Waste/ byproducts; maximumincorporation of the materials used in the process into the final products (Atom Economy);prevention/ minimization of hazardous/ toxic products; designing safer chemicals – differentbasic approaches to do so;
2.4 Selection of appropriate auxiliary substances (solvents, separationagents), green solvents, solventless processes, immobilized solvents and ionic liquids;
2.5 Energyrequirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protectinggroups;
2.6 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 hazardoussubstances in chemical processes.

UNIT 3.Examples of Green Synthesis/ Reactions **(24L)**

3.1 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.

3.2 Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).

3.3 Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

3.4 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.

3.5. Ultrasound assisted reactions: Esterification, saponification, substitution reactions,Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

3.6. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", anonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role ofTellurium in organic syntheses; Biocatalysis in organic syntheses.

Future Trends in Green Chemistry **(8L)**

4.1 Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistryin 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. 5.M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, AmericanChemical Society,
6. Washington (2000).
7. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society,
8. Washington (2002).

Course Outcomes:

After examination the student should be able to: -

1. Explain the theoretical principles and important applications of green chemistry.
2. Explain the green chemistry principles of selected problems
3.Application of green principles to chemical synthesis.

CHYB5341	**GREEN CHEMISTRY**	**0L:0T:4P**	**2 Credits**

1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch. Effect of concentration on clock reaction Effect of temperature on clock reaction. (if possible)

2. Using renewable resources

Preparation of biodiesel from vegetable oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy

can illustrate Green Chemistry.
Preparation of propene by two methods can be studied
(I) Triethylamine ion + OH- → propene + trimethylpropene + water
(II) 1-propanol
H2SO4/Δpropene + water
The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
Alternative Green solvents

5. Diels Alder reaction in water

Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

6. Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.
7. Mechanochemical solvent free synthesis of azomethines
8. Co-crystal controlled solid state synthesis (C2S3) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.
Alternative sources of energy
9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

1)Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, OxfordUniversity Press (1998).
2) Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
3) Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American ChemicalSociety, Washington DC (2002)
4) Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment:A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN978-93-81141-55-7 (2013).

CHYB6310	**Research Methodology for chemistry**	**5L:1T:0P**	**6 Credits**

UNIT-1 Literature Survey:(20 Lectures)

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

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 andcommunities, 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-2Methods of Scientific Research and Writing Scientific Papers:(20 Lectures)

Reporting practical and project work. Writing literature surveys and reviews. Organizing aposter display. Giving an oral presentation.
Writing scientific papers – justification for scientific contributions, bibliography, descriptionof methods, conclusions, the need for illustration, style, publications of scientific work.Writing ethics. Avoiding plagiarism.

UNIT-3:Chemical Safety and Ethical Handling of Chemicals:(12 Lectures)

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals,procedure for working with substances that pose hazards, flammable or explosive hazards,procedures for working with gases at pressures above or below atmospheric – safe storageand disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation oflaboratory waste, disposal of chemicals in the sanitary sewer system, incineration andtransportation of hazardous chemicals.

UNIT-3:Data Analysis (13 Lectures)

The Investigative Approach: Making and Recording Measurements. SI Units and theiruse.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 itsabuse. Basic aspects of multiple linear regression analysis.

UNIT-4 Electronics(10 Lectures)

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

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

CHYB6320	**POLYMER CHEMISTRY**	**4L:0T:0P**	**4 Credits**

UNIT 1: Introduction and history of polymeric materials: (4 Lectures)
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces andchemical bonding in polymers, Texture of Polymers.

UNIT 2: Functionality and its importance: (8 Lectures)
Criteria for synthetic polymer formation, classification of polymerization processes,Relationships between functionality, extent of reaction and degree of polymerization. Bifunctionalsystems, Poly-functional systems.

UNIT 3:Kinetics of Polymerization: (8 lectures)
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic andanionic) and coordination polymerizations, Mechanism and kinetics of copolymerization,polymerization techniques.

UNIT 4:Crystallization and crystallinity: (6 Lectures)
Determination of crystalline melting point and degree of crystallinity, Morphology ofcrystalline polymers, Factors affecting crystalline melting point.
Nature and structure of polymers-Structure Property relationships.

UNIT 5:Determination of molecular weight of polymers (8 Lectures)
(*Mn*, *Mw*, etc) by end group analysis,viscometry, light scattering and osmotic pressure methods. Molecular weight distribution andits significance.Polydispersity index.
UNIT 6: Glass transition temperature(8 Lectures)
(Tg) and determination of Tg, Free volume theory, WLFequation, Factors affecting glass transition temperature (Tg).

UNIT 7: Polymer Solution(8 Lectures)
Criteria for polymer solubility, Solubility parameter, Thermodynamicsof polymer solutions, entropy, enthalpy, and free energy change of mixing of polymerssolutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

UNIT 8:Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). (10 Lectures)
Brief introduction to preparation, structure, properties and application of the followingpolymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and relatedpolymers, 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-phenylenesulphide polypyrrole, polythiophene)].

Reference Books:

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

CHYB6321	**POLYMER CHEMISTRY**	**0L:0T:4P**	**2 Credits**

I. Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
a. Purification of monomer
b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)

2. Preparation of nylon 66/6

Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC)and phenolphthalein
a. Preparation of IPC
b. Purification of IPC
c. Interfacial polymerization
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

II.Polymer characterization
1. Determination of molecular weight by viscometry:
(a) Polyacrylamide-aq.$NaNO_2$ solution
(b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

III.Polymer analysis
1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis

***At least 7 experiments to be carried out.**

Reference Books:
1.Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.

2. Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary PolymerChemistry, 3rd ed. Prentice-Hall (2003)

3.Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)

4. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)

5. Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)

6. L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)

7.Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)

8. Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

CHYB6330	NOVEL INORGANIC SOLIDS	4L:0T:0P	4 Credits

UNIT 1:Synthesis and modification of inorganic solids:(10 Lectures)
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

UNIT 2:Inorganic solids of technological importance: (10 Lectures)
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 3:Nanomaterials: (10 Lectures)

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

UNIT 4: Introduction to engineering materials for mechanical construction: (10 Lectures)
Composition, mechanical and fabricating characteristics and applications of various types ofcast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin,brasses and bronzes cutting tool materials, super alloys thermoplastics, thermosets andcomposite materials.

UNIT 5: Composite materials: (10 Lectures)
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 6:Speciality polymers: (10 Lectures)
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, JonathaRourke, 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 structuralchemistry.
3.Frank J. Ovens, Introduction to Nanotechnology

CHYB6331	NOVEL INORGANIC SOLIDS	0L:0T:4P	2 Credits

1. Determination of cation exchange method
2. Determination of total difference of solids.
3. Synthesis of hydrogel by co-precipitation method.
4. Synthesis of silver and gold metal nanoparticles.

Reference Book:
1) Fahan, *Materials Chemistry*, Springer (2004).

CHYB6340	APPLICATIONS OF COMPUTERS IN CHEMISTRY	**4L:0T:0P**	**4 Credits**

UNIT 1: Basics: 30 LECTURES

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

UNIT 2:Numerical methods: 30 LECTURES

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterativemethod, Newton-Raphson method, Binary bisection and Regula-Falsi.*Differential calculus:* Numerical differentiation.*Integral calculus:* Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.*Simultaneous equations:* Matrix manipulation: addition, multiplication. Gauss-Siedal method.*Interpolation, extrapolation and curve fitting:* Handling of experimental data. *Conceptual background of molecular modelling:* Potential energy surfaces. Elementary ideasof molecular mechanics and practical MO methods.

Reference Books:

1) Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2) Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
3) Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).
4)Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

CHYB6341	APPLICATIONS OF COMPUTERS IN CHEMISTRY	**0L:0T:4P**	**2 Credits**

Computer programs based on numerical methods for
1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pHof a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van derWaals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probabilitydistributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Siedel method in colourimetry.
5. Simple exercises using molecular visualization software.

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.* JaicoPublishing House: Delhi (1996).

LIST OF GENERAL ELECTIVE SUBJECTS

List of Generic Electives Available for students of B.Sc. (Hons.) Bioinformatics

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	Botany	MCRB1010+ MCRB1011	Microbiology and Phycology	4-0-4	6
II	Botany	BOTB2010+ BOTB2011	Diversity of Archegoniate &Plant Anatomy	4-0-4	6
III	Botany	BOTB3020+ BOTB2021	Economic botany	4-0-4	6
IV	Botany	BOTB4020+ BOTB4021	Phytogeography	4-0-4	6
I	Zoology	ZOOB1010+ ZOOB1011	Non-Chordates	4-0-4	6
II	Zoology	ZOOB2010+ ZOOB2011	Chordates	4-0-4	6
III	Zoology	ZOOB3010+ ZOOB3011	Animal Physiology: Controlling and coordinating system	4-0-4	6
IV	Zoology	BCHB4210+ BCHB4211	Biochemistry of Metabolic Processes	4-0-4	6

I	Biotechnology	BCHB1010+ BCHB1011	Biochemistry & Metabolism	4-0-4	6
II	Biotechnology	BCHB2010+ BCHB2011	Animal Physiology & Plant Physiology	4-0-4	6
III	Biotechnology	BCHB3010+ BCHB3011	Immunology	4-0-4	6
IV	Biotechnology	BCHB4010+ BCHB4011	Pharmagenomics	4-0-4	6

----------BOTANY ----------

MCRB1010	**MICROBIOLOGY AND PHYCOLOGY**	**4L:0T:0P**	**4Credits**

Course objectives:

The objectives of this course are

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Bacteria and algae).

UNIT- 1: Microbial World (Origin and Evolution of Life, Microbial diversity (12Lectures)

1.1. Discovery of microorganisms, origin of life, spontaneous, biogenesis, Pasteur experiments, germ theory of disease.

1.2. Classification of microorganisms – R.H. Whittaker's five kingdom concept, Carl Woese's-Domain system.

1. 3. Brief account of special groups of bacteria- Archaebacteria, Mycoplasma, Chlamydia, Actinomycetes, Rickettsias and Cyanobacteria.

UNIT- 2 : VIRUSES (12 Lectures)

2.1. Viruses- Discovery, general account, structure& replication of –T4 Phage (Lytic, Lysogenic) and TMV, Viroids, Prions.

2.2. Plant diseasescaused by viruses– Symptoms, transmission and control measures (Brief account only).

2.3. Study of Tobacco Mosaic, Bhendi Vein clearing and Papaya leaf curl diseases.

UNIT 3: BACTERIA (12 Lectures)

3. 1. Bacteria: Discovery, General characteristics, cell structure andnutrition.

3.2. Reproduction- Asexual and bacterial recombination (Conjugation, Transformation, Transduction).

3.3. Economic importance of Bacteria.

UNIT –4: ALGAE (12Lectures)

4.1. General account - thallus organization and reproduction in Algae.

4.2. Fritsch classification of Algae (up to classes only) and economic importance.

4.3. Structure, reproduction and life history of Oedogonium, Ectocarpus and Polysiphonia.

UNIT 5: FUNGI (12 Lectures)

5.1. General characteristics and outline classification (Ainsworth).

5.2. Structure, reproduction and life history of Rhizopus (Zygomycota),Penicillium (Ascomycota), and Puccinia (Basidiomycota).

5.3. Lichens-Structure and reproduction; ecological and economic importance.

Text /Reference Books:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop understanding on the concept of microbial nutrition
2. Classify viruses based on their characteristics and structures
3. Develop critical understanding of plant diseases and their remediation.
4. Examine the general characteristics of bacteria and their cell reproduction/ recombination
5. Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance
6. Conduct experiments using skills appropriate to subdivisions

MCRB1011	**MICROBIOLOGY AND PHYCOLOGY LAB**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).
5. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,Procholoron* through electron micrographs, temporary preparations and permanent slides.

BOTB2010	**O4 DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY**	**4L:0T:0P**	**4 Credits**

Course Objectives:

2. This course aims at making a familiarity with special groups of plants joined together by a common feature of sexual reproduction involving Archegonia.
3. To Create an understanding by observation and table study of representative members of phylogenetically important groups should be able to make students learn the process of evolution in a broad sense.
4. To Study of morphology, anatomy, reproduction and developmental changestherein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants

UNIT – 1: BRYOPHYTES (12Lectures)

1.1 Bryophytes: General characters, Classification (up to classes)

1.2. Structure, reproduction and Life history of Marchantia, and Funaria.

1.3. Evolution of Sporophyte in Bryophytes.

UNIT – 2: PTERIDOPHYTES (12Lectures)

2.1. Pteridophytes: General characters, classification (up to Classes)

2.2. Structure, reproduction and life history of Lycopodium, and Marsilea.

2.3. Heterospory and seed habit.

2.4. Evolution of stele in Pteridophytes.

UNIT – 3: GYMNOSPERMS (12Lectures)

3.1. Gymnosperms: General characters, classification (up to classes)

3.2. Morphology, anatomy, reproduction and life history of Pinus and Gnetum

3.3. Economic importance with reference to wood, essential oils and drugs

UNIT –4: Tissues and Tissue systems (12Lectures)

4.1.Meristems - Root and Shoot apical meristems and their histological organization.

4.2.Tissues – Meristematic and permanent tissues (simple, complex, secretory)

4.3.Tissue systems–Epidermal, ground and vascular.

UNIT – 5. Secondary growth (12Lectures)

5.1. Anomalous secondary growth in Achyranthes, Boerhaavia and Dracaena.

5.2. Study of local timbers of economic importance-Teak, Rosewood, Red sanders and Arjun (Tella maddi).

Course Learning Outcomes:

1. Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms
2. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
3. Understanding of plant evolution and their transition to land habitat.
4. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperm

Text /Reference Books

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

BOTB2010	**O5 DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY LAB**	**0L:0T:2P**	**4 Credits**

LIST OF EXPERIMENTS

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.

8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia.
9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

BOTB3020	**ECONOMIC BOTANY**	**4L:0T:2P**	**5 Credits**

COURSE OBJECTIVES

1. To relate the principles of Economic Botany to other disciplines in biology.
2. To relate useful plants to the affairs of mankind.
3. To relate useful plants to the local and world economy.

Unit 1: Origin of Cultivated Plants (6 lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals and Legumes (6 lectures)

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man
and ecosystem.

Unit 3: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry.
Potato – morphology, propagation & uses.

Unit 4 : Spices and Beverages (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper Tea, Coffee (morphology, processing & uses)

Unit 5 : Sources of oils and fats (10 lectures)

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

COURSE OUTCOME

1. Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
2. Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
3. Develop a basic knowledge of taxonomic diversity and important families of useful plants
4. Increase the awareness and appreciation of plants & plant products encountered in everyday life
5. Appreciate the diversity of plants and the plant products in human use

Text/ Reference Books

1) Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2) Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,
3) The Netherlands.
4) Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

BOTB3020	**ECONOMIC BOTANY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1) **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2) **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3) **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests),
4) Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
5) **Spices:** Black pepper, Fennel and Clove (habit and sections).
6) **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
7) **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
8) **Essential oil-yielding plants**: Habit sketch of *Rosa*, *Vetiveria*, *Santalum* and *Eucalyptus* (specimens/photographs).

BOTB4010	**PHYTOGEOGRAPHY**	**4L:0T:2P**	**5 Credits**

COURSEOBJECTIVE

1. To give a fundamental understanding of the distribution of vascular plants and of the basic models which describe it.
2. To know about the floristic regions and plant formations of the Planet, in the light of previous continental and climatic evolution.
3. To learn floristic recording of specific habitats and the assessment of their naturality on the basis of chorological and life form spectra of the flora.

Unit I: Introduction, soil and water 15 lectures

Basic concepts; Levels of organization. Abiotic and biotic Components and their interrelationships and dynamism, homeostasis. Soil: Origin; Types and Formation; Composition; Physical, Chemical and Biological components; Soil profile. Types of soils in India. Water: States of water in the environment; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Atmospheric moisture; Water in soil; Ground water table. Water resources of India

Unit II: Ecological adaptations, Population ecology 15 lectures

Variations in adaptation of plants in relation to light, temperature, water, wind and fire. Biotic interactions: Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, Population ecology: Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit III: Plant Communities and Ecosystem 15 lectures

Community characteristics: analytical and synthetic; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect; Succession: processes, types; climax concept. Primary vs Secondary succession. Ecosystem: Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Ecosystems of India.

Unit IV: Functional Aspects of Ecosystem and Phytogeography 15 lectures

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus. Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical division of India; Local Vegetation.

Course outcomes

On completion of this course, the students will be able to:

1. Understand core concepts of biotic and abiotic
2. Classify the soils on the basis of physical, chemical and biological components
3. Analysis the phytogeography or phytogeographical division of India
4. Evaluate energy sources of ecological system
5. Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
6. Conduct experiments using skills appropriate to subdivisions

Text/ Reference Books

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

BOTB4010	**PHYTOGEOGRAPHY LAB**	**4L:0T:2P**	**5 Credits**

LIST OF EXPERIMENTS:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (with pH meter, universal indicator/Lovibond comparator and/or pH paper strip)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid
5. titration method.
6. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
7. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
8. Study of morphological adaptations of hydrophytes and xerophytes (four each).
9. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).
10. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

11. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

----------ZOOLOGY----------

ZOOB1010	**NON-CHORDATES : PROTISTS TO ECHINODERMATA**	**4L:0T:2P**	**5 Credits**

Course Objectives:

1. To understand different levels of biological diversity through the systematic classification of invertebrate fauna
2. To understand the taxonomic position of protozoa to echinodermatas.
3. To understand the general characteristics of animals belonging to protozoa to echinodermatas.
4. To understand the body organization of phylum from protozoa to echinodermatas.
5. To understand the origin and evolutionary relationship of different phylum from protozoa to to echinodermata.

Unit 1: Protista, Parazoa and Metazoa 12 lectures

1.1.General characteristics and Classification up to classes
1.2.Study of *Euglena*, *Amoeba* and *Paramecium*
1.3.Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
1.4. Locomotion and Reproduction in Protista

Unit 2: Porifera and Cnidaria 12 lectures

2.1.General characteristics and Classification up to classes
2.2. Canal system and spicules in sponges
2.3. General characteristics and Classification up to classes and Metagenesis in *Obelia*
2.4. Polymorphism in Cnidaria
2.5. Corals and coral reefs

Unit 3: Helmimthes, Platyhelminthes and Annelida 12 lectures

3.1.General characteristics and Classification up to classes
3.2. Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

Unit 4: Arthropoda 12 lectures

4.1. General characteristics and Classification up to classes
4.2. Type study of palamaneous
4.3. Type study of periplata
4.4. Insect and vectorsof human diseases.

Unit 5 Mollusca and Echinodermata **12 lectures**

5.1. General characteristics and Classification up to classes
5.2. Mollusca –type study of prawn
5.3. Echinodermata – study of star fish.
5.4. Minor Phyla- Ectophora and rotifera

Course Learning Outcomes: The course will enable the students to learn the following:

1. Student should be able to describe unique characters of protozoa to echinodermata
2. Student should be able to recognize life functions of protozo to echinodermata
3. To recognise the ecological role of phylum protozoa to echinodermata
4. **T**o recognise the diversity from protozoa to echinodermata

Text /Reference Books:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

O6

ZOOB1011	**NON CHORDATES LAB**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla*
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro- photographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

ZOOB2010	**CHORDATES**	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVES

1. To understand what the chordates are.
2. To understand different categories of chordates.
3. To understand the general characters of chordates.
4. To understands the level of organization in chordate subphylum.

5. To understand the origin and evolutionary relationship in different subphylum of chordates.

UNIT 1:

1.1. General characters of Chordata
1.2 Prochordata
1.2.1 Salient features of Cephalochordata
1.2.2 Structure of Branchiostoma
1.2.3 Affinities of Cephalochordata
1.2.4 Salient features of Urochordata
1.2.5 Structure and life history of Herdmania
1.2.6 Significance of Retrogressive metamorphosis

Unit – 2:

2.1 Cyclostomata
2.1.1 General characters of Cyclostomata
2.1.2 Comparision of the Petromyzon and Myxine
2.2 Pisces
2.2.1 General characters of Fishes
2.2.2 Classification of fishes up to sub - class level with examples
2.2.3 Scoliodon - External features, Digestive system, Respiratory system, Heart, Brain
2.2.4 Migration in Fishes
2.2.5 Types of Scales

Unit – 3:

3.1 Amphibia
3.1.1 General characters of Amphibian
3.1.2 Classification of Amphibia upto orders with examples.
3.1.3 Rana hexadactyla - External features, Digestive system, Respiratory system, Heart, Brain
3.2 Reptilia
3.2.1 General characters of Reptilia
3.2.2 Classification of Reptilia upto orders with examples
3.2.3 Calotes - External features, Digestive system, Respiratory system, Heart, Brain
3.2.4 Identification of Poisonous snakes and Skull in reptiles

Unit :4 Aves

4.1 General characters of Aves
4.2. Classification of Aves upto subclasses with examples.
4.3 Columba livia - External features, Digestive system, Respiratory system, Heart, Brain
4.4 Migration in Birds
4.5 Flight adaptation in birds

Unit -5 Mammalia

5.1 General characters of Mammalia
5.2 Classification of Mammalia upto sub - classes with examples
5.3 Comparision of Prototherians, Metatherians and Eutherians
5.4. Dentition in mammals

COURSE OUTCOME

1. Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
2. Student should be able to recognize life functions of urochordates to fishes.
3. To understand the ecological role of different groups of chordates.
4. To understand the diversity ofchordates

Text Books/ Reference Books

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

ZOOB2011	**CHORDATES LAB**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Protochordata : Herdmania, Amphioxus, Amphioxus T.S. through pharynx
2. Cyclostomata : Petromyzon, Myxine
3. Pisces : Pristis, Torpedo, Channapleuronectes, Hippocampus, Exocoetus, Eheneis, Labeo, Catla, Clarius, Auguilla,Protopterus Placoid scale, Cycloid scale, Ctenoid scale
4. Amphibia : Ichthyophis, Amblystoma, Siren, Hyla, Rachophous Axolotl larva
5. Reptilia : Draco, Chemaeleon, Uromastix, Vipera russeli, Naja, Bungarus, Enhydrina, Testudo, Trionyx, Crocodilus
6. Aves : Passer, Psittacula, Bubo, Alcedo, Columba, Corvus, Pavo,
7. Study of different types of feathers : Quill, Contour, Filoplume down
8. Mammalia : Ornithorthynchus, Tachyglossus, Pteropus, Funambulus, Manis, Loris, Hedgehog Osteology : Appenducular skeletons of Varanus, Pigeon Rabbit - Skull, fore limbs, hind limbs and girdles

ZOOB3010	**ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM**	**4L:0T:0P**	**4 Credits**

COURSE OBJECTIVE

1. To know about the functioning of various system of organisms and their interrelationship for well-coordinated function.
2. To understand structure and functions of different animal tissues and endocrine glands

Unit 1:Tissues

1.1. Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

1.2. Bone and Cartilage Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 2:Nervous System

2.1. Structure of neuron, resting membrane potential,

2.2. Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers;

2.3. Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc;

2.4. Physiology of hearing and vision.

Unit 3:Muscle Histology of different types of muscle;

3.1. Ultra structure of skeletal muscle;

3.2 Molecular and chemical basis of muscle contraction;

3.3. Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 4:Reproductive System

4.1. Histology of testis and ovary;

4.2. Physiology of male and female reproduction; Puberty,

4.3. Methods of contraception in male and female

Unit 5 :Endocrine System

5.1. Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action;

5.2. Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones;

5.3. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones

COURSE OUTCOME

1. Should be able to recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same i.e., should learn about an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body. e.g. Cardiovascular and Respiratory systems to meet the oxygen demand of the body.
2. Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances i.e. how physiological mechanisms adapt in response to various external and internal stimuli in order to maintain health.
3. Knowledge of role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes

TEXT / REFERENCE BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

ZOOB3011	**ANIMAL PHYSIOLOGY:**	**0L:0T:2P**	**2 Credits**

	CONTROLLING AND COORDINATING SYSTEM LAB		

LIST OF EXPERIMENTS

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues (*Subject to UGC guidelines)

BCHB4210	**BIOCHEMISTRY OF METABOLIC PROCESSES**	**4L:0T:0P**	**4 Credits**

COURSE OBJECTIVES

1. To understand The relationship between the structure and function of specific biological molecules and enzymes are regulated
2. To understand main principles of metabolic biochemistry concepts and homeostasis is controlled in the body
3. To understand function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated
4. To Understand the metabolism of carbohydrates and fates of various intermediate and end products

Unit 1: Overview of Metabolism

1.1 Catabolism vs Anabolism, Stages of catabolism,

1.2. Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions;

1.3. Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

2.1. Sequence of reactions and regulation of glycolysis, Citric acid cycle,

2.2. Phosphate pentose pathway,

2.3. Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

3.1. β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms;

3.2.Biosynthesis of palmitic acid;

3.3. Ketogenesis

Unit 4: Protein Metabolism

4.1. Catabolism of amino acids: Transamination, Deamination,

4.2. Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

5.1.Redox systems; Review of mitochondrial respiratory chain,

5.2.Inhibitors and un-couplers of Electron Transport System

COURSE OUTCOME

1. Students gain knowledge and skill in the interactions and interdependence of physiological and biomolecules and the understand essentials of the metabolic pathways along with their regulation.
2. To understand the principles, instrumentation and applications of bioanalytical techniques.
3. To expose the students to various processes used in industries.
4. Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation and be able to design and conduct scientific experiments and analyze the resulting data.

Text/ Reference Books

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

BCHB4211	**BIOCHEMISTRY OF METABOLIC PROCESSES LAB**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS:

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

----------BIOTECHNOLOGY ----------

BCHB1010	**BIOCHEMISTRY & METABOLISM**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems. .
2. To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively
3. To Understand the importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions.

UNIT 1: Chemical constituents of Life I: (12L)

1.1. Amino acids: Structure & Function. Structure and properties of Amino acids

1.2. Proteins**:** Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

1.3.Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT 2: Chemical constituents of Life II 12 lectures

2.1. Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

2.2. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids,

2.3. Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, 2.4. Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT 3 : Bioenergenetics (12 lectures)

3.1. Laws of thermodynamics,
3.2. concept of free energy, endergonic and exergonic reactions, coupled reactions,
3.3. Redox reactions.
3.4. ATP: structure, its role as a energy currency molecule.

UNIT 4: Enzymes (12 lectures)

4.1. Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group;
4.2. Classification of enzymes
4.3. Features of active site, substrate specificity,
4.4. Mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

UNIT 5: Carbohydrates Metabolism (12 lectures)

5.1. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions.
5.2. Pentose phosphate pathway and its significance,
5.3. Gluconeogenesis Glycogenolysis and glycogen synthesis.
5.4. TCA cycle, Electron Transport Chain, Oxidative phosphorylation

Text /Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman
2. and Co.
3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of
4. Plants.American Society of Plant Biologists.
5. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH
6. Freeman and Company, New York, USA.
7. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
8. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.
2. Gain proficiency in basic laboratory techniques in both chemistry and biology, and be able to apply the scientific method to the processes of experimentation and hypothesis testing.

BCHB1011	**BIOCHEMISTRY & METABOLISM LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Quantitative estimation of RNA by orcinol reagent.
2. Quantitative estimation of DNA by DPA method.
3. Principles of Colorimetry**: (i)** Verification of Beer's law, **(ii)** To study relation between absorbance and % transmission.
4. Preparation of buffers.
5. Isolation of casein from milk.
6. Separation of sugars/amino acids by paper chromatography.
7. Qualitative tests for Carbohydrates, lipids and proteins
8. Determination of acid number of fats.

General Elective - II

BTEB2020	**PLANT AND ANIMAL PHYSIOLOGY**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To acquaint students with Physiological Processes in Plants and Animals
2. To impart the knowledge of Physiology and Ecology

Detailed Syllabus:

1: Carbon and nitrogen metabolism in plants (12 Lectures)

1.1 Photosynthesis- Photosynthesis pigments,

1.2 concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point

1.3 Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

1.4 Nitrogen cycle

Unit 2: Plant Growth and development (12 L)

2.1. Growth and development: Definitions, phases of growth, growth curve

2.2. Growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

2.3. Concept of photoperiodism and vernalization

Unit 3 :Animal Physiology (12 L)

3.1.Physiology of Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids.

3.2.Mechanism of Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.

3.3.Phsiology of excretion: urine formation and osmoregulation, ornithine cycle

Unit 4: Animal Physiology II (12 L)

4.1. Composition of blood, Plasma proteins & their role, blood cells, Haematopoisis, Mechanism of coagulation of blood.

4.2. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

4.3. Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters

4.4. Endocrine system-Mechanism of action of hormones (insulin and steroids)

Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Unit 5: Mineral nutrition in plants and animals (12 L)

5.1. Plant Nutrients- micro and macro nutrients and their role.

5.2. Mineral toxicity and Hydroponics

5.3. Vitamins and Minerals in animals

Text /Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & sons,Inc.
3. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
4. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
5. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
6. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
7. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
8. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th edition, W.H.
9. Freeman and Company, New York, USA.

10. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
11. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand basic life processes of plants and animals
2. Understand important chemical reactions and pathways involved in major processes of plants and animals
3. Have knowledge about hormones and other chemical/ non chemical factors that affect the plant and animal growth characteristics
4. Have knowledge about the basic anatomy of organs and their systems along with their linkage to one another

BTEB3020	**IMMUNOLOGY**	**4L:0T:0P**	**4Credits**

COURSE OBJECTIVE

- To Understand of the overview of immune system including cells, organs and receptors.
- To learn structure and functions of different classes of immunoglobulins, the genetic basis of antibody diversity and the importance of humoral, cell-mediated and innate immune responses in combating pathogens.
- To understand mechanisms involved in different types of hypersensitivity, and the importance of conventional vs.recombinant vaccines.
- To get acquainted with the importance of antigen-antibody interaction in disease diagnosis.
- To understand the principles of tolerance, autoimmunity and the role of immunity in protection against pathogens.

Unit 1 Introduction to Immunology (12 lectures)

Immune Response - An overview, components of mammalian immune system Molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Unit 2 Immunoglobulin regulation (12 lectures)

Regulation of immunoglobulin gene expression – clonal selection theory, Allotypes & idiotypes, allelic exclusion immunologic memory, Heavy chain gene transcription, genetic basis of antibody diversity, Hypotheses (germ line & somatic mutation), antibody diversity.

Unit 3. MHC(12 lectures)

Major Histocompatibility complexes – class I & class II MHC antigens, Antigen processing.

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

Unit 4. Immunotechniques (12 lectures)

Antigen antibody interaction techniques- Precipitation Reactions: Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D ImmunoelectrophoresisAgglutination Reactions: Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests. Synthesis of Monoclonal antibodies & Applications.

Unit 5 DNA Vaccines (12 lectures)

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents,Passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA

COURSE OUTCOME

- Students will be able to understand and apply basic microbiological techniques and correlate them with their fundamental concepts in the subject.
- Students will be able to understand and apply basic immunological techniques and correlate them with their fundamental concepts in the subject.

Text/ Reference Books

1. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
3. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
5. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
6. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
7. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publications.

BTEB3021	**IMMUNOLOGY LAB**	**0L:0T:4P**	**2Credits**

List of Experiments:

1. Differential leucocytes count
2. Total leucocytes count

3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Passive Agglutination- RA Factor Test.
8. ELISA (Kit based).
9. Dot ELISA
10. Single radial immune diffusion Ouchterlony double immune diffusion

BTEB4010	**PHARMAGENOMICS**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To understand different antimicrobial agents
2. To learn the general principles of pharmacology
3. To understand the concept of toxicology
4. To study the mechanism of drug absorption and distribution
5. To understand basic and regulatory toxicology

Detailed Syllabus:

Unit I- Chemotherapeutic agents

Discovery and Design of antimicrobial,Classification of Antibacterial agents, Selective toxicity, MIC, MLC, Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin Injury to plasma membrane: Polymyxin, Inhibition of protein synthesis: Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides Erythromycin, Inhibition of nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole, Antimetabolites: Sulphonamides, Trimethoprim Drug resistance: Mechanism origin, transmission, Use and misuse of antimicrobial agents, Antifungal drugs, Antiviral drugs.

Unit 2 General principles of pharmacology

Mechanism of drug action , drug receptors and biological responses second-messenger systems, the chemistry of drug–receptor binding, dose–response relationship: therapeutic index, ED, LD, Potency and Intrinsic Activity, Drug antagonism

Unit 3 Drug Absorption and distribution

Absorption of drugs from the alimentary tract, factors affecting rate of gastrointestinal absorption, absorption of drugs from lungs and skin , absorption of drugs after parenteral administration factors influencing drug distribution , binding of drugs to plasma proteins, Physiological barriers to drug distribution

Unit 4 Basic and regulatory toxicology

Background Definitions Causation: degrees of certainty Classification, Causes Allergy in response to drugs, Effects of prolonged administration: chronic organ toxicity , Adverse effects on reproduction Poisons: Deliberate and accidental self-poisoning, Principles of treatment Poison-specific measures

General measures , Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, herbicides and pesticides, biological substances (overdose of medicinal drugs is dealt with under individual agents), Incapacitating agents: drugs used for torture, Nonmedical use of drugs

Text /Reference Books:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier
5. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
6. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A 18th edition
7. Medical Microbiology by Patrick Murray 5th edition
8. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
9. Understanding Viruses by Teri Shors
10. Mim's Medical Microbiology 5th edition
11. Casarett & Doull's Toxicology- The Basic Science Of Poisons

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Elucidate the concepts of pharmacology
2. Comment on causes of allergic reactions with response to drug or poison
3. Obtain clarity about mechanism of absorption of drugs from different tissues
4. State the mechanism of action of different antimicrobials

BTEB4011	**PHARMAGENOMICS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Antibiotic sensitivity test using agar cup method
2. Antibiotic sensitivity test using paper disc method
3. Antibiotic sensitivity test using ditch method.
4. Synergistic action of two drugs
5. LD 50, ED 50 evaluation using suitable models

Skill Enhancement Course (any four) (Credit: 02 each)- SEC1 to SEC4

IT SKILLS FOR CHEMISTS (Credits: 02) 30 Lectures

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 concentrationtime 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:
• McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).

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

BASIC ANALYTICAL CHEMISTRY (Credits: 02) 30 Lectures

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 6th 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 *2nd 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 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

CHEMICAL TECHNOLOGY & SOCIETY (Credits: 02) Theory: 30 Lectures

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.

CHEMOINFORMATICS

(Credits: 02)
Theory: 30 Lectures

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:

• Andrew R. Leach & Valerie, J. Gillet (2007) *An introduction to Chemoinformatics.* Springer: The Netherlands.

• Gasteiger, J. & Engel, T. (2003) *Chemoinformatics: A text-book*. Wiley-VCH.

• Gupta, S. P. (2011) *QSAR & Molecular Modeling.* Anamaya Pub.: New Delhi.

BUSINESS SKILLS FOR CHEMISTS(Credits: 02)Theory: 30 Lectures

Business Basics

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

Chemistry in Industry

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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

INTELLECTUAL PROPERTY RIGHTS (IPR)
(Credits: 02)
Theory: 30 Lectures

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:

• N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).

• Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).

• P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).

• Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell*, West Group Publishers (2000).
• Jayashree Watal, *Intellectual property rights in the WTO and developing countries*, Oxford University Press, Oxford.

ANALYTICAL CLINICAL BIOCHEMISTRY(Credits: 02)THEORY: 30 Lectures

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:

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

GREEN METHODS IN CHEMISTRY(Credits: 02)Theory: 30 Lectures

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

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PHARMACEUTICAL CHEMISTRY (Credits: 02) Theory: 30 Lectures

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory 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:

• G.L. Patrick: Introduction to *Medicinal Chemistry, Oxford University* Press, UK.

• Hakishan, V.K. Kapoor: *Medicinal and Pharmaceutical Chemistry,* Vallabh Prakashan, Pitampura, New Delhi.

• William O. Foye, Thomas L., Lemke , David A. William: *Principles of Medicinal Chemistry*, B.I. Waverly Pvt. Ltd. New Delhi.

CHEMISTRY OF COSMETICS & PERFUMES (Credits: 02)30 Lectures

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:

• E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.

• P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.

• B.K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.

PESTICIDE CHEMISTRY(Credits: 02) 30 Lectures

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

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

2 Preparation of simple organophosphates, phosphonates and thiophosphates

Reference Book:

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

FUEL CHEMISTRY (Credits: 02) 30 Lectures

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:

• E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
• P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
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