SYLLABUS

SESSION: 2023-2024

PROGRAMME: B. Sc. (Honours) Chemistry II

PROGRAMME CODE: BSHCHE

FACULTY OF SCIENCES

P. G. DEPARTMENT OF CHEMISTRY

MATA GUJRI COLLEGE

Fatehgarh Sahib

(AN AUTONOMOUS COLLEGE)
Affiliated to Punjabi University, Patiala

Prof. (Dr.) Baljit Singh
Prof. (Dr.) Sonal Singhal
Mr. Ravinderjeet Singh
Mrs. Rachna Bhardwaj
Dr. Poonam Patyar
Mr. Puneet Bhardwaj
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SYLLABUS
B.Sc. II (Hons.) Chemistry
Semester III and IV

SEMESTER III

Paper Code	Title of Paper	No. of Lectures	LTP (Credits)	Max. Marks (External+Internal) Pass Percentage 40%
BSHCHE 301	Inorganic Chemistry-II	60	4 0 0 (4)	100 (75+25)
BSHCHE301 (P)	Inorganic Chemistry-II Lab	60	0 02 (2)	50
BSHCHE302	Organic Chemistry-II	60	4 0 0 (4)	100 (75+25)
BSHCHE 302 (P)	Organic Chemistry-II Lab	60	0 0 2 (2)	50
BSHCHE 303	Physical Chemistry-III	60	4 0 0 (4)	100 (75+25)
BSHCHE 303 (P)	Physical Chemistry III Lab	60	0 0 2 (2)	50
BPHGE3/ UGCS1903/ BSHMATGE-301/ BSHZ(G) 03	Physics / Computer / Maths/ Zoology	60	4 0 0 (4) 5 1 0 (6) For Maths	100 (75+25)
BPHGE3Lab/ UGCS1903-Lab / BSHZ(G) 03- Lab	Physics Lab/ Computer Lab/ Zoology Lab	60	0 0 2 (2)	50
BSHCHE 304 A/B (P)	Skill Enhancement Course: 304 A: Green Methods in Chemistry OR 304 B: Pesticide Chemistry	45	0 0 2 (2)	50

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SEMESTER III
Core Course V
BSHCHE 301: INORGANIC CHEMISTRY-II

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60 Lectures

COURSE OBJECTIVES

- To provide knowledge and understanding of properties, structure and uses of important compounds of s, p block elements, noble gases and inorganic polymers.
- To provide understanding of principles involved in metallurgical processes and the chemistry of acids and bases

COURSE OUTCOMES

Upon completion of this course the students will be able to:

CO1: Explain the properties, structure and uses of important compounds of s and p block elements.

CO2: Outline the structural aspects and summarize the applications of various types of inorganic polymers.

C03: Explain the structures and properties of important compounds of noble gas elements

C04: Identify the principles involved in metallurgical processes

CO5: Utilise the various acid-base concepts to identify acids and bases.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Chemistry of *s* and *p* Block Elements (20 hr)

Comparative study of s-and p block elements, relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group, inert pair effect, allotropy and catenation, complexation tendencies of s and p block elements, hydrides and their classification (ionic, covalent and interstitial), study of oxides of s and p block

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elements, basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, boron hydrides (diborane), carboranes, graphite, silanes, oxoacids of nitrogen, phosphorus, sulphur and chlorine, interhalogen compounds, polyhalide ions, pseudohalogens.

Inorganic Polymers **(10 hr)**

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones, polysiloxanes, borazines, silicates, phosphazenes & polysilanes.

UNIT-II

Noble Gases **(8 hr)**

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

General Principles of Metallurgy **(12hr)**

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

Acids and Bases **(10 hr)**

Acids and Bases: Brönsted–Lowry concept, conjugate acids and bases, relative strength of acids and bases, types of acid-base reactions, effects of substituent and solvent on strength of acids and bases, differentiating and levelling solvents, Lewis's acid-base concept, Classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.

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4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Rodger, G.E. *Inorganic and SolidState Chemistry*, Cengage Learning India Edition, 2002.
6. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
7. Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).
8. M.C. Day, J. Selbin, *Theoretical Inorganic Chemistry*.

Teaching-learning Activities

Seminar presentations
Assignments
Quiz
Group tutorial work

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BSHCHE 301 (P): INORGANIC CHEMISTRY-II Lab.

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- To demonstrate the principle of iodometric and iodimetric titrations and carry out estimations using these methods.
- To carry out preparation of inorganic compounds
- To carry out standardisation of EDTA and complexometric titrations using EDTA

COURSE OUTCOMES

On completion of the course, the students will be able to:
CO1: Perform standardisation of various reagents like sodium thiosulphate and EDTA.
CO2: Perform estimations using iodometric and iodimetric titrations.
CO3: Carry out synthesis of simple inorganic compounds.
CO4: Perform determinations using complexometric titrations.
CO5: Develop observation, analytical and experimentation skills.

(A) Iodometric Titrations and Iodimetric Titration:
(i) Standardisation of sodium thiosulphate.
(ii) To determine the strength of copper sulphate solution iodometrically.
(iii)To determine the strength of potassium dichromate solution.
(iv)To determine the strength of potassium permanganate solution.
(v) To estimate percentage of available chlorine in bleaching powder.

(B) Inorganic preparations:
(i) Cuprous Chloride, Cu_2Cl_2
(ii) Preparation of Manganese (III) phosphate, $MnPO_4.H_2O$
(iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.

(C) Complexometric Titrations (EDTA):
(i) Standardisation of EDTA with $Pb(NO_3)_2$ / $ZnSO_4.\ 7H_2O$
(ii) Determination of Al^{3+} by back titrations.
(iii) Determination of total hardness of water (permanent and temporary)

Reference Books:

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

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2. *Advanced Practical Inorganic Chemistry,* Gurdeep Raj, Krishna Prakashan.

Teaching learning activities:

Demonstrations
Hands on Training
Viva Voce

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Core Course VI
BSHCHE 302: ORGANIC CHEMISTRY-II

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60 Lectures

COURSE OBJECTIVES

- To discuss the reactivity, preparation and important reactions of halogenated compounds.
- The understand the method of formations and reactions of alcohols, phenols, ethers, carbonyl compounds, carboxylic acids & their derivatives.

COURSE OUTCOMES:

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

CO1: name the different class of organic compounds including halogenated hydrocarbons, alcohols, phenols, carbonyl compounds and carboxylic acids.

CO2: Understand the mechanistic detail of Nucleophilic substitution reactions.

CO3: compare the properties of organic compounds containing different functional groups.

CO4: predict electronic flow and arrow pushing mechanism in a chemical reaction.

CO5: Apply their knowledge to deduce structures and synthesize simple organic molecules using the studied reactions.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Chemistry of Halogenated Hydrocarbons

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent, nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; S_NAr, Benzyne mechanism.

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Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Alcohols, Phenols, Ethers and Epoxide

Alcohols: Classification and nomenclature.
Monohydric alcohol: Nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature. Reactions of alcohol.
Dihydric alcohols: Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.
Trihydric alcohols: Nomenclature and methods of formation, chemical reactions of glycerol.
Phenols: Preparation and properties, Acidity of phenols and substituent effects, Comparative acidic strengths of alcohols and phenols, Resonance stabilization of phenoxide ion. Ring substitution reactions, Reimer–Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism.
Ethers: Preparation of ether from alkyl halides, alcohols, alkenes & Grignard reagent. Reaction of ethers with acid.
Epoxides: Synthesis of epoxides from alkenes. Acid and base catalysed ring cleavage of epoxide. **30 Hrs.**

UNIT-II

Carbonyl Compounds; Nomenclature and structure of the carbonyl group. Synthesis of aldehyde and ketones with particular reference to the synthesis from alcohols, acid chlorides, carboxylic acid, nitriles, 1,3-Dithianes, alkenes and alkynes. Physical Properties of the aldehydes and ketones.
Chemical reactions of Aldehyde and Ketones; Relative reactivity of aldehydes and ketones in nucleophilic addition reaction, Nucleophilic addition reactions (with mechanisms) with particular reference to addition of Grignard reagent, organolithium and organozinc. Nucleophilic addition-elimination reactions with ammonia derivatives, mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PCC)
Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

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Carboxylic Acids: Nomenclature, structure and bonding, physical properties and preparatory methods of monocarboxylic acids including synthesis from Grignard reagent, Malonic ester and acetoacetic ester synthesis. Chemical reactions including formation of functional derivatives and decarboxylation reactions.

Substituted Carboxylic acids:

(i) Hydroxy acids: Preparation of α-hydroxy acid (Hydrolysis of α-halo acids and cyanohydrins) and β-hydroxy acids (Reformatsky reaction). Chemical reactions including individual reaction of -OH and-COOH group, action of heat and acidic strength.

(ii) Hydroxy acid derivatives: *Malic acid*: Synthesis by hydrolysis of maleic acid & α-Bromo succinic acid and reactions including oxidation & reduction.

Tartaric acid: Synthesis from acetylene, maleic & fumaric acid and reactions including complex formation, with Tollens's reagent, reduction & oxidation.

Citric acid: Synthesis from glycerol and reactions including acetylation and complex formation.

(iii) Unsaturated monocarboxylic acid: Synthesis by Knoevenagel & Perkin reaction and chemical reaction including electrophilic addition and reaction of carboxyl group.

Dicarboxylic acids: Nomenclature and synthesis from malonic ester & acetoacetic ester and Grignard reagent. Physical and chemical properties (solubility, acidity, action of heat and dehydrating agent)

Carboxylic acid derivatives:

Electronic structure of the acid derivatives, nucleophilic acyl substitution & relative stability of the acid derivatives.

Acid chlorides: synthesis from carboxylic acid and reaction involving Schotten- Baumann reaction and Rosenmund reduction.

Acid anhydrides: synthesis of acetic anhydride by acetic acid and ketene. Reactions involving ammonolysis, Friedel craft acylation and reduction with $LiAlH_4$.

Esters: Synthesis by esterification and chemical reactions involving acidic & alkaline hydrolysis of esters and Claisen condensation.

Amides: Synthesis by ammonolysis and hydrolysis of alkyl cyanides. Reactions involving acid & base hydrolysis and Hofmann bromamide reaction.

30 Hrs.

Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).

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2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
4. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

Teaching learning activities:

1. Student directed learning: Small groups of students will be given individual assignments which they will present in the form of power point presentation.
2. Lectures supported by group tutorial work.
3. Technology enabled learning.
4. Peer teaching and learning.

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BSHCHE 302(P): ORGANIC CHEMISTRY-II Lab.

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- The course objective is to apply fundamental methods and procedures for the synthesis of organic compounds.
- To develop basic skills for the multi-step synthesis of organic compounds.

COURSE OUTCOMES

On completion of this course students will be able to

CO1: develop practical skills in performing synthesis of organic compounds at lab scale.

CO2: learn isolation and purification of product of organic synthesis reaction.

CO3: compare theoretical and experimental knowledge by planning and executing organic synthesis in the laboratory.

CO4: apply the concept of green chemistry to various synthetic methods in order to carry out environment friendly synthesis.

Organic Preparations:

i. Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidine and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
   a. Using conventional methods.
   b. Using a green approach.
ii. Benzoylation of one of the following amines (aniline, o-, m-, p- toluidine and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
iii. Oxidation of ethanol/isopropanol (Iodoform reaction).
iv. Nitration of Salicylic acid by green approach (using ceric ammonium nitrate).
v. Selective reduction of m-dinitrobenzene to m-nitroaniline.
vi. Hydrolysis of esters.
vii. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
viii. Aldol condensation using either conventional or green methods.
ix. Benzil-Benzilic acid rearrangement.
x. Synthesis of Schiff base using ball milling approach.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid

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samples must be collected and may be used for recrystallization, melting point and TLC.

Reference Books:

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

Teaching learning activities:

1. Viva-voce
2. Laboratory-based practical components and experiments.
3. Practicum and project-based learning.

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Core Course VII
BSHCHE 303: PHYSICAL CHEMISTRY-III

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60 Lectures

COURSE OBJECTIVES

- The objective of the course is to give the students insight into the basics of chemistry in everyday life through the study of topics like concepts of phases, components, degrees of freedom, binary solutions, azeotropes, steam distillation, Nernst Distribution Law etc.
- The course will make a better understanding and designing of different research problems based on the study of catalysis and mechanism of catalyzed reactions.

COURSE OUTCOMES

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

CO1: Explain the concept of eutectic point, congruent and incongruent melting points, CST and CSC by exactly knowing the equilibrium existing between different states of matter.

CO2: Learn the various phenomena occurring at the interface of two surfaces and how these phenomena get affected by change in pressure and temperature.

CO3: determine the effect of impurity on Upper Critical Solution Temperature (UCST) and Lower Critical Solution Temperature (LCST).

CO4: develop various catalytic reaction mechanisms

CO5: Compare the variation in reaction rate with change in temperature and concentration.

CO6: Explain adsorption process with their mechanisms on the surfaces and catalyst for different types of reactions.

Self-study

1. Application of phase diagram.
2. Study of reaction kinetics
3. Acid-base catalysis.
4. Application of adsorption isotherms.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

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Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Phase Equilibria

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for non-reactive and reactive systems, Clausius-Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting point (lead-silver, $FeCl_3$-H_2O), Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary Solutions

Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation, Nernst distribution law: its derivation and applications. **30Hrs.**

UNIT-II

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions:
(i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (iv) chain reactions.
Temperature dependence of reaction rates, Arrhenius equation, activation energy, Collision theory for unimolecular reaction (Lindemann theory), collision theory for bimolecular reaction, qualitative treatment of the theory of absolute reaction rates.

Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces, effect of particle size and efficiency of nanoparticles as catalysts, Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Surface Chemistry

Physisorption, chemisorption, adsorption isotherms, nature of adsorbed state, Adsorption of gases on solids, Freundlich adsorption isotherm, Langmuir adsorption isotherm and BET isotherm. **30Hrs.**

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Reference Books:

1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.:New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
6. Zundhal, S.S*. Chemistry concepts and applications* Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
9. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
10. Metz, C. R*. Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

Teaching-learning Activities:

Assignments
Seminar presentation
Group tutorial work
Use of e-learning resources and self-study materials

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BSHCHE 303 (P): PHYSICAL CHEMISTRY-III Lab.

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- The students will be made to practically analyse theoretical concepts through various practical problems like determination of critical solution temperature and composition of two component systems.
- The students will learn how to determine the effect of impurities on Critical solution temperature and Critical solution concentration by construction of phase diagrams using cooling curves.
- To impart skills to the students to study the kinetics of reactions and verification of different adsorption isotherms.

COURSE OUTCOMES

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

CO1: evaluate the eutectic point, congruent melting point by constructing the phase diagram for two component system

CO2: Measure the kinetic of various reactions in the acidic and basic media.

I. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a) simple eutectic and
b) congruent melting systems.

II. Distribution of acetic/ benzoic acid between water and cyclohexane.

III. Study the equilibrium of at least one of the following reactions by the distribution method: a) $I_2(aq) + I^- \rightarrow I_3^-$
b) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

IV. Study the kinetics of the following reactions.
a) Initial rate method: Iodide-persulphate reaction
b) Integrated rate method:
i. Acid hydrolysis of methyl acetate with hydrochloric acid.
c) Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

V. Adsorption
a) Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

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Dr. Kiran
Dr. Kuldeep Kaur
Mrs. Seema Maheshwari
Dr. Manpreet Kaur

Teaching-learning Activities:

Viva-voce

Laboratory-based practical component and experiments

practicum and project-based learning

Reference Books:

1. Khosla, B. D.; Garg, V. C. &Gulati, A. *Senior Practical Physical Chemistry,* R.Chand& Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman &Co.: New York (2003).
4. Athawale, V. D. and Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

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Skill Enhancement Course

BSHCHE 305 A (P): GREEN METHODS IN CHEMISTRY

Max. Marks: 50 No. of Lectures: 60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- The primary goal of this course is to make students aware of how chemical processes can be designed, developed and run in a sustainable way.
- Students acquire the competence to think of greener and environmental benign routes of chemical synthesis.

COURSE OUTCOMES

On the completion of this course, students will be able to:
CO1: Recall the twelve principles of green chemistry.
CO2: design safer chemical processes that are less toxic than current alternatives.
CO3: Compare the conventional methods of synthesis with green methods.
CO4: Explain the benefits of using green solvents and biocatalysts to carry out environment friendly synthesis.

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry, with examples, atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, green energy and sustainability, Eco Scale, E-Factor.

The following Green Chemistry procedures should be discussed:

1. **Inorganic Analysis**: Alternative of H_2S gas generated from Kipp's apparatus, Spot test.

2. **Organic preparations**: Conventional method (reaction, non-green components), Alternative green method (reaction, mechanism and advantages over conventional method) for the following:

(i) Acetylation of Primary amines
(ii) Halogen addition to C=C bond
(iii) Microwave assisted synthesis of Knoevenagel reaction.

3. **Inorganic Preparations**: Conventional method (reaction, non-green components), Alternative green method (reaction and advantages over conventional method) for the following:

(i) Preparation of Iron (III) acetylacetonate
(ii) Preparation of Manganese (III) acetylacetonate

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4. **Organic Qualitative analysis**: Detection of N, S, Cl, Br, I: Use of Zinc and Sodium carbonate instead of Sodium metal (Procedure and advantages).

Practicals:

Organic preparations (any three):

(i) Acetylation of Primary amines: Preparation of acetanilide (without acetic anhydride).

(ii) Halogen addition to C=C bond (with bromating mixture of KBr and $KBrO_3$)

(iv) Microwave assisted synthesis of Knoevenagel reaction.

(v) Synthesis of dihydropyrimidinone (without sulfuric acid).

Organic Qualitative analysis: Detection of elements N, S, Cl, Br, I Using Zinc and Sodium carbonate instead of Sodium metal.

Transesterification: Synthesis of Biodiesel

Reference Books:

1. Anastas, P.T. & Warner, J.K. Green Chemistry- Theory and Practical, Oxford University Press (1998).
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
3. Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
4. Ryan, M.A. & Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
5. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. Green Chemistry Experiments: A monograph I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore.
6. Lancaster, M. Green Chemistry: An introductory text RSC publishing, 2nd Edition.
7. Sidhwani, I.T., Saini, G., Chowdhury, S., Garg, D., Malovika, Garg, N. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A Social Awareness Project", Delhi University Journal of Undergraduate Research and Innovation, 1(1): 2015.
8. Ahluwalia, V. K. and Kidwai, M. New Trends in GREEN CHEMISTRY. ISBN 978-94-015-7102-9 ISBN 978-1-4020-3175-5 DOI 10.1007/978-1-4020-3175-5.

Teaching-learning Activities:

Viva-voce

Laboratory-based practical component and experiments

practicum and project-based learning

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Prof. (Dr.) Sonal Singhal
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Skill Enhancement Course
BSHCHE 305 B (P): PESTICIDE CHEMISTRY

Max. Marks: 50 No. of Lectures: 60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

The major goal of this course is to provide students with knowledge about the fundamental chemistry of various pesticides considering their importance for our environment. The aim is to provide knowledge about the classification of various pesticides and their synthesis and applications.

COURSE OUTCOMES

On completion of the learning process, students will be able to:

CO1: explain about the fundamental chemistry and structure of pesticides.

CO2: design the synthesis processes used for pesticide production.

CO3: apply their knowledge for benefits and concerns arising from using pesticides for various purposes including agriculture.

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).

Teaching-learning Activities

Peer teaching and learning
seminar presentation
Assignments
use of e-learning resources and self-study materials

Prof. (Dr.) Baljit Singh
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Dr. Poonam Patyar
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Mrs. Priya Sharma
Dr. Kamalpreet Kaur
Mrs. Simrat Kaur
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SEMESTER IV

Paper Code	Title of Paper	No. of Lectures	L T P (Credits)	Max. Marks (External+Internal) Pass Percentage 40%
BSHCHE 401	Inorganic Chemistry-III	60	400 (4)	100 (75+25)
BSHCHE 401 (P)	Inorganic Chemistry-III Lab	60	002 (2)	50
BSHCHE 402	Organic Chemistry III	60	400 (4)	100 (75+25)
BSHCHE 402 (P)	Organic Chemistry-III Lab	60	002 (2)	50
BSHCHE 403	Physical Chemistry-IV	60	400 (4)	100 (75+25)
BSHCHE 403 (P)	Physical Chemistry-IV Lab	60	002 (2)	50
BPHGE4/ UGCS1904/ BSHMATGE-401/BSHZ(G) 04	Physics/ Computer/ Maths/ Zoology	60	400 (4) 510(6) For Maths	100 (75+25)
BPHGE3-Lab/ UGCS1904-Lab/ BSHMATGE-401 Lab/ BSHZ(G) 04- Lab	Physics Lab/ Computer Lab/ Maths Lab/ Zoology Lab	60	002 (2)	50
BSHCHE 404 A/B (P)	Skill Enhancement Course: 404 A: Basic Analytical Chemistry OR 404 B: Minor Project in chemistry	45	002 (2)	50

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Semester IV

Core Course VII

BSHCHE 401: INORGANIC CHEMISTRY-III

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60 Lectures

COURSE OBJECTIVES

- To learn about the nomenclature, stereochemistry, and in stability of coordination compounds.
- To understand the crystal field splitting and its effects in coordination compounds.
- To understand the chemistry of transition elements-their oxidation states, stability, colour, magnetic and catalytic properties.
- To understand the chemistry of Lanthanides and Actinides – their separation, color, spectra and magnetic behaviour.
- To understand the role of metal ions in biological systems.

COURSE OUTCOMES

On completion of this course, the learners would be able to:

CO1: Name the coordination compounds, draw isomers and predict the stability of coordination compounds

CO2: Predict the splitting of d-orbitals in octahedral, tetrahedral and square planar geometries and identify the factors affecting the magnitude of crystal field splitting.

CO3: Explain the origin of colour, spectral and magnetic properties in coordination compounds.

CO4: Explain the chemistry of transition elements-their oxidation states, stability, colour, magnetic and catalytic properties

CO5: Identify the inorganic elements essential for biological systems and explain their role in biological systems**.**

Self-study:

1. IUPAC nomenclature of coordination compounds/complexes.
2. Prediction of structure of complexes using various theories; color and magnetic properties of different complexes.
3. Use of lanthanide/actinide compounds in industries.
4. Toxicity of various metals and mechanism of metal-biological system interactions.

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INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Coordination Chemistry-I

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers, Werner's theory, Effective Atomic Numbers, stability of complexes, factors affecting stability of the complexes (Chelate effect), labile and inert complexes. Valence bond theory (inner and outer orbital complexes).

Coordination Chemistry-II

Crystal field theory, the splitting of d-orbitals in different fields fields (octahedral, tetrahedral, tetragonally distorted octahedral, square planar, trigonal bipyramidal), crystal field stabilization energy CFSE in weak and strong fields, pairing energies, measurement of 10 Dq (Δ_o), factors affecting the magnitude of 10Dq, stereochemical series, origin of colour and magnetic properties of transition metal complexes. Structural effects of crystal field splitting; ionic radii, Jahn-Teller effect in octahedral complexes. Qualitative aspects of Ligand field and MO Theory. **30Hrs.**

UNIT-II

Transition Elements

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Frost diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanides and Actinides

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

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Bioinorganic Chemistry

Role of metal ions in biological systems, essential elements, bulk and trace elements, metal deficiency diseases, Sodium/K-pump, metalloenzymes carbonic anhydrase and carboxypeptidase. Iron and its role in bio-systems; oxygen transport and storage pigments haemoglobin and myoglobin, cooperativity and Bohr effect, iron storage and transport by ferritin and transferrin, Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. **30Hrs.**

Reference Books:

1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
2. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley &Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
7. Shriver and Atkins, *Inorganic Chemistry, 5th edition.*
8. M.C. Day, J. Selbin, *Theoretical Inorganic Chemist.*

Teaching-learning activities:

Seminar presentations on self-study topics
Assignments
Visual demonstrations using online resources
Quizzes

Prof. (Dr.) Baljit Singh
Prof. (Dr.) Sonal Singhal
Mr. Ravinderjeet Singh
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BSHCHE 401 (P): INORGANIC CHEMISTRY-III Lab

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- To train the students in the quantitative analysis of metal ions and anions using gravimetric methods
- To enable the students carry out separations using chromatographic techniques
- To enable the students to carry out synthesis of coordination compounds.
- To develop observation, analytical and experimentation skills in students.

COURSE OUTCOMES

On completion of the course, the student will be able to:
CO1: Perform gravimetric determination of mixed metal ions.
CO2: Perform synthesis of simple coordination compounds.
CO3: Perform chromatographic separations
CO4: Demonstrate analytical and experimental skills.

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN.
iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$.
ii. *Cis* and *trans*-$K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III).
iii. Tetraamminecarbonatocobalt (III) ion.
iv. Potassium tris(oxalato)ferrate (III).

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Reference Book:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. *Advanced Practical Inorganic Chemistry,* Gurdeep Raj, Krishna Prakashan.

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Teaching learning activities:

Laboratory-based practical component and experiments.
viva voce interview.

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Core Course VIII
BSHCHE 402: ORGANIC CHEMISTRY-III

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60Lectures

COURSE OBJECTIVES

- To discuss the synthetic methods and reaction mechanism of nitrogen containing functional groups, heterocyclic compounds & polynuclear hydrocarbons.
- To discuss the ever-growing classes of natural products including alkaloids and terpenoids which possess a broad range of biological activities.

COURSE OUTCOMES

On the completion of this Course student will be able to:

CO1: Outline various preparation methods, properties and reactions of amines, diazonium salts and polynuclear hydrocarbons.

CO2: learn the technique of synthesis of heterocyclic compounds used in synthesis of various drugs.

CO3: predict the reactivity of any heterocyclic compound from its structure.

CO4: identify the various classes of natural products and know their medicinal importance.

CO5: apply the chemical principles studied for the natural products to synthesize other unseen natural products.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Nitrogen Containing Functional Groups:

Nitro compounds: Preparation of Nitro compounds (Nitroalkanes and Nitroarenes), Chemical reactions of Nitroalkanes (Aldol Condensation, Michael addition, Mannich reaction & Nef

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carbonyl synthesis) and Nitroarenes (Electrophilic & Nucleophilic substitution reaction and their reduction in acidic, basic and neutral medium).

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2°and 3°amines with Hinsberg's reagent and nitrous acid.

Diazonium salts: Preparation from aromatic amines, Chemical Reactions such as conversion to benzene, phenol and dyes.

Polynuclear Hydrocarbons: Reactions of naphthalene, phenanthrene and anthracene Structure, Preparation, structure elucidation and important derivatives of naphthalene and anthracene. **30Hrs.**

UNIT-II

Heterocyclic Compounds:

Introduction to five and six membered heterocyclic compounds: Molecular orbital picture of pyrrole, furan, thiophene, pyridine. Classification, Nomenclature, structure and aromaticity in 5 and 6 membered rings containing heteroatom. Methods of synthesis and chemical reactions with special emphasis on mechanism and orientation of electrophilic substitution of: Furan (Paal Knorr synthesis, Feist-Benary synthesis) Pyrrole (Paal Knorr synthesis, Knorr pyrrole synthesis, Hantzsch pyrrole synthesis), thiophene (Paal Knorr synthesis, from acetylene), pyridine (Hantzsch synthesis, from pyrrole), comparison of basicity of pyridine, piperidine and pyrrole.

Introduction to Benzo fused five and six membered heterocyclic compound with one hetero atom: Method of synthesis and chemical reaction with particular emphasis on the mechanism and orientation of substitution reaction of: Indole (Fischer indole synthesis, Madelung synthesis, Bischler synthesis), Quinoline (Skraup synthesis, Knorr quinoline synthesis), Isoquinoline (Bischler-Napieralski synthesis).

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Quinine, Morphine and Reserpine.

Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol. **30Hrs**

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Dr. Kamalpreet Kaur
Mrs. Simrat Kaur
Dr. Kiran
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Dr. Manpreet Kaur

Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Wiley & Sons (1976).
5. Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
6. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
7. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P)Ltd. Pub.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.
9. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Pragati Prakashan (2010)

Teaching learning activities:

1. Student directed learning: Small groups of students are given individual assignments, then they will introduce their assignment in the form of Power point presentation.
2. Lectures supported by group tutorial work.
3. Technology enabled learning.
4. Peer teaching and learning.

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BSHCHE 402(P): ORGANIC CHEMISTRY-III Lab

Max. Marks: 50 No. of Lectures: 60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- To study the chemistry of some selected functional groups with a view to develop proper aptitude toward the analysis of organic compounds and their reactions.
- This course will give the quantitative idea about the synthesis of heterocyclic compounds by using single step or multi step synthetic approaches.

COURSE OUTCOMES

On the completion of this Course the student would be able to:
CO1: analyse organic compounds containing different functional groups in a systematic manner.
CO2: Synthesise heterocyclic compounds by using various methods.
CO3: Develop basic skills for the multi-step synthesis of organic compounds.

1. **Functional Group Analysis:**
   The preliminary examination of physical and chemical characteristics (physical state, colour,odor and ignition tests), elemental analysis (nitrogen, sulphur, chlorine, bromine, iodine),solubility tests including acid-base reactions, classification tests involving functional reactivity other than acid-base test, preparation of derivatives for given pure organic compounds. The following categories of compounds should be analyzed.
   -Phenols, Carboxylic Acids
   -Carbonyl Compounds - Ketones, Aldehydes
   -Carbohydrates
   -Aliphatic Amines (1°,2°,3°)
   -Aromatic Amines
   -Nitro, Amides, Urea and Anilides
   -Aromatic hydrocarbons and their halo- derivatives.

2. **Synthesis of Heterocyclic compounds:**
   (a) Synthesis of 2-Phenylindole from Phenylhydrazine.
   (b) Synthesis of Indole by Paal- Knorr Synthesis method.
   (c) Synthesis of 1,2,3,4 tetrahydrocarbazole.

Reference Books:

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)

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

Teaching learning activities:

Viva-voce
Laboratory-based practical components and experiments.
Practicum and project-based learning.

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Core Course IX
BSHCHE-403: PHYSICAL CHEMISTRY-IV

Maximum Marks: 100
University Examination: 75 Time: 3 Hours
Internal Assessment: 25 Pass Marks: 40%
(Credits: 04) Theory: 60 Lectures

COURSE OBJECTIVES

- The course intends to impart basic knowledge of electrochemistry and its application in industrial and metallurgical processes covering all the important topics such as Faraday's laws of electrolysis, Chemical cells, EMF of cell and its measurement etc.
- In addition to this, the course includes the application of EMF measurements in determining (i) equilibrium constants and (ii) pH values using different electrodes.
- Moreover, the course includes the study of electrical and magnetic properties of atoms and molecules.

COURSE OUTCOMES

On completion of this course, the students will be able to:
CO1: Define the basic laws of electrochemistry.
CO2: construct electrochemical cells and their functioning.
CO3: measure the cell potential for an electrochemical cell and how to use this measured cell potential to calculate the free energy change, enthalpy change and entropy change.
CO4: Apply some methods for the determination of transference number of electrolytes.

Self-study:

1. Measurements of conductance for strong and weak electrolytes by the use of a conductometry.
2. Electrical and Magnetic properties of Atoms and Molecules and their interpretation.
3. EMF measurements by using different electrodes.

INSTRUCTIONS FOR THE PAPER-SETTER

The question paper will consist of three units: I, II and III. Unit I and II will have four questions from each unit of the syllabus and will carry 12 marks each. Unit III will consist of 9 questions from the whole syllabus and will be of 3 marks each.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt two questions each from units: I and II, unit III is compulsory.

Prof. (Dr.) Baljit Singh
Prof. (Dr.) Sonal Singhal
Mr. Ravinderjeet Singh
Mrs. Rachna Bhardwaj
Dr. Poonam Patyar
Mr. Puneet Bhardwaj
Mrs. Priya Sharma
Dr. Kamalpreet Kaur
Mrs. Simrat Kaur
Dr. Kiran
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Note: Internal assessment will be given on the basis of mid semester tests (12), class performance (6), assignments/quiz (7).

UNIT-I

Conductance

Arrhenius theory of electrolytic dissociation, Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Molar conductivity at infinite dilution, Kohlrausch's law of independent migration of ions, Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules, Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods, Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations (v) hydrolysis constants of salts.

Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mossotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements, Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation. **30Hrs.**

UNIT-II

Electrochemistry

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry, Chemical cells, reversible and irreversible cells with examples, Electromotive force of a cell and its measurement, Electrochemical series and its application, Nernst equation, Standard electrode (reduction) potential and its application to different kinds of half-cells, Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes, Concentration cells with and without transference, liquid junction potential, determination of activity coefficients and transference numbers, Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). **30Hrs.**

Reference Books:

1. Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
3. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry 5th Ed.,* Tata McGraw Hill: New Delhi (2006).

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5. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
6. Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
7. Silbey, R. J.Alberty, R. A. &Bawendi, M. G. *Physical Chemistry 4th Ed.,* JohnWiley& Sons, Inc. (2005).

Teaching-learning Activities

Peer teaching and learning
seminar presentation
group tutorial
Assignments
use of e-learning resources and self-study materials

Prof. (Dr.) Baljit Singh
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BSHCHE 403 (P): PHYSICAL CHEMISTRY-IV Lab

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- To impart the knowledge of use of instruments such as Conductometer, Potentiometer for determination of some physical parameter.
- The students will learn to do acid-base titration to find out ent points.

COURSE OUTCOMES

On completion of the course, the student will be able to:

CO1: Determine the cell constant with the help of a conductometer.

CO2: Measure the strength and equivalence point of different types of the electrolytes by the use of a Conductometer.

CO3: Evaluate the end point for redox titrations with e help of Potentiometer.

Conductometry:

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) To titrate the given mixture of sulphuric acid, acetic acid, and copper sulphate against 0.1 M NaOH solution conductometrically.
b) Strong acid vs. weak base

Potentiometry:

I. Perform the following potentiometric titrations:

a) Mixture of halides against silver nitrate solution.
b) Weak acid vs. strong base.
c) Dibasic acid vs. strong base.
d) Potassium dichromate vs. Mohr's salt

Flame Photometry:

a) Flame photometric determination of Na^+ and K+ ions
b) Flame photometric determination of Ca^{2+} in tap water

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Reference Books:

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

Teaching-learning Activities:

1. Viva-Voce
2. Laboratory-based practical component and experiments
3. workshops

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Skill Enhancement Course

BSHCHE 404 A (P): BASIC ANALYTICAL CHEMISTRY

Max. Marks: 50 No. of Lectures:60 Hrs.
Time Allowed: 3 hrs. Pass Marks: 40%
(Credits: 02)

COURSE OBJECTIVES

- The major goal of this course is to familiarize students with basic concepts of analytical chemistry including fundamental terms such as precision, accuracy, and sources of error in experimental settings.
- The course is also aimed at nurturing students with practical knowledge about analytical chemistry, with focus on soil and water pollution, food analysis, chromatography, and personal care products.

COURSE OUTCOME

On completion of the course, student will be able to:

CO1: explain the concept of sampling in analytical applications, the importance of accuracy, precision, and source of error in analytical measurements.

CO2: perform common laboratory techniques of paper chromatography and thin layer chromatography to separate the components of mixtures.

CO3: perform classical analytical experiments, and make observations and assessments of important factors that could affect the analytical result.

CO4: determine the pH of water and soil samples.

CO5: make up methodical reports from chemical experiments and present the results in a transparent manner.

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

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

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

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

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

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Analysis of cosmetics: Major and minor constituents and their function.

PRACTICALS

1. Analysis of soil:

a. Determination of pH of soil samples.

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

2. Analysis of water:

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

3. Analysis of food products:

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

4. Chromatography:

a. Chromatographic separation (Paper/ TLC) of mixture of metal ion, fluorescent dyes.

5. Analysis of cosmetics:

a. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

6. Suggested Instrumental demonstrations (any two):

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

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

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic acid in soft drinks.

Reference Books:

1. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A. Holler F.J. &Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
5. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
6. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
7. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA.16 (1977).

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8. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.
9. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

Teaching-learning Activities:

Viva-Voce
Laboratory-based practical component and experiments
workshops

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Skill Enhancement Course

BSHCHE 404 B(P): Minor Research Project in Chemistry

Max. Marks: 50 No. of Hours: 60 Hrs.

(Credits: 02) Pass Marks: 40%

COURSE OBJECTIVES

- The minor research course will address problems of societal and industrial interest.
- Students get exposed to a blend of theoretical as well as practical knowledge.
- Students will get expertise in understanding, formulating and solving problems.

COURSE OUTCOMES

On completion of this course, student will be able to:

CO1: search the related literature.

CO2: develop skills of formulating their own method and ability to use instruments for analysis.

CO3: develop report writing skills.

Students can work on any of the research project of their interest with the consent of teacher in charge and availability of Chemicals.

Project Report: 30 marks (Students have to submit project report comprising introduction, Experiment, Result and discussion, Conclusion)

Viva voce: 20 marks

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Formatting Instructions

Section	Page	Required/optional
Title Page	No page number	Required
Preliminary Pages (Give page numbers in Roman)	1. Declaration by supervisor (Page i) 2. Declaration by candidate (Page ii) 3. Declaration by Committee (Page iii) 4. Abstract 5. Acknowledgements 6. Table of Contents 7. List of Tables 8. List of Figures 9. Abbreviations (optional)	Required
Main Body (start numbering from 1) Divide into 4 chapters	1. Introduction (including review of literature) 2. Experimental 3. Results and Discussions 4. Conclusions	Required
References	You can follow any style but it should be same throughout	Required

The total number of Pages should be between 25-30.

The minor project thesis should be in Times new Roman font size 12 with 1.5 spacing, justified and with margins set to 1.25" left/right and 1" top/bottom printed on single side.

Colour Black

Hard bound

Total No. of copies =5 (library, department, supervisor, student, examiner)

Teaching-learning Activities

Laboratory-based practical component and experiments

Peer teaching and learning

use of e-learning resources

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