SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & Recognized by UGC u/s (2f) of UGC Act 1956]

Patel Nagar, Dehradun-248001, Uttarakhand

MINUTES OF MEETING

SECOND BOARD OF STUDIES FOR UG, PG and Ph.D PROGRAMMES IN CHEMISTRY

AGENDA FOR MEETING OF SECOND BOARD OF STUDIES IN CHEMISTRY

School of Basic & Applied Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun

The Following agenda points will be discussed with Honourable External Expert and other respected members in the meeting of BOS Chemistry, is scheduled on 3rd july 2021 in the school of basic and applied Science, SGRR University.

Item No. 1 To confirm the minutes of the 1st meeting of BOS for UG Program held on 11september 2017, PG Program held on 25 august, 2018 and PhD Program held on 8 may 2020.

Item No. 2 Addition of Program outcome, Program specific outcome in all programs & course objective, course outcome, and mapping of CO with PO and PSO in all courses of chemistry department as per UGC Regulations 2016, Shri Guru Ram Rai University, Patel Nagar, Dehradune.

Item No. 3 Allotment, description of credits and max marks to different courses in the all Programme.

Item No. 4 Addition, deletion or modification in syllabus, if required.

Item No. 5 Allotment of course codes to different core and elective courses in the proposed degree course Programme.

Item No. 6 Medium of instruction, question paper pattern, medium of Examination, duration of Examination, allotment of marks in Internal and External Exams.

Item No. 7 Evaluation pattern and distribution of marks.

chemistry department as per UGC Regulations 2016, Shri Guru Ram Rai University, Patel Nagar, Dehradun.

Resolutions: The inclusion of PO, PSO, CO and mapping in the revised programmes were discussed in detail with the honourable members.

Item No. 3 To review the allotment, description of credits and max marks to different courses in the all Programme.

Resolutions: The credits and max marks for the all Courses have been finalized.

Item No. 4 To review the addition, deletion or modification in syllabus, if required.

Resolutions: After going through the syllabi, the detailed discussion took place with certain correction and suggestions from all the members. As recommended by honourable experts, likewise the corrections were made.

M.Sc. Chemistry

Correction 1: Few topics in Unit V and VI were deleted in the core paper Heterocyclic Chemistry (MCHC302).

Correction 2: Few topics in Unit I and II were deleted in the elective paper Bioinorganic, Bioorganic & Biophysical Chemistry (MCHE313).

B.Sc. Chemistry

Correction 1: Few topics were deleted from Unit 1, 2, 4,5 and 7 in the core paper Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry(BCHC301) that students will be studying in further semesters.

Correction 2: Few topics in Unit 4 were deleted in the core paper Coordination Chemistry, states of Matter & Chemical Kinetics (BCHC401).

Correction 3: Few topics in Unit 2 and 3 were deleted in the elective paper Analytical Methods in Chemistry (BCHD501). Those topics in detail will be studied by students in M.Sc. programme.

Correction 4: Elective paper Polymer Chemistry (BCHD502) has been replaced by elective paper Industrial Chemical & Environment (BCHD505).

Correction 5: Skill paper Basic Analytical Chemistry (BCHS604) has been replaced by skill paper Chemistry of Soil, Water & Food (BCHS605) because student is studying similar paper in Vth Sem.

Item No. 5 To review the allotment of course codes to different core and elective courses in the degree course Programme.

Resolutions: The course codes to different core and elective courses in the degree course programme were allotted unanimously.

Item No. 6 To review the medium of instruction, question paper pattern, medium of Examination, duration of Examination, allotment of marks in Internal and External Exams.

Resolutions:

- The members were of the view that the medium of instruction would be English for all the course which would be finalized later as per SGRR University norms
- The duration of the End term examination would be two or three hours for each Theory paper as per SGRR University norms.

Item No. 7 To review the evaluation pattern and distribution of marks

Resolutions: The members were of the view that the evaluation pattern and distribution of marks should follow university norms to bring the uniformity with other subjects.

The meeting ended with a vote of thanks to the chair.

Prof. Dwarika Prasad
(Chairperson)

Prof. H. V. Pant
(External Expert)

Prof. Arun Kumar
(Member)

Dr. Sheetal Tyagi
(Member)

Mrs. Shreya Kotnala
(Member)

MINUTES OF MEETING

SECOND BOARD OF STUDIES IN DEPARTMENT OF CHEMISTRY

Attendance sheet

A meeting of all the members of second board of tudies in Department of chemistry, school of basic and applied Science, SGRR University held on 3rd july 2021 at 02.00 PM. The following members attended the meeting:

S.No	Name	Signature
1	Prof. Dwarika Prasad, Head, Department of chemistry, SGRRU, Dehradun. (Chairperson)	
2	Prof. H. V. Pant, Associate Professor, Department of chemistry, SGRR PG College Dehradun. (External Expert)	
3	Prof. Arun Kumar, Dean research, SGRRU, Dehradun (Member)	
4	Dr. Sheetal Tyagi, Assistant Professor, Department of chemistry, SGRRU, Dehradun. (Member)	
5	Mrs. Shreya Kotnala, Assistant Professor, Department of chemistry, SGRRU, Dehradun. (Member)	

SHRI GURU RAM RAI UNIVERSITY

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SYLLABUS

Bachelor of Science (Chemistry)

School of Basic & Applied Sciences

(W.E.F 2021-2022)

Bachelor of Science

OUTCOME BASED EDUCATION

Programme outcome (POs)

Students will be able to

PO 1	Bachelor of Science offers theoretical as well as practical knowledge about different subject areas.
PO2	Graduates will develop scientific temperament to solve scientific problems in emerging areas of science at National and International level.
PO3	Graduates will acquire coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future.
PO4	Graduate will have clarity of thought and expression. Qualities like logical thinking and decision making will be enhanced
PO5	Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
PO6	Graduates will be able to compete in various national and international competitive examinations.
PO7	Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological context with a systematic approach towards sustainable development.
PO8	Graduates will have critical thinking, follow innovations and developments in Science and technology
PO9	Graduates will acquire effective communication skills
PO10	Graduates will understand ethical principles and responsibilities for effective citizenship.
PO11	Graduates will develop new and enhancing conversational skills that lead to not only to good communication but also to the excellent drafting abilities linked with technical reports and presentations.
PO12	Graduates will competent enough for doing jobs in Govt. and private sectors of academia, research and industry.

Program Specific Outcome (PSOs)

PSO 1	Chemistry graduates will become familiar with the fundamental concepts in organic, inorganic, physical and analytical chemistry.
PSO2	Chemistry graduates will develop analytical skills and acquire the ability to synthesize, separate and characterize compounds using laboratory techniques.
PSO3	Chemistry graduates will be able to understand the qualitative and quantitative chemical analysis of the compounds in the laboratory.
PSO4	Skill enhancement courses like chemistry of cosmetics & perfumes, pesticide and polymer chemistry will equip students with the knowledge and skills which will help them to make a successful career in the respective industries.

Eligibility for admission:

Any candidate who has passed the Plus Two of the Higher Secondary Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in PCM/PCB with not less than 45 %-marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme: 3 years

STUDY & EVALUATION SCHEME
Choice Based Credit System
Bachelor of Science (Chemistry)

First Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BCHC101	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic hydrocarbons	4	-	-	4	30	70	100
2	Elective	AECC101/102/103 (Compulsory common course in UG programmes *CBZ/BT/MB/PCM	Environmental Science/English/MIL Communication	4	-	-	4	30	70	100
Practical										
1	Core	BCHL101	Lab Course Based on BCHC101	-	-	4	2	30	70	100
			Total	8	-	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BCHC201	Chemical Energetics, Equilibria & Functional Group Organic Chemistry	4	-	-	4	30	70	100
2	Elective	AECC201/202/203 (Compulsory common course in UG programmes *CBZ/BT/MB/PCM	Environmental Science/English/MIL Communication	4	-	-	4			
Practical										
1	Core	BCHL201	Lab Course Based on BCHC201	-	-	4	2	30	70	100
			Total	8	-	4	10	60	140	200

L – Lecture, T – Tutorial, P – Practical, C – Credit

Third Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BCHC301	Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional group Organic Chemistry	4	-	-	4	30	70	100
2	Skill Enhancement	BCHS302	Pesticide Chemistry	4	-	-	4	30	70	100
Practical										
1	Core	BCHL301	Lab Course Based on BCHC301	-	-	4	2	30	70	100
			Total	8	-	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Fourth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BCHC401	Coordination Chemistry, States of Matter & Chemical Kinetics	4	-	-	4	30	70	100
2	Skill Enhancement	BCHS402	Chemistry of Cosmetics & Perfumes	4	-	-	4	30	70	100
Practical										
1	Core	BCHL401	Lab Course Based on BCHC401	-	-	4	2	30	70	100
			Total	8	-	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Fifth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Elective	BCHD 501/503/505(Anyone to be opted by students)	Analytical Methods in Chemistry Green Chemistry Industrial Chemicals and Environment	4	-	-	4	30	70	100
2	Skill Enhancement	BCHS504	Polymer Chemistry	4	-	-	4	30	70	100
Practical										
1	Elective	BCHL501/503/505	Lab Course Based on BCHD501/503/505	-	-	4	2	30	70	100
			Total	8	-	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Sixth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Elective	BCHD601/602/ 603 (Any one opted by students)	Spectroscopic Methods of Analysis Organometallics, Bio-inorganic, Polynuclear Hydrocarbon, UV and IR Spectroscopy Molecules of Life	4	-	-	4	30	70	100
2	Skill Enhancement	BCHS 605	Chemistry of Soil, Water and Food	4	-	-	4	30	70	100
Practical										
1		BCHL601/602/603	Lab Course Based on BCHD601/602/603	-	-	4	2	30	70	100
			Total	8	-	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Examination Scheme:

Components	Ist internal	IInd Internal	External (ESE)
Weightage (%)	15	15	70

Course code: BCHC101				
Course Name: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons				
Semester /Year: I				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The course reviews the structure of the atom, which is a necessary pre-requisite to understand the nature of chemical bonding in compounds. It provides knowledge about the three main types of bonding viz. ionic, covalent and metallic bonding. This core course is designed to revisit the fundamental concepts of organic chemistry in details so that the students can acquire the must needed foundation for better understanding of other organic chemistry topics in subsequent semesters. Stereochemistry is introduced to visualize the organic molecules in a three-dimensional space. To establish the application of these concepts, the functional groups- alkanes, alkenes, and alkynes are introduced.

Couse Contents

Unit 1 Atomic Structure **[No. of Hours: 14]**

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

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

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

Unit 2 Chemical Bonding and Molecular Structure **[No. of Hours: 16]**

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

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

tetrahedral, trigonal bipyramidal and octahedral arrangements.
Concept of resonance and resonating structures in various inorganic and organic compounds.
MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Unit 3 Fundamentals of Organic Chemistry **[No. of Hours: 8]**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.
Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.
ReactiveIntermediates: Carbocations, Carbanions and free radicals.
Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK_a values.
Aromaticity: Benzenoids and Hückel's rule.

Unit 4 Stereochemistry **[No. of Hours: 10]**

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit 5 Aliphatic Hydrocarbons **[No. of Hours: 12]**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.
Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis,from Grignard reagent. Reactions: Free radical Substitution: Halogenation.
Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.
Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO4, ozonolysis andoxidation with hot alk. KMnO4.

Text Books:

TB1. Puri Sharma Kalia, Principles Of Organic Chemistry, Milestone Publishers
TB2. R L Madan, Chemistry For Degree Students, S. Chand

Reference Books:

RB1. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
RB2. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge of basics of atomic structure, chemical bonding, fundamentals of organic chemistry, stereochemistry and aliphatic hydrocarbons
CO2	Understand fundamentals of organic chemistry, stereochemistry, atomic structure and bonding.
CO3	Illustrate VSEPR, MOT, preparation and reactions of aliphatic hydrocarbons.
CO4	Compare various types of reaction intermediates.
CO5	Predict the configurations of the organic compounds on the basis of stereochemistry.
CO6	Solve problems related to atomic structure and chemical bonding.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	2	1	1	1	1	2	3	3	1	1	1
CO2	3	1	2	1	3	2	1	1	1	1	2	3	3	1	1	1
CO3	1	1	1	3	2	3	3	1	1	1	2	3	3	1	1	1
CO4	1	1	1	3	1	3	1	1	3	1	2	3	3	1	1	1
CO5	3	1	1	1	1	1	1	1	3	1	2	3	3	1	1	1
CO6	2	3	2	3	2	2	3	3	3	1	2	3	3	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL101				
Course Name: Lab Course Based On BCHC101				
Semester /Year: I				
	L	**T**	**P**	**C**
	-	**-**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The aim of this course is to make learners understand the concept of quantitative analysis. It also provides opportunity to the students to practice hands on experiments related to paper chromatography.

Couse Content **[No. of Hours: 60]**

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given)
   - Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   - Identify and separate the sugars present in the given mixture by paper chromatography.

Text Books:

TB1. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand
TB2. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

Reference Books:

RB1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
RB2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

Course outcomes (COs):

Upon successful completion of the course, student will be able to:

CO1	Gain knowledge about methodology used for detection of extra elements present in organic compounds.
CO2	Understand the concept of quantitative analysis of various inorganic compounds by means of titrations.
CO3	Apply the concept of paper chromatography for the separation of mixtures of amino acids and sugars.
CO4	Analyze the results of titrations and paper chromatography.
CO5	Estimate the amount of oxalic acid by titrating it with KMnO4
CO6	Calculate retention factor values of amino acids and sugars separated by paper chromatography

CO-PO-PSO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	1	3	1	1	3	1	2	1	2	3	1	3	3	1
CO2	3	3	1	3	1	1	3	1	1	1	2	3	1	3	3	1
CO3	3	2	1	3	1	1	1	3	3	1	2	3	1	3	3	1
CO4	3	2	2	1	2	2	3	2	2	1	2	3	2	2	2	2
CO5	3	1	2	1	2	2	1	2	1	1	2	2	2	2	2	2
CO6	3	1	2	1	2	2	3	2	1	1	1	1	2	1	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHC201				
Course Name: Chemical Energetics, Equilibria & Functional Group Organic Chemistry				
Semester /Year: II				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course aims to make the students understand some of the most important topics in physical chemistry like thermodynamic concepts, laws of thermodynamics, thermochemistry, ionic equilibrium, and chemical equilibrium. Discussion on topics like dissociation of strong and weak electrolytes, hydrolysis of salts, solubility and solubility product of sparingly soluble salts, pH, and buffers will enable the learners to understand the chemistry of everyday life. This course also provides the in-depth knowledge of preparations and properties of aromatic hydrocarbons, haloalkanes, haloarenes and oxygen containing functional groups.

Couse Contents

Unit 1 Chemical Energetics **[No. of Hours: 10]**

Review of thermodynamics and the Laws of Thermodynamics.

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

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

Unit 2 Chemical Equilibrium **[No. of Hours: 8]**

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

Unit 3 Ionic Equilibria **[No. of Hours: 12]**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Unit 4 Aromatic Hydrocarbons **[No. of Hours: 8]**

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

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

Unit 5 Alkyl and Aryl Halides **[No. of Hours: 8]**

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

Preparation: from alkenes and alcohols.

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

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

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

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

Unit 6 Alcohols, Phenols and Ethers (Upto 5 Carbons) **[No. of Hours: 7]**

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

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

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Unit 7 Aldehydes and ketones **[No. of Hours: 7]**

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

Preparation: from acid chlorides and from nitriles.

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

Text Books:

TB1. R L Madan , Chemistry For Degree Students, S. Chand

TB2. Puri Sharma Pathania, Principles of Physical Chemistry, Vishal Publishing Co.

Reference Books:

RB1. Arun Bahl, B S Bahl & G D Tuli, Essentials Of Physical Chemistry, S. Chand

RB2. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO1	Gain knowledge about the basics of chemical energetics, chemical and ionic equibria and various aromatic hydrocarbons, haloalkanes and oxygen containing functional groups
CO2	Understand the preparations and properties of aromatic hydrocarbons, haloalkanes, haloarenes and oxygen containing functional groups
CO3	Explain various laws of thermodynamics, Le Chateliers principle, buffer solution, salt hydrolysis.

CO4	Distinguish various types of nucleophilic substitution reactions.
CO5	Justify the applications of laws of chemical energetics.
CO6	Solve numerical problems related to chemical energetics, ionic and chemical equilibria.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	3	1	3	1	1	3	3	1	1	1
CO2	2	1	1	3	3	3	1	1	1	3	3	1	3	1	1	1
CO3	2	1	1	3	1	1	3	1	3	1	3	3	3	1	1	1
CO4	3	1	3	1	3	1	1	1	1	1	1	1	3	1	1	1
CO5	3	2	2	2	2	2	1	1	3	2	2	3	2	2	2	3
CO6	3	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL201				
Course Name: Lab Course Based on BCHC201				
Semester /Year: II				
	L	**T**	**P**	**C**
	-	**-**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course familiarizes students with the practical aspects of thermochemistry and pH metry. The course also deals with the one step synthesis of different oxygen containing organic compounds.

Couse Contents **[No. of Hours:60]**

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of H.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done

(a) Bromination of Phenol/Aniline
(b) Benzoylation of amines/phenols
(c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone

Text Books:

TB1. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand
TB2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Reference Books:

RB1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
RB2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about experiments related to thermochemistry
CO2	Understand the basic concept of pH and its measurement using pH meter.
CO3	Apply the concepts of thermochemistry and pH-metry in performing practical's related to it
CO4	Analyze the results of experiments.
CO5	Assess the mechanism involved in preparation of organic compounds.
CO6	Synthesize oxygen containing organic compounds by using one step synthesis process.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	1	1	2	1	1	3	3	1
CO2	3	1	1	3	1	1	1	1	3	2	2	3	1	3	3	1
CO3	3	1	1	3	1	1	1	1	3	2	2	3	1	3	3	1
CO4	3	2	1	2	1	2	2	2	2	3	1	1	2	3	3	2

CO5	3	2	2	2	1	2	2	2	2	1	3	2	2	3	3	2
CO6	3	2	2	2	2	2	2	2	2	1	3	2	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHC301				
Course Name: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry				
Semester /Year: III				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course aims to familiarize students with the basic concepts of solutions, phase equilibrium, conductance and electrochemistry. It also overs chemistry of organic molecules bearing a few common functional groups, which include oxygen & nitrogen containing functional groups. Synthetic avenues, physical & chemical properties and characteristic reactions of such compounds will be discussed in details. The course also encompasses various named reactions associated with these functional groups and their mechanisms.

Couse Contents

Unit 1 Solution **[No. of Hours:8]**

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications.

Unit 2 Phase Equilibrium **[No. of Hours:8]**

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one- component and two component system.

Unit 3 Conductance **[No. of Hours:8]**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit 4 Electrochemistry **[No. of Hours:8]**

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential. pH determination using hydrogen electrode and quinhydrone electrode.

Unit V Carboxylic acids (aliphatic and aromatic) and their derivatives

[No. of Hours:6]

Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell–Vohlard - Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. Reactions: Comparative study of nucleophilicity of acyl derivatives.

Unit VI Amines and Diazonium Salts **[No. of Hours:6]**

Amines (Aliphatic and Aromatic): Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2, Schotten–Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.

Unit VII Amino Acids, Peptides and Proteins **[No. of Hours:10]**

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

Reactions of Amino acids: ester of–COOH group, acetylation of–NH2group, complexation with Cu2+ions, ninhydrin test.

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

Unit VIII Carbohydrates **[No. of Hours:8]**

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

Text Books:

TB1. R L Madan, Chemistry For Degree Students, S. Chand.
TB2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

Reference Books:

RB1. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
RB2. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn and gain knowledge about the concept of solutions, phase equilibrium, conductance, electrochemistry, carboxylic acids, amines, amino acids and carbohydrates
CO2	Develop the basic understanding of solutions, phase equilibrium, conductance, electrochemistry, carboxylic acids, amines, amino acids and carbohydrates

CO3	Illustrate Nernst distribution law, Gibbs Phase rule, Kohlrausch law, concentration cell, preparation and properties of amines, diazonium salts, carbohydrates, amino acids and carbohydrates
CO4	Classify different types of solutions, proteins and carbohydrates & calculate thermodynamic properties of cell.
CO5	Distinguish amines, carbohydrates and proteins.
CO6	Solve numerical problems related to conductance, electrochemistry and solutions.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	1	3	1	1	2	1	3	3	1	1	1
CO2	3	2	1	1	2	1	3	1	3	3	2	3	3	1	1	1
CO3	3	2	1	3	1	1	1	1	3	2	2	3	3	1	1	1
CO4	3	2	3	1	2	3	1	1	1	2	2	2	3	1	1	1
CO5	3	1	1	1	2	2	2	2	2	1	3	2	2	2	2	2
CO6	3	2	3	2	1	2	3	1	2	2	1	1	3	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL301				
Course Name: Lab Course Based on BCHC301				
Semester /Year: III				
	L	**T**	**P**	**C**
		-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The main aim of this course is to make learners understand the concept of systematic qualitative analysis and apply the same for the detection of functional groups in organic compounds. It also makes students familiarize with the practical aspects of phase equilibria and conductance measurement.

Couse Contents **[No. of Hours:60]**

Section A: Physical Chemistry

Phase equilibria

a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

I. Determination of cell constant.
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
(a) Strong acid vs. strong base
(b) Weak acid vs. strong base

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

1. Separation of amino acids by paper chromatography.
2. Determination of the concentration of glycine solution by formylation method.
3. Titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. Differentiation between a reducing and a nonreducing sugar.

Text Books:

TB1. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.
TB2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Reference Books:

RB1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
RB2. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about the basic practical's related to phase equilibria and conductance.
CO2	Understand concepts involved in separation and titration of amino acids.
CO3	Apply the concept of systematic qualitative analysis for the detection of functional groups in organic compounds.
CO4	Differentiate reducing and non-reducing sugars.
CO5	Test the action of salivary amylase on starch.
CO6	Prepare curves for conductometric titrations of various acids and bases.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	1	1	3	1	1	1	1	3	3	1
CO2	3	1	1	3	1	1	1	3	3	3	1	3	1	3	3	1
CO3	3	3	1	1	1	1	1	3	1	3	1	3	1	3	3	1
CO4	3	2	2	2	2	2	2	1	2	1	2	1	2	3	3	2
CO5	3	1	2	2	2	2	2	2	1	2	1	2	1	3	3	2
CO6	3	1	2	2	2	2	2	2	1	2	2	2	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHC401				
Course Name: Coordination Chemistry, States Of Matter & Chemical Kinetics				
Semester /Year: IV				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objectives of this course are

The course introduces the students to coordination compounds which find manifold applications in diverse areas. Students will also be familiarized to the concept of viscosity, surface tension, laws of crystallography and defects in solids. The course also helps to make students understand the concept of chemical kinetics in deriving integrated rate equations and half-lives of first and second order reaction.

Couse Contents

Unit 1 Transition Elements (3d series) **[No. of Hours:12]**

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

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

Unit 2 Coordination Chemistry **[No. of Hours:8]**

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

Unit 3 Crystal field Theory **[No. of Hours:8]**

Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_O. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.

Unit 4 Kinetic Theory of Gases **[No. of Hours:10]**

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation).

Unit 5 Liquids **[No. of Hours:6]**

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

Unit 6 Solids **[No. of Hours:8]**

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

Unit 7 Chemical Kinetics **[No. of Hours:8]**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

Text Books:

TB1. R L Madan, Chemistry For Degree Students, S. Chand.
TB2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

Reference Books:

RB1. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
RB2. Cotton, F.A. & Wilkinson, G. Basic Inorganic Chemistry, Wiley.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn about transition elements, coordination chemistry, chemical kinetics, solids, liquids and kinetic theory of gases
CO2	Understand the basic concepts of transition elements, kinetic theory of gases, coordination chemistry, solids, liquids and chemical kinetics
CO3	Apply the concepts of chemical kinetics in deriving integrated rate equations and half-lives of first and second order reaction.
CO4	Calculate CFSE of Oh and Td complexes, rate constants and half-lives of first and second order reaction
CO5	Assess surface tension and viscosity of liquids using stalagmometer and Ostwald's viscometer.
CO6	Solve numerical problems related to chemical kinetics, solids, liquids and kinetic theory of gases.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	3	1	3	1	1	1	1	1	3	1	1	1
CO2	3	1	1	1	3	1	1	3	1	1	1	2	3	1	1	1
CO3	3	2	1	1	3	1	1	1	1	1	1	2	3	1	1	1
CO4	3	2	3	1	1	1	3	1	3	2	2	1	3	2	1	1
CO5	3	1	3	1	3	1	1	1	1	3	2	1	3	1	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL401				
Course Name: Lab Course Based on BCHC401				
Semester /Year: IV				
	L	T	P	C
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objective of this course is to impart knowledge about the concept of qualitative analysis of cations and anions in inorganic mixtures to the students. It also makes learners understand the concept involved in determination of surface tension and viscosity of liquids.

Couse Contents **[No. of Hours:60]**

Section A: Inorganic Chemistry

Qualitative analysis of not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations: NH_4^+, Pb^{2+}, Ag^+, Bi^{3+}, Cu^{2+}, Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions: CO_3^{2-}, S^{2-}, SO_2^-, $S_2O_3^{2-}$, NO^{3-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^-

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel (II) as oximate in a given solution gravimetrically.
2. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound (KMnO4/ CuSO4) and estimate the concentration of the same in a given solution.
3. Determine the composition of the Fe3+-salicylic acid complex solution by Job's method.
4. Estimation of (i) Mg2+ or (ii) Zn2+ by complexometric titrations using EDTA.
5. Estimation of total hardness of a given sample of water by complexometric titration.
6. Determination of concentration of Na+ and K+ using Flame Photometry.

Section B: Physical Chemistry

(I) Surface tension measurement.

a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement.

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

(III)Chemical Kinetics
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.
   c. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

Text Books:

TB1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
TB2. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand

Reference Books:

RB1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
RB2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain knowledge about the concepts of qualitative analysis of cations and anions in inorganic mixtures.
CO2	Estimate total hardness of water by complexometric titration.
CO3	Apply the concept of chemical kinetics for performing practical's related to it.
CO4	Explain the principle of gravimetric analysis.
CO5	Evaluate the relative viscosity and surface tension of a liquid or dilute solution using an Ostwald's viscometer and stalagmometer, respectively.
CO6	Draw calibration curve for various concentrations of coloured compounds and estimate its concentration.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	3	1	1	2	1	3	3	1
CO2	3	1	1	3	1	1	2	1	3	1	2	2	1	3	3	1
CO3	3	1	1	3	1	1	3	1	3	2	2	2	1	3	3	1
CO4	3	2	2	1	2	2	1	2	1	2	1	1	2	2	3	2
CO5	3	2	2	1	2	2	2	2	1	1	2	1	2	2	3	2
CO6	3	2	2	1	2	2	1	2	1	2	2	1	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

SKILL ENHANCEMENT COURSE

Course code: BCHS302				
Course Name: Pesticide Chemistry				
Semester /Year: III				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objective of this course is to impart knowledge on pesticides and their effect on environment.

Couse Contents **[No. of Hours:60]**

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).

Text Books:

TB1. Handa S.K., Principles of Pesticide Chemistry, Agrobios India (1 January 2004).
TB2. Saha C., Chakraborty B., Chakraborty S., Basu k., Lectures on Pharamaceutical Chemistry and Pesticide Chemistry, Techno world.

Reference Books:

RB1. Cremlyn, R. Pesticides. Preparation and Modes of Action, John Wiley & Sons, New York, 1978.
RB2. Matolcsy Gy., Nadasy M., Andriska V., Pesticide Chemistry, Elsevier.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about pesticides
CO2	Develop understanding of various types of pesticides.
CO3	Learn about the applications of various synthetic classes of pesticides.
CO4	Explain benefits, adverse effects and types of pesticides.
CO5	Distinguish various types of pesticides.
CO6	Write the synthesis and properties of pesticides.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	3	3	3	2	1	2	1	1	1	3
CO2	2	1	1	3	1	1	3	1	3	2	1	1	1	1	1	3
CO3	2	1	1	3	1	1	3	1	3	1	2	1	1	1	1	3

CO4	3	1	1	1	3	2	1	1	3	2	2	1	1	1	1	3
CO5	3	2	2	2	2	2	2	2	1	1	2	2	2	2	2	3
CO6	3	2	2	2	2	2	2	2	1	1	2	3	2	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHS402				
Course Name: Chemistry of Cosmetics & Perfumes				
Semester /Year: IV				
	L	**T**	**P**	**C**
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course is designed to provide students the basic idea on the preparation, properties and importance of cosmetics in daily lives.

Couse Contents **[No. of hours:60]**

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.

Text Books:

TB1. P.C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
TB2. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.

Reference Books:

RB1. Smith W. and Chapman R., Chemical Process Industries, CRC Publishers and Distributors Pvt. Ltd.
RB2. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about the preparations of various important cosmetic products.
CO2	Develop understanding of uses of various cosmetic products in daily life.
CO3	Explain the importance of essential oils in cosmetic industries.
CO4	Explain the synthesis and uses of various cosmetic products.
CO5	Assess the characteristics of various cosmetic products.
CO6	Express the constituents of different cosmetic products.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	1	1	3	3	3	1	1	1	1	1	1	3
CO2	2	1	1	1	1	1	3	3	3	2	3	1	1	1	1	3
CO3	2	1	1	1	1	1	3	3	3	2	2	1	1	1	1	3
CO4	3	2	2	3	2	2	1	1	2	1	1	2	2	2	2	3
CO5	3	2	2	2	2	2	2	2	1	2	2	2	2	2	2	3
CO6	3	2	2	2	2	2	1	1	2	2	1	2	2	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHS504				
Course Name: Polymer Chemistry				
Semester /Year: V				
	L	**T**	**P**	**C**
	4	**-**	**-**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course is designed with the aim to introduce the theory and applications of polymer chemistry to the students. They will also learn kinetics of polymerization, study of a few industrially important polymers.

Couse Contents

Unit 1 Introduction, Functionality and Kinetics of Polymerization [No. of Hours:15]

Introduction and history of polymeric materials: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

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

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

Unit 2 Structure of Polymers [No. of Hours:15]

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

Nature and structure of polymers-Structure Property relationships.

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

Unit 3 Thermodynamics of Polymeric solutions **[No. of Hours:15]**

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

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

Unit 4 Structure, Properties and applications of some important classes of polymers [No. of Hours:15]

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)].

Text Books:

TB1. Seymour, R.B. & Carraher, C.E. Polymer Chemistry: An Introduction, Marcel Dekker, Inc. New York, 1981.
TB2. Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004.

Reference Books:

RB1. Ghosh, P. Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
RB2. Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge basics of polymer chemistry.
CO2	Understand polymers, their structure and applications in various fileds.
CO3	Explain the physical properties of polymeric solutions.
CO4	Illustrate preparation, structure, properties and applications of selective important polymers.
CO5	Evaluate the thermodynamic parameters related to polymeric chemistry.
CO6	Produce the mechanism of kinetics of polymerization.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	1	1	3	3	3	1	1	2	1	1	1	3
CO2	2	3	1	1	3	1	3	1	1	1	1	2	1	1	1	3

CO3	2	2	3	3	3	1	1	1	1	2	2	2	1	1	1	3
CO4	2	1	1	3	1	1	3	1	3	2	1	2	1	1	1	3
CO5	3	2	2	2	2	2	2	2	1	2	2	2	2	2	2	3
CO6	3	2	2	2	2	2	2	2	1	1	1	1	2	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHS605				
Course Name: Chemistry of Soil, Water and Food				
Semester /Year: VI				
	L	**T**	**P**	**C**
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objective of the course is to impart basic knowledge about composition of soil, concept of pH and its determination. It also imparts knowledge about the determination of pH, acidity, alkalinity and dissolved oxygen present in water. It also provides students the basic idea on the analysis of food products.

Couse Contents

Unit1 Analysis of soil **[No. of Hours:20]**

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Unit 2 Analysis of water **[No. of Hours:20]**

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Unit3 Analysis of food products **[No. of Hours:20]**

Nutritional value of foods, idea about food processing and food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

Text Books:

TB1. Srilakshmi, B., Food Science, 7th Ed., New Age International, New Delhi (2018)
TB2. Biswas, T. D.; Mukherjee, S. K., Text Book of Soil Science, 2nd Ed., McGraw Hill Publishing Company, New Delhi (2017).

Reference Books:

RB1. Srivastava, A., Waste Water Treatment and Water Management: Water Treatment and Management, Notion Press (2018).
RB2. Sharma, B. K., Industrial Chemistry (Including Chemical Engineering), Goel Publishing House, Meerut (2016).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about basic composition of soil and water.
CO2	Describe about the nutritional value of food, processing of food and adulteration of food.
CO3	Explain physical, chemical and biological parameters of soil.
CO4	Analyze physical, chemical and biological parameters of water
CO5	Evaluate pH of soil and water samples
CO6	Test the quality of soil, water and food samples.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	1	1	3	3	1	2	1	1	1	3
CO2	2	1	1	1	1	3	1	3	3	1	1	1	1	1	1	3
CO3	2	1	1	3	1	1	1	3	3	1	1	2	1	1	1	3
CO4	2	2	1	3	1	1	3	1	3	1	1	1	1	1	1	3
CO5	3	3	3	2	2	2	2	2	1	1	2	2	3	2	2	3
CO6	3	3	3	2	2	2	2	2	1	1	2	2	3	1	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

DISCIPLINE SPECIFIC ELECTIVES

Course code: BCHD501				
Course Name: Analytical Methods In Chemistry				
Semester /Year: V				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course is designed to complement the needs of students who wish to learn more about the qualitative/quantitative characterization and separation techniques. The content of this course aims to cover basic concepts, principles, and techniques of modern analytical chemistry that would empower students with an analytical aptitude and abilities to solve diverse analytical problems in an efficient way.

Couse Contents

Unit 1 Qualitative and quantitative aspects of analysis **[No. of Hours:5]**

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

Unit 2 Basics of spectroscopic techniques **[No. of Hours:25]**

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

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

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

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

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

Unit 3 Thermal & Electroanalytical methods of analysis **[No. of Hours:15]**

Thermal methods of analysis: Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

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

Unit 4 Solvent Extraction and Chromatography **[No. of Hours:15]**

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: Frontal, elution and displacement methods.

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

Text Books:

TB1. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher,2009.
TB2. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.

Reference Books:

RB1. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
RB2. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn and gain knowledge about quantitative and qualitative analysis.
CO2	Understand basics of spectroscopic, thermal and electroanalytical techniques.
CO3	Illustrate different separation techniques.
CO4	Explain errors, sampling, chromatography solvent extraction and spectroscopy.
CO5	Summarize different terms used in spectroscopic and separation techniques.
CO6	Express the applications of different spectroscopic and separation techniques.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	3	1	1	3	1	3	2	1	1	3	1	1	3
CO2	2	3	1	2	1	1	3	1	3	2	1	2	3	1	1	3

CO3	2	1	1	3	1	3	1	3	1	2	3	1	3	1	1	3
CO4	3	1	2	1	3	1	3	1	1	1	2	3	3	1	1	3
CO5	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
CO6	3	2	2	2	2	1	2	2	2	3	2	1	3	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL501				
Course Name: Lab Course Based on BCHD501				
Semester /Year: V				
	L	**T**	**P**	**C**
	-	-	4	2

L – Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The main aim of this course is to make learners develop understanding of different techniques like solvent extraction, IR spectroscopy, paper chromatography, TLC, pH metry, flame photometry and ion exchange.

Couse Contents **[No. of Hours:60]**

1. Separation Techniques

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

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 flame photometric techniques.

4. Determination of pH of soil, total soluble salt, Estimation of calcium, magnesium, phosphate, nitrate.

5.Spectrophotometry:

- Determination of pKa values of indicator using spectrophotometry.
- Structural characterization of compounds by infrared spectroscopy.
- Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

6.Determination of dissolved oxygen in water.

7. Determination of chemical oxygen demand (COD).

8.Determination of Biological oxygen demand (BOD).

Text Books:

TB1. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
TB2. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

Reference Books:

RB1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
RB2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Remember the basics of chemistry practicals and lab rules.
CO2	Understand separation of ions, sugars and pigments by chromatography.
CO3	Apply solvent extraction technique for determination of Nickle.
CO4	Analyse PH of different shampoo solutions.
CO5	Measure BOD, COD, DO and other parameters the obtained results
CO6	Solve the experimental data.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	3	2	3	2	1	3	3	1
CO2	3	1	1	3	1	1	1	3	3	3	2	3	1	3	3	1
CO3	3	1	1	3	1	1	3	1	3	2	1	2	1	3	3	1
CO4	3	2	2	2	1	2	1	2	2	1	1	1	3	3	3	1
CO5	3	2	2	2	2	2	2	2	2	1	2	2	1	3	3	2
CO6	3	2	2	1	2	2	3	2	2	1	2	3	2	3	3	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHD503				
Course Name: Green Chemistry				
Semester /Year: V				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course is designed to introduce the students to green chemistry. They will be taught about the emerging discipline of green chemistry, its applications in sustainable development and some real-world cases.

Couse Contents

Unit 1 Introduction to Green Chemistry **[No. of Hours:10]**

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

[No. of Hours:15]

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ by-products; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity. risk = (function) hazard × exposure; waste or pollution prevention hierarchy.
- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.
- Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
- Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

Unit 3 Examples/Reactions and some real-world cases of Green Synthesis

[No. of Hours:20]

- Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
- Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
- Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
- Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.
- Designing of Environmentally safe marine antifoulant.
- Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
- Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils
- Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Unit 4 Future Trends in Green Chemistry **[No. of Hours:15]**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

Text Books:

TB1 Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
TB2. Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

Reference Books:

RB1. Ryan, M.A. & Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
RB2. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge about green chemistry, its need, limitations and future prospects of it.
CO2	Understand the principle and future trends of green chemistry.
CO3	Apply the principles of green chemistry to some real-world examples.
CO4	Analyze the concept of green chemistry.

CO5	Assess the role of green chemistry in sustainable development.
CO6	Design the green synthetic routes by applying 12 principles of green chemistry for preparation of compounds.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	3	1	3	1	1	1	1	2	3	1	1	1
CO2	3	1	1	1	1	1	1	3	3	1	1	3	3	1	1	1
CO3	2	2	1	1	1	1	3	3	3	1	2	2	3	1	1	1
CO4	2	1	1	1	1	1	3	3	3	2	2	1	3	1	1	1
CO5	2	2	2	3	3	2	3	1	1	3	3	2	2	1	1	1
CO6	2	2	2	3	3	2	2	1	1	3	3	1	3	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL503				
Course Name: Lab Course Based on BCHD503				
Semester /Year: V				
	L	**T**	**P**	**C**
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

Experiments are aimed at helping learners acquire hands on experience in preparation of nanoparticles, biodiesel, and propene.

Couse Contents

[No. of Hours:60]

1. Safer starting materials
- Preparation and characterization of nanoparticles of gold using tea leaves.
2. Using renewable resources
- Preparation of biodiesel from vegetable/ waste cooking oil.
3. Avoiding waste
- 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

H_2SO_4/ H_2SO_4/Δ

(II) 1-propanol ⟶ propene + water

- 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.
5. Alternative Green solvents
- Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.

Mechanochemical solvent free synthesis of azomethines.

6. Alternative sources of energy
- Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Text Books:

TB1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
TB2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).

Reference Books:

RB1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
RB2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Describe the preparation of biodiesel from vegetable/ waste cooking oil.
CO2	Explain the condensation of benzene by using biocatalyst.
CO3	Illustrate solvent free alternative methods of reactions/synthesis.
CO4	Deduce experiments based on the concept of green chemistry.
CO5	Assess the use of enzymes as catalysts in organic reactions.
CO6	Synthesize and characterize gold nanoparticles from tea leaves

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	1	1	3	1	2	2	2	2	1	3	3	1
CO2	2	1	1	3	1	1	3	1	3	2	2	1	1	3	3	1
CO3	2	1	1	3	1	1	3	1	3	2	2	2	1	3	3	1
CO4	2	2	2	1	2	2	1	2	1	2	1	1	2	3	2	2
CO5	1	2	1	2	3	2	1	2	1	1	1	2	1	2	2	2
CO6	3	2	1	2	2	2	1	2	1	1	2	2	3	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHD505				
Course Name: Industrial Chemicals and Environment				
Semester /Year: V				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course will introduce the students to various industrial gases and inorganic chemicals, their manufacturing processes, applications, storage and hazards in handling them. Major causes of air and water pollution and their effects on living organisms and the environment will also be taught. This course also discusses about management of the different kinds of wastes and their safe disposal.

Couse Contents

Unit 1 Industrial Gases **[No. of Hours:6]**

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

Unit 2 Inorganic Chemicals

Manufacture, applications, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potassium dichromate and potassium permanganate

Unit 3 Environment and its segments **[No. of Hours:15]**

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere, chemical and photochemical reactions in atmosphere.

Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Major sources of air pollution, Pollution by SO2, CO2, CO, NOx, H2S and other foul-smelling gases, methods of estimation of CO, NOx, SOx and control procedures, Effects of air pollution on living organisms and vegetation

Greenhouse effect and Global warming, Environmental effects of ozone, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, Air pollution control, Settling Chambers, Venturi Scrubbers, Cyclones, Electrostatic Precipitators (ESPs).

Unit 4 Water Pollution **[No. of Hours:15]**

Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries

and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro fertilizer. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

Unit 5 Energy & Environment **[No. of Hours:10]**

Sources of energy: Coal, petrol and natural gas. Nuclear fusion / fission, solar, hydrogen, geothermal, tidal and hydel.

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

Biocatalysis: Introduction to biocatalysis: Importance in green chemistry and chemical industry.

Text Books:

TB1. De A.K., Environmental Chemistry (VIII Edition), New Age Techno Press.
TB2. Banerji S.K., Environmental Chemistry (II Edition), PHI Learning Pvt. Ltd.

Reference Books:

RB1. Smith W. and Chapman R., Chemical Process Industries, CRC Publishers and Distributors Pvt. Ltd.
RB2. Rose Phillo K.J. and Jacob J., Industrial Chemicals and Environment, Vishal Publishing Co.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain knowledge about the different toxic gases, their toxicity hazards and types of pollution.
CO2	Explain composition of air, air pollutants, effects and preventive measures for controlling air pollution.
CO3	Illustrate about various sources of water, its quality parameters, impact and treatment of water pollution
CO4	Distinguish various types of pollutants and pollution.
CO5	Assess the impact of air pollution on the environment.
CO6	Formulate various measures to control air, water and noise pollution.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	1	1	3	1	1	1	2	3	3	1	1	2
CO2	2	1	1	3	1	1	3	1	3	2	3	2	3	1	1	2
CO3	2	1	1	3	1	1	1	3	3	1	1	3	3	1	1	2
CO4	2	1	1	1	1	1	3	3	3	2	1	2	3	2	2	2
CO5	2	1	2	1	3	3	1	1	1	1	1	2	3	1	1	2
CO6	3	2	2	2	3	2	1	1	1	1	2	2	2	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL505				
Course Name: Lab Course Based on BCHD505				
Semester /Year: V				
	L	T	P	C
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objective of this course is to provide students hands on experience in determination of DO, COD, BOD, and alkalinity of water samples.

Couse Contents **[No. of Hours:60]**

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^{1-}) using double titration method.
7. Determination of hexavalent Chromium Cr (VI) concentration in waste water sample using UV-Vis spectrophotometry technique.

Text Books:

TB1. R L Madan, Chemistry For Degree Students, S. Chand.
TB2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

Reference Books:

RB1. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
RB2. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge of physical parameters of water by titration methods.
CO2	Determine percentage of chlorine in bleaching powder.
CO3	Apply UV-Vis spectroscopy to determine concentration of Cr (VI) in waste water sample.
CO4	Analyze the UV-Vis spectra.
CO5	Evaluate DO, COD and BOD of water samples.
CO6	Report the amount of chloride, sulphate and salinity in water samples by simple titration method.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	3	1	1	2	1	3	3	1
CO2	3	1	1	3	1	1	3	1	3	1	2	1	1	3	3	1
CO3	3	1	1	3	1	1	3	1	3	1	2	3	1	3	3	1
CO4	2	2	2	2	3	2	2	2	3	2	1	2	2	2	2	2
CO5	2	2	2	1	3	2	2	2	2	2	2	1	2	2	2	2
CO6	1	2	3	1	2	3	1	3	1	3	2	2	1	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHD601				
Course Name: Spectroscopic Methods Of Chemical Analysis				
Semester /Year: VI				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course introduces learners with the spectroscopic methods of analysis. It also provides knowledge about the instrumentation and applications of UV-Vis, IR, Mass and NMR spectroscopy. Students will be taught to interpret UV-Vis, IR and NMR spectra of organic compounds.

Couse Contents

Unit 1 Introduction to spectroscopic methods of analysis **[No. of Hours:4]**

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

Unit 2 Molecular spectroscopy **[No. of Hours:8]**

Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR).

Unit 3 UV-Visible/ Near IR spectroscopy **[No. of Hours:8]**

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

Unit 4 Mass spectroscopy **[No. of Hours:14]**

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

Unit 5 NMR spectroscopy **[No. of Hours:6]**

Principle, Instrumentation, shielding, deshielding, chemical shift, factors affecting chemical shift, Spin-coupling, factors influencing coupling constant 'J', Applications.

Text Books:

TB1. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
TB2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

Reference Books:

RB1. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
RB2. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge of basic components of IR, FTIR, UV-Visible, Mass and NMR spectroscopy.
CO2	Interpret IR, FTIR and UV-visible spectra.
CO3	Apply the concepts of UV-Vis, FTIR and NMR spectroscopy in explaining the spectra.
CO4	Analyze various FTIR, NMR and Mass spectra.
CO5	Distinguish between various spectroscopic methods of analysis.
CO6	Solve problems related to UV-Vis, NMR, FTIR and mass spectrometry.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	3	1	3	1	3	2	1	2
CO2	2	3	1	3	1	2	1	1	3	2	2	1	3	1	2	2
CO3	2	3	1	3	1	3	1	1	1	1	1	3	3	2	2	2
CO4	2	2	1	2	1	1	3	3	3	2	1	2	3	1	1	2
CO5	3	2	3	2	3	2	2	2	2	1	2	2	3	2	2	3
CO6	3	3	3	2	3	2	2	2	2	1	2	2	3	1	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL601				
Course Name: Lab Course Based on BCHD601				
Semester /Year: VI				
	L	**T**	**P**	**C**
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course provides knowledge about the applications of UV-Vis, IR, Mass and NMR spectroscopy for the interpretation of spectra of organic compounds.

Couse Contents **[No. of Hours:60]**

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.

4. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
5. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
6. Interpretation of IR of selected organic compounds.
7. Interpretation of Mass Spectra of selected organic compounds.
8. Interpretation of NMR Spectra of selected organic compounds.

Text Books:

TB1. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
TB2. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.

Reference Books:

RB1. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.
RB2. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach, W.B. Saunders, 1995.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain knowledge about the statistical analysis of data.
CO2	Interpret IR and UV-Vis spectra of organic compounds.
CO3	Apply the concept of Mass and NMR spectroscopy to elucidate the structure of organic compounds.
CO4	Analyze the IR, mass and NMR spectra of organic compounds.
CO5	Assess isoelectric pH of protein samples.
CO6	Develop titration curve of amino acids.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	3	1	1	2	1	1	3	3	1
CO2	3	1	1	3	1	1	3	1	3	1	3	2	1	3	3	1
CO3	3	1	1	2	1	1	3	3	3	1	2	3	1	3	3	1
CO4	3	2	2	1	3	3	2	3	1	3	3	2	2	3	3	2
CO5	2	2	3	2	2	3	3	2	1	3	2	1	3	3	3	2
CO6	2	2	1	2	2	1	2	2	2	2	1	2	3	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHD602				
Course Name: Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy				
Semester /Year: VI				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The course incorporates chemistry of 3d elements, organometallic compounds, poly and heteronuclear aromatic compounds. It also makes the learners to understand the role of important metal ions in biological systems. It also introduces the learner to UV-Visible & IR spectroscopy as tools for identifying and characterizing organic compounds.

Couse Contents

Unit 1 Chemistry of 3d metals **[No. of Hours:10]**

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, K2Cr2O7, KMnO4, K4[Fe(CN)6], sodium nitroprusside, [Co(NH3)6]Cl3, Na3[Co(NO2)6].

Unit 2 Organometallic Compounds **[No. of Hours:12]**

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

Unit 3 Bio-Inorganic Chemistry **[No. of Hours:10]**

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na+, K+ and Mg2+ ions: Na/K pump; Role of Mg2+ ions in energy production and chlorophyll. Role of Ca2+ in blood clotting, stabilization of protein structures and structural role (bones).

Unit 4 Polynuclear and heteronuclear aromatic compounds **[No. of Hours:12]**

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

Unit 5 Application of Spectroscopy to Simple Organic Molecules **[No. of Hours:16]**

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

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen

bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Text Books:

TB1. James E. Huheey, Ellen Keiter & Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
TB2. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.

Reference Books:

RB1. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
RB2. John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain basic knowledge of transition elements, organometallics, bio-inorganic, polynuclear chemistry and spectroscopic techniques.
CO2	Develop basic understanding of chemistry of organometallic and bio inorganic compounds.
CO3	Explain preparation and uses of polynuclear and active methylene compounds.
CO4	Analyze UV-VIS and IR spectra
CO5	Predict the structure of organic compounds on the basis of UV and IR spectroscopy
CO6	Justify the role of metal ions in biological processes.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	3	1	1	1	1	1	2	3	3	1	1	2
CO2	3	3	1	1	3	1	1	1	1	2	2	2	3	1	1	2
CO3	3	3	1	1	3	1	1	2	2	3	1	2	3	1	1	2
CO4	2	2	2	3	1	2	3	1	3	2	2	2	3	1	1	2
CO5	2	3	2	2	2	2	2	3	2	2	1	2	3	3	1	2
CO6	2	3	2	2	2	3	2	2	1	2	1	2	3	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL602				
Course Name: Lab Course Based on BCHD602				
Semester /Year: VI				
	L	**T**	**P**	**C**
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The objective of this course is to impart knowledge about separation of mixtures by paper chromatography, preparation of certain complexes and qualitative analysis of organic compounds.

Couse Contents **[No. of Hours:60]**

Section A: Inorganic Chemistry

1. Separation of mixtures by chromatography: Measure the R_f value in each case. (Combination of two ions to be given)
Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+}

2. Preparation of any two of the following complexes and measurement of their conductivity

I. tetraamminecarbonatocobalt (III) nitrate
II. tetraamminecopper (II) sulphate
III. potassium trioxalatoferrate (III) trihydrate

Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.

Section B: Organic Chemistry

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative.

Text Books:

TB1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
TB2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.

Reference Books:

RB1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
RB2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge of principle of paper and thin layer chromatography.
CO2	Understand preparation of complexes and their conductivity measurement.
CO3	Illustrate qualitative analysis of organic compounds having different functional groups.
CO4	Explain the difference in retention factor values obtained in the experiment for separation of ions by paper chromatography.
CO5	Assess retention factor values of various inorganic ions separated by paper and thin layer chromatography.

CO6	Prepare one of the derivatives of organic compounds possessing monofunctional group (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines)

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	3	1	1	3	1	3	2	3	2	1	3	3	1
CO2	3	3	1	3	1	1	3	1	1	2	3	2	1	3	3	1
CO3	3	1	1	3	1	1	3	1	3	2	2	3	1	3	3	1
CO4	3	2	2	1	2	2	1	2	1	1	1	1	2	2	2	2
CO5	3	1	2	1	2	2	2	2	2	1	1	2	2	2	1	2
CO6	2	1	2	2	2	3	1	1	2	2	3	2	2	1	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHD603				
Course Name: Molecules of Life				
Semester /Year: VI				
	L	T	P	C
	4	-	-	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

This course aims to introduce the learner to bioorganic chemistry. Students will learn about the fascinating chemistry of biomolecules such as carbohydrates, enzymes, amino acids, peptides, proteins, lipids and nucleic acids that work within biological systems. The course also includes topics on concept of energy in biosystems

Couse Contents

Unit 1 Carbohydrates **[No. of Hours:10]**

Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Unit 2 Amino Acids, Peptides and Proteins **[No. of Hours:12]**

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

Unit 3 Enzymes and correlation with drug action **[No. of Hours:12]**

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (Including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure –activity relationships of drug molecules, binding role of –OH group, -NH2 group, double bond and aromatic ring.

Unit 4 Nucleic Acids **[No. of Hours:10]**

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

Unit5 Lipids **[No. of Hours:8]**

Introduction to lipids, classification, oils and fats, common fatty acids present in oils and fats, omega fatty acids, trans fats, hydrogenation, saponification value, iodine number. Biological importance of triglycerides, phospholipids, glycolipids and steroids (cholesterol).

Unit 6 Concept of Energy in Biosystems **[No. of Hours:8]**

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.

Text Books:

TB1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
TB2. Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7thEd., W. H. Freeman.

Reference Books:

RB1. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
RB2. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Learn and gain knowledge of molecules of life.
CO2	Understand the classifications and other details of carbohydrates, enzymes, lipids etc.
CO3	Illustrate the concept of lipids, proteins, nucleic acids etc.
CO4	Explain carbohydrates, enzymes, proteins, lipids nucleic acids etc
CO5	Summarize the concept of different biomolecules.
CO6	Express the details of energy in biosystem.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	3	1	1	1	1	2	3	1	3	1	1	1
CO2	2	1	3	1	3	1	1	1	1	1	3	2	3	1	1	1
CO3	2	1	3	1	2	1	1	1	3	2	2	1	3	3	1	1
CO4	2	1	3	2	3	2	1	2	1	1	1	2	3	1	3	1
CO5	2	3	3	2	3	2	2	1	1	1	2	3	3	1	1	3
CO6	3	3	3	2	1	2	2	2	1	1	2	1	2	2	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code: BCHL603				
Course Name: Lab Course Based on BCHD603				
Semester /Year: VI				
	L	T	P	C
	-	-	4	2

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:

The main objective of this course is to provide knowledge of separation of amino acids, saponification of oils/fats, action of salivary amylase on starch and synthesis of aspirin.

Couse Contents **[No. of Hours:60]**

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/ nonreducing sugar.
9. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

Text Books:

TB1. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's Textbook of Practical Organic Chemistry, ELBS.
TB2. Dr O P Pandey, D N Bajpai & Dr D Giri, Practical Chemistry, S Chand

Reference Books:

RB1. Sawhney S.K.; Singh R, Introductory Practical Biochemistry, Narosa.
RB2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Course outcomes (COs):

Upon successful completion of the course, students will be able to

CO1	Gain knowledge of separation and titrations of amino acids.
CO2	Understand saponification and iodine value of oil/fats.
CO3	Examine the action of salivary amylase on starch.
CO4	Differentiate between reducing and non-reducing sugar.
CO5	Evaluate and interpret the obtained results
CO6	Synthesize organic compounds.

CO-PO-PSO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	3	1	1	1	1	1	2	2	1	3	3	1
CO2	3	1	1	3	1	1	3	1	3	1	2	3	1	3	3	1
CO3	2	3	1	3	1	1	3	1	1	1	3	1	1	3	3	1
CO4	3	1	1	3	1	1	3	1	3	2	3	2	1	3	3	1
CO5	2	2	2	1	2	2	1	2	2	2	1	2	3	3	2	2
CO6	2	2	2	1	2	2	1	2	1	1	1	1	3	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated