



1.1.2

List of Employability/ Entrepreneurship/ Skill Development Courses with Course Contents

Colour Codes		
Name of the Subjects	Yellow	
Employability Contents	Green	
Entrepreneurship Contents	Light Blue	
Skill Development Contents	Pink	



**List of Courses Focus on Employability/ Entrepreneurship/
Skill Development**

Department : Chemistry

Programme Name : B. Sc.

Academic Year : 2020-21

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	CBL-1	Inorganic Chemistry-1 Practical
02.	CBL-2	Physical Chemistry-I Practical
03.	ECA	ECA-Extracurricular activity/ Tour, Field visit/Industrial training/ NSS/ Swachhta./ vocational Training/ Sports/ others
04.	CBT-3	Organic Chemistry-I
05.	CBL-3	Organic Chemistry-I Practical
06.	CBL-4	Physical Chemistry-II Practical
07.	AECC	Environmental Science
08.	ECA	ECA-Extracurricular activity/ Tour, Field visit/ Industrial training/ NSS/ Swachhta,/ vocational Training/ Sports/ others
09.	CBL-5	Inorganic Chemistry II: Practical
10.	CBT-6	Organic Chemistry -II
11.	CBL-6	Organic Chemistry-II : Practical
12.	CBL-7	Physical Chemistry -III: Practical
13.	SEC-1	Select one from the Pool of 4 2 (4) SEC Courses offered By Different Departments
14.	CBL.8	Inorganic Chemistry- III: Practical
15.	CBT-9	Organic Chemistry- III
16.	CBL-9	Organic Chemistry- III Practical
17.	CBL-10	Physical Chemistry- IV Practical
18.	CBT-11	Organic Chemistry- IV
19.	CBT-11	Organic Chemistry- IV Practical
20.	CBL-12	Physical Chemistry-V: Practical
21.	DSE-I-THEORY	DSE-1 : Theory
22.	DSE-1-LAB	DSE-1: Practical
23.	DSE-2-THEORY	DSE-2 : Theory
24.	DSE-2-LAB	DSE-2: Practical
25.	CBL-13	Inorganic Chemistry-IV: Practical

गुरु घासीदास विश्वविद्यालय
(केन्द्रीय विश्वविद्यालय अधिनियम 2009 क्र. 25 के अंतर्गत स्थापित केन्द्रीय विश्वविद्यालय)
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26.	CBT-I4	Organic Chemistry-V
27.	CBL-I4	Organic Chemistry-V: Practical
28.	DSE-3-THEORY	DSE-3 : Theory
29.	DSE-3-THEORY	DSE-3 : Theory Practical
30.	DSE-4-PROJECT	Dissertation/ Project work followed by seminar

अध्यक्ष/Head
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Scheme and Syllabus

B.Sc. Hon's Programme: Department of Chemistry

Semester	Course Opted	Course Code	Name of the course	Credit	Hour / week
I	Core-1	CBT-1	Inorganic Chemistry I:	4	4
	Core -1 Practical	CBL-1	Inorganic Chemistry-I Practical	2	4
	Core -2	CBT-2	Physical Chemistry I:	4	4
	Core -2 Practical	CBL-2	Physical Chemistry-I Practical	2	4
	Generic Elective -1		1A Physics-I 1B Mathematics-I 1C Zoology-I 1D Botany-I	4	4
	Generic Elective - Practical		Generic Elective – Practical-I	2	4
	Ability Enhancement Compulsory Course (AECC)		English Communication / MIL	4	4
	ECA		ECA-Extracurricular activity/ Tour, Field visit/ Industrial training/ NSS/ Swachhta/ vocational Training/ Sports/ others	2	(2)
		TOTAL	24	28	
II	Core-3	CBT-3	Organic Chemistry-I	4	4
	Core -3 Practical	CBL-3	Organic Chemistry-I Practical	2	4
	Core -4	CBT-4	Physical Chemistry-II	4	4
	Core -4 Practical	CBL-4	Physical Chemistry-II Practical	2	4
	Generic Elective -2		2A Physics-II 2B Mathematics-II 2C Zoology-II 2D Botany-II	4	4
	Generic Elective - Practical		Generic Elective – Practical-II	2	4
	Ability Enhancement Compulsory Course (AECC)		Environmental Science	4	4
	ECA		ECA-Extracurricular activity/ Tour, Field visit/ Industrial training/ NSS/ Swachhta/ vocational Training/ Sports/ others	2	(2)
		Total	24	28	

Dr. B. K. Singh
22/06/18

Chauhan Akash
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S. M. S.
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23.06.18
Dr. S. S.
23.06.18



SUMMER Internship: 15 days		Swayam Swachhta / NSS / Industrial/ others		2	100
III	Core-5	CBT-5	Inorganic Chemistry II	4	4
	Core -5 Practical	CBL-5	Inorganic Chemistry II: Practical	2	4
	Core -6	CBT-6	Organic Chemistry-II	4	4
	Core -6 Practical	CBL-6	Organic Chemistry-II : Practical	2	4
	Core - 7	CBT-7	Physical Chemistry-III	4	4
	Core - 7 Practical	CBL-7	Physical Chemistry-III: Practical	2	4
	Generic Elective -3		3A 3B 3C 3D	4	4
	Generic Elective - Practical			2	4
	Skill Enhancement Course (SEC - 1)		Select one from the Pool of SEC courses offered by different departments	4	2(4)
			Total	28	34
IV	Core-8	CBT-8	Inorganic Chemistry III:	4	4
	Core -8 Practical	CBL-8	Inorganic Chemistry III: Practical	2	4
	Core -9	CBT-9	Organic Chemistry III	4	4
	Core -9 Practical	CBL-9	Organic Chemistry III: Practical	2	4
	Core - 10	CBT-10	Physical Chemistry-IV	4	4
	Core -10 Practical	CBL-10	Physical Chemistry-IV: Practical	2	4
	Generic Elective - 4		4A 4B 4C 4D	4	4
	Generic Elective - Practical			4	4
	Skill Enhancement Course (SEC -2)		Select one from the Pool of SEC courses offered by different departments	4*	2(4)
			TOTAL	28	34
SUMMER Internship: 15 days		Swayam Swachhta / NSS / Industrial/ others		2	100
V	Core-11	CBT-11	Organic Chemistry IV	4	4
	Core-11 Practical	CBL-11	Organic Chemistry IV: Practical	2	4

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	Core -12	CBT-12	Physical Chemistry-V	4	4
	Core -12 Practical	CBL-12	Physical Chemistry-V: Practical	2	4
	Discipline Specific Elective (DSE-1)	DSE-1-THEORY	DSE-I : Theory	4	4
	DSE-1 - Practical	DSE-1-LAB	DSE-I: Practical	2	4
	Discipline Specific Elective (DSE-2)	DSE-2-THEORY	DSE-II : Theory	4	4
	DSE-2 - Practical	DSE-2-LAB	DSE-II: Practical	2	4
			TOTAL	24	32
VI	Core-13	CBT-13	Inorganic Chemistry IV	4	4
	Core -13 Practical	CBL-13	Inorganic Chemistry IV: Practical	2	4
	Core -14	CBT-14	Organic Chemistry V	4	4
	Core -14 Practical	CBL-14	Organic Chemistry V: Practical	2	4
	Discipline Specific Elective (DSE-3)	DSE-3-THEORY	DSE-III : Theory	4	4
	DSE-3 - Practical	DSE-3-LAB	DSE-III: Practical	2	4
	Discipline Specific Elective (DSE-4) + DSE-4 - Practical	DSE-4-Project		4+2=6	
	Or Dissertation/ Project work followed by seminar		Dissertation/ Project work followed by seminar	Or 5+1=6	8
			TOTAL	24	32
			TOTAL CREDITS		152 + 4 (SI)

As per UGC CBCS guidelines, University / departments have liberty to offer GE and SEC courses offered by one department to students of other departments. The No. of GE course is four. One GE course is compulsory in first 4 semesters each.

Minimum One Skill Enhancement course shall be proposed by each department. (4 credits) [4 L or 2L + 2P or 1L + 3P or 3L + 1T] 1P = 2 hours

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CHEMISTRY-DSE I-IV (ELECTIVES)

CHEMISTRY-DSE-I:	ANALYTICAL METHODS IN CHEMISTRY
CHEMISTRY-DSE-II:	BIOCHEMISTRY
CHEMISTRY-DSE-III:	NOVEL INORGANIC SOLIDS
CHEMISTRY-DSE-IV:	POLYMER CHEMISTRY
CHEMISTRY-DSE-V:	APPLICATIONS OF COMPUTERS IN CHEMISTRY
CHEMISTRY-DSE-VI:	RESEARCH METHODOLOGY FOR CHEMISTRY
CHEMISTRY-DSE-VII:	GREEN CHEMISTRY

SKILL ENHANCEMENT COURSE (ANY TWO) (CREDIT: 02 EACH)

SEC-1:	BASIC ANALYTICAL CHEMISTRY
SEC-2:	INTELLECTUAL PROPERTY RIGHTS (IPR)
SEC-3:	GREEN METHODS IN CHEMISTRY
SEC-4:	PHARMACEUTICAL CHEMISTRY
SEC-5:	CHEMISTRY OF COSMETICS & PERFUMES
SEC-6:	PESTICIDE CHEMISTRY

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Chauhan



CHEMISTRY LAB-C1: INORGANIC CHEMISTRY-I PRACTICAL
(PSCHCR0101P)
60 LECTURES

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus
- (ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.
- (iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution.
- (ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iii) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Course Outcome:

After this course students will be able estimate amount of different type acids, bases, and metal ions in unknown sample.

Reference text:

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

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A. S. S.
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Sharma



CHEMISTRY LAB-C II: PHYSICAL CHEMISTRY-I PRACTICAL
(PSCHCR0102P)
60 LECTURES

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

Any other experiment carried out in the class.

Course Outcome:

After this course students will be able measure Surface tension, Viscosity & pH in unknown sample.

Reference Books

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

Dr. H.H. S

BSS

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Dr. S.



Semester II

CHEMISTRY-C III: ORGANIC CHEMISTRY I (PSCHCR0203L)
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Structure and Bonding: Classification, nomenclature and general structure of organic compounds. Hybridization, orbital representation of methane, ethane, ethylene, acetylene and benzene. Bond energy, bond length and bond angles. Polarity of covalent bonds—Inductive, resonance, hyper-conjugation and steric inhibition in resonance and its influence on acidity and basicity of organic compounds.

Mechanism of Organic reactions: Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows. Homolysis and heterolysis of carbon-carbon bonds; Reactive species e.g. Carbocations, carbanions, free radicals and their stability. Nucleophiles and electrophiles.

Alkanes and cycloalkanes: Preparation and general reactions of alkanes and cycloalkanes, Bayer Strain theory of strainless ring; Conformation of ethane, *n*-butane and cyclohexane, chlorination of methane and side chain chlorination of toluene.

Alkenes: General methods for preparation of alkenes, Reactions of alkenes: Addition reactions (Electrophilic and free radical), Halogenation, Hydrohalogenation, Hydration, Hydroxylation, Hydroboration-oxidation, Mercuration-demercuration, Epoxidation and Ozonolysis.

Dienes: Conjugated and isolated Dienes; 1,2- versus 1,4-addition. Diels-Alder reaction of dienes: Mechanism

Alkynes: Preparation of alkynes, acidity and metal acetylides, Electrophilic addition reactions viz., Halogenation, Hydrohalogenation, Hydration, Hydroboration-oxidation, Mercuration-demercuration and Ozonolysis.

Course Outcome

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

- Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
- Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and nomenclature.
- Aromatic compounds and aromaticity, mechanism of aromatic reactions.

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- Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
- Electrophile, nucleophiles, free radicals, electronegativity, resonance, and intermediates along the reaction pathways.
- Mechanism of organic reactions (effect of nucleophile/leaving group, solvent), substitution vs. elimination.

Books Recommended:

1. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P)Ltd., New Delhi.
2. "Organic Chemistry", S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
3. "Organic Chemistry", I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
4. "Organic Chemistry – Structure and Reactivity", Seyhan N. Ege, 3rd Edition (1998), AITBS Publishers and Distributors, Delhi.
5. "Organic Chemistry", Paula Y. Bruice, 2nd Edition, Prentice-Hall, International Edition (1998).
6. "Organic Chemistry", G. Solomon, Willey India, Paper Back, 9th Edition.
7. "Modern Organic Chemistry", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012).

**PRACTICAL CORE COURSE – III ORGANIC CHEMISTRY –I LAB
(PSCHCR0203P)**

60 Lectures

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
a. Water b. Alcohol, c. Alcohol-Water
3. Determination of the melting points of unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Detection of special elements (N, S, Cl, Br, I).

Course Outcome:

After this course students will be able to purify organic compounds, basic characterizations & detection of special elements (N, S, Cl, Br, I).

Reference Books

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

Dr. H. H. S. *Dr. S. S.*
Chauhan *S. S. S.* *Dr. S.*



- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012)

CHEMISTRY LAB- C IV PHYSICAL CHEMISTRY-II LAB (PSCHCR0204P)

60 Lectures

Thermochemistry

- Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
- Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- Calculation of the enthalpy of ionization of ethanoic acid.
- Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- Determination of enthalpy of hydration of copper sulphate.
- Study of the solubility of benzoic acid in water and determination of ΔH .

Any other experiment carried out in the class.

Course Outcome:

After this course students will be able to determine heat capacity, enthalpy & heat of solubility of different reactions.

Reference Books

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

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- Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

CHEMISTRY LAB-C V INORGANIC CHEMISTRY LAB (PSCHCR0305P)

60 Lectures

(A) Iodo / Iodimetric Titrations

- Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
- Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
- Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

- Cuprous Chloride, Cu_2Cl_2
- Preparation of Manganese(III) phosphate, $MnPO_4 \cdot H_2O$
- Preparation of Aluminium potassium sulphate $KAl(SO_4)_2 \cdot 12H_2O$ (Potash alum) or Chrome alum.

Course Outcome:

After this course students will be able estimate amount of different type pollutants and metal ions in unknown sample. Also learn to synthesize inorganic compounds.

Reference Books:

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

CHEMISTRY-C VI: ORGANIC CHEMISTRY-II (PSCHCR0306L)

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Alkyl halides: Preparation and general reactions of alkyl halides; Grignard reagents: preparation and synthetic applications; Reformatsky reaction; Wurtz reactions.

Substitution and Elimination Reactions: Nucleophilic substitution – SN_1 and SN_2 mechanisms; Elimination reaction: E_1 and E_2 mechanisms, Elimination Vs Substitution reactions; energy profile diagrams – transition states, intermediates (general considerations).

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Cham Arora *S. S. S.* *Dr. S.*



Alcohols and ethers: General properties of alcohols. Synthesis of alcohols from alkenes *via* hydroboration-oxidation, oxymercuration-demercuration. Reactions of alcohols: Dehydration, oxidation and distinction of primary, secondary and tertiary alcohols. Acetal and ketal formation, Pinacole-pinacolone rearrangement. Preparation and general reactions of ethers; nucleophilic ring-opening of epoxides.

Aldehydes and Ketones: Preparation of carbonyl compounds. Oxidation and reduction reaction, Condensation reactions, Nucleophilic addition reactions: aldol condensation, Perkin reaction, Wittig Reaction, Cannizzaro reaction, benzoin condensation, Haloform reaction, Keto-enol tautomerism.

Carboxylic acids & its Derivatives: General method for the preparation of carboxylic acids, amides, esters, anhydrides, acid halides, and acid azides; Relative reactivity of carboxylic acids and their chemical reactions.

Stereochemistry: Optical activity and plane-polarized light. Plane and centre of Symmetry, Chirality, enantiomers, diastereoisomers, mesomers, atropisomers and racemic mixtures. Fischer, Newman and Sawhorse Projection Formula. E/Z, D/L and R/S nomenclature. Walden inversion.

Course Outcome:

After completion of the course, the learner shall be able to understand:

- Familiarization about classes of organic compounds and their methods of preparation.
- Basic uses of reaction mechanisms.
- Name reactions, uses of various reagents and the mechanism of their reaction.
- Preparation and uses of various classes of organic compounds.
- Organometallic compounds and their uses.
- Organic chemistry reactions and reaction mechanisms.
- Use of reagents in various organic transformation reactions.

Books Recommended

1. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. "Organic Chemistry", S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.

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3. "Organic Chemistry – Structure and Reactivity", Seyhan N. Ege, 3rd Edition (1998), ITBS Publishers and Distributors, Delhi.
4. "Organic Chemistry", I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
5. "A Guide Book to Mechanism in Organic Chemistry", P. Sykes, 6th Edition (1997), Orient Longman Ltd., New Delhi.
6. "Organic Chemistry", J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).
7. "Stereochemistry of Organic Compounds", D. Nasipuri, New Age International.
8. "Stereochemistry of Organic Compounds", P.S. Kalsi, New Age International.
9. "Organic Chemistry", G. Solomon, Wiley India, Paper Back, 9th Edition.
10. "Modern Organic Chemistry", M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012).

CHEMISTRY LAB- C VI ORGANIC CHEMISTRY – II LAB (PSCHCR0306P)

60 Lectures

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Preparation of Derivatives of functional groups:

Course Outcome:

After this course students will be able to identify different functional groups of organic compounds & synthesize their derivatives.

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012)

CHEMISTRY PRACTICAL-C VII PHYSICAL CHEMISTRY-III LAB (PSCHCR0307P)

60 Lectures

- I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
- II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
 - a. simple eutectic and
 - b. congruently melting systems.
- III. Distribution of acetic/ benzoic acid between water and cyclohexane.

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Dr. H. H. S.

Dr. S. S.

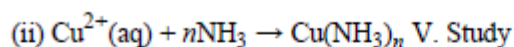
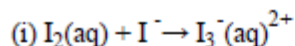
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IV. Study the equilibrium of at least one of the following reactions by the distribution method:



the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:
 - a. Acid hydrolysis of methyl acetate with hydrochloric acid.
 - b. Saponification of ethyl acetate.
3. Compare the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

- I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Course Outcome:

After this course students will be able to determine phase diagram, critical solution temperature & kinetics of reactions.

Reference Books:

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

CHEMISTRY-C VIII: INORGANIC CHEMISTRY-III LAB (PSCHCR0408P)

60 Lectures

Gravimetric Analysis:

- i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
- ii. Estimation of copper as CuSCN
- iii. Estimation of iron as Fe₂O₃ 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(NH₃)₄]SO₄.H₂O
- ii. *Cis* and *trans* K[Cr(C₂O₄)₂.(H₂O)₂] Potassium dioxalatochromate (III)

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- iii. Tetraamminecarbonatocobalt (III) ion
- iv. Potassium tris(oxalate)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)

Course Outcome:

After this course students will be able to estimate different types of metal ions by gravimetric methods & synthesize inorganic complexes.

Reference Book:

- 1. Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.

CHEMISTRY-C IX: ORGANIC CHEMISTRY-III (PSCHCR0409L)

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Aromatic Compounds: Introduction, nomenclature of benzene derivatives, the Kekule structure of benzene, Valance bond & molecular orbital theories of the structure of benzene, Huckel's rule: $(4n+2)$ π electron rule, Anti-aromatic compounds, non-aromatic, homoaromatic.

Electrophilic Substitution Reactions of Aromatic Compounds: Electrophilic substitution reactions (S_EAr), A general mechanism for electrophilic aromatic substitution – Arenium ions, Halogenation, Nitration and sulphonation of benzene, Friedel–Crafts alkylation and its limitations, Friedel–Crafts acylation; Effect of substituent's on reactivity and orientation.

Nucleophilic Substitution Reactions of Aromatic Compounds: Halobenzenes, and nucleophilic aromatic substitutions (S_NAr), bimolecular mechanism (A_ND_N), benzyne mechanism (D_NA_N). Preparation and uses of DDT and BHC.

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S. S. S.
Dr. S. S.



Phenols: General methods of preparation and reactions of phenol. Relative acidity of phenol, alcohol and carboxylic acid. Reimer-Tiemann and Kolbe reactions; Claisen and Fries rearrangements.

Nitrogen Containing Compounds: Nitrobenzene and reduction products. Amines and amides. Comparative basicity of aliphatic and aromatic amines, Diazonium salts: preparation (Diazo reaction) and synthetic applications (Sandmeyer reactions).

Polynuclear Aromatic Hydrocarbons: Synthesis and reactions of naphthalene, anthracene, phenanthrene.

Course Outcome:

After completion of the course, the learner shall be able to understand:

- Nitrogen containing functional groups and their reactions.
- Familiarization with polynuclear hydrocarbons and their reactions.
- Heterocyclic compounds and their reactions.
- Alkaloids and Terpenes
- Understanding reactions and reaction mechanism of nitrogen containing functional groups.
- Understanding the reactions and mechanisms of diazonium compounds.
- Understanding the structure and their mechanism of reactions of selected polynuclear hydrocarbons.
- Understanding the structure, mechanism of reactions of selected heterocyclic compounds.
- Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

Books Recommended:

1. "Organic Chemistry", R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
2. "Organic Chemistry", S. M. Mukherji, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), 5th Reprint (1999), New Age International (P) Ltd. Publishers, New Delhi.
3. "Organic Chemistry – Structure and Reactivity", Seyhan N. Ege, AITBS publishers, Delhi (1998).
4. "Organic Chemistry", Paula Y. Bruice, 2nd Edition, Prentice-Hall International Inc, New Jersey, International Edition (1998).
5. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).

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6. "Organic Chemistry", G. Solomon, Willey India, Paper Back, 9th Edition.

**CHEMISTRY PRACTICAL-C IX ORGANIC CHEMISTRY-III LAB
(PSCHCR0409P)**

60 Lectures

Organic preparations:

1. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β -naphthol, vanillin, salicylic acid) by any one method:
2. Benzoylation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, resorcinol, p- cresol)
3. Hydrolysis of amides and esters.
4. Aldol condensation reactions.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Course Outcome:

After this course students will be able to synthesize different types of organic compounds & their reactions.

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).

**CHEMISTRY PRACTICAL-C X PHYSICAL CHEMISTRY-IV LAB
(PSCHCR0410P)**

60 Lectures

Conductometry

- I. Determination of cell constant
- II. Determination of equivalent conductance, degree of dissociation and dissociation

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Constant of a weak acid.

- III. Perform the following conductometric titrations:
- Strong acid vs. strong base
 - Weak acid vs. strong base
 - Mixture of strong acid and weak acid vs. strong base
 - Strong acid vs. weak base

Potentiometry

- I. Perform the following potentiometric titrations:
- Strong acid vs. strong base
 - Weak acid vs. strong base
 - Dibasic acid vs. strong base
 - Potassium dichromate vs. Mohr's salt

Course Outcome:

After this course students will be able to estimate concentration of acids, bases & salts by conductometric and potentiometric titration methods.

Reference Books:

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

CHEMISTRY PRACTICAL-C XI ORGANIC CHEMISTRY IV LAB (PSCHCR0511P)

60 Lectures

- Functional group test for nitro, amine and amide groups.
- Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters)

Course Outcome:

After this course students will be able to identify functional groups such as nitro, amine and amide, alcohols, carboxylic acids, phenols, carbonyl compounds and esters etc.

Reference Books:

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

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4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY PRACTICAL-C XII PHYSICAL CHEMISTRY V LAB

(PSCHCR0512P)

60 Lectures

UV/Visible spectroscopy

- I. Study the 200-500 nm absorbance spectra of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1} , kJ mol^{-1} , cm^{-1} , eV).
- II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $\text{K}_2\text{Cr}_2\text{O}_7$.
- III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

- I. Verify Lambert-Beer's law and determine the concentration of $\text{CuSO}_4/\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ in a solution of unknown concentration
- II. Determine the concentrations of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ in a mixture.
- III. Study the kinetics of iodination of propanone in acidic medium.
- IV. Determine the amount of iron present in a sample using 1,10-phenanthroline.
- V. Determine the dissociation constant of an indicator (phenolphthalein).
- VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
- VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Course Outcome:

After this course students will be able to record & analyze spectra of compounds by UV/Visible spectroscopy and estimation of solute by colorimetric method.

Reference Books

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

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CHEMISTRY PRACTICAL-C XIII INORGANIC CHEMISTRY-IV (PSCHCR0613P)

LAB 60 Lectures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-} , NO_2^- , S^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , BO_3^{3-} , $\text{C}_2\text{O}_4^{2-}$, PO_4^{3-} , NH_4^+ , K^+ , Pb^{2+} , Cu^{2+} , Cd^{2+} , Bi^{3+} , Sn^{2+} , Sb^{3+} , Fe^{3+} , Al^{3+} , Cr^{3+} , Zn^{2+} , Mn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+}

Mixtures should preferably contain one interfering anion, or insoluble component (BaSO_4 , SrSO_4 , PbSO_4 , CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-} , NO_2^- and NO_3^- ,

Cl^- and Br^- , Cl^- and I^- , Br^- and I^- , NO_3^- and Br^- , NO_3^- and I^- .

Spot tests should be done whenever possible.

- Measurement of 10 Dq by spectrophotometric method
- Verification of spectrochemical series.
- Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.
- Preparation of acetylacetonato complexes of $\text{Cu}^{2+}/\text{Fe}^{3+}$. Find the λ_{max} of the complex.
- Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetonone, DMG, glycine) by substitution method.

Course Outcome:

After this course students will be able analyze cations, anions & radicals, and preparations of inorganic compounds & their spectral analysis.

Reference Books

- Vogel's *Qualitative Inorganic Analysis*, Revised by G. Svehla.
- Marr & Rockett *Inorganic Preparations*.

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CHEMISTRY-C XIV: ORGANIC CHEMISTRY-V (PSCHCR0614L)

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Carbohydrates:

Introduction, monosaccharides, glycoside bond formation, mutarotation. Reactions of aldoses and ketoses (oxidation and reductions). Killiani synthesis, Osazone formation. Glucose-structure (including cyclic structure), Fructose (reactions only). Degradation of monosaccharides: Ruff degradation.

Heterocyclic Compounds: Synthesis and chemistry of furan, thiophene, pyrrole, indole, pyridines, isoquinoline and quinoline.

Chemistry of Natural Products:

A study of the following compounds involving their isolation, structure elucidation and synthesis: Alkaloids- Hofmann exhaustive methylation, nicotine; Terpenes- Isoprene rule, citral.

Organic Synthesis via enolates: Preparation of DEM and EAA. Synthesis of mono/dicarboxylic acid, diketones, uracil, barbutric acid using DEM/EAA: Mukhayama Aldol reactions and Michael reactions.

Photochemistry: Principles of photochemistry, photochemical reactions of carbonyl compounds and olefins.

¹H NMR Spectroscopy: NMR phenomenon, precessional motion, Chemical shift, Shielding and de-shielding effects, Spin-spin splitting, Coupling constant, Interpretation of NMR spectra.

Course Outcome:

After completion of the course, the learner can be able to understand:

- Chemistry of carbohydrates, heterocyclic compounds & Chemistry of Natural Products.
- Synthesis, structures and characterizations of organic compounds.
- NMR Spectroscopy.

Books Recommended

1. "Chemical Applications of Group Theory" F. Albert Cotton, 3rd Edition 1993, Wiley-India .
2. "Environmental Chemistry", A. K. De, 3rd Edition (1994), Wiley Eastern, New Delhi.
3. "Analytical Chemistry", G. D. Christian, 4th Edition (1986), John Wiley & Sons, New York.
4. "Principles of Instrumental Analysis", D.A. Skoog, 5th Edition (1998), Saunders College Publishing, Philadelphia, London, New York.
5. "Basic Concepts of Analytical Chemistry", S. M. Khopkar, 2nd Edition (1998), New Age International Publications, New Delhi.

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Cham Akash *S. G. S.* *D. S.*



6. "Instrumental Methods of Analysis", H. H. Willard, L. L. Merritt, and J. A. Dean, 6th Edition (1986), CBS Publishers & Distributors, Shahdara, Delhi.
7. "Organic Chemistry", I. L. Finar, [Vol. 2, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.

**CHEMISTRY PRACTICAL-C XIV: ORGANIC CHEMISTRY-V LAB
(PSCHCR0614P)**

60 Lectures

1. Preparation of organic dyes.
2. Preparation of organic compounds

Course Outcome:

After this course students will be able to prepare organic dyes & compounds.

Reference Books:

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

**PRACTICALS- DSE-I LAB: ANALYTICAL METHODS IN CHEMISTRY
(PSCHDS0501P)**

60 Lectures

I. Separation Techniques

1. Chromatography:
 - (a) Separation of mixtures
 - (i) Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .

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- (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
- (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
- (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

- (i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} -DMG complex in chloroform, and determine its concentration by spectrophotometry.
- (ii) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.
3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:
 - (i) Determination of pH of soil.
 - (ii) Total soluble salt
 - (iii) Estimation of calcium, magnesium, phosphate, nitrate
6. Ion exchange:
 - (i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
 - (ii) Separation of metal ions from their binary mixture.
 - (iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pK_a values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Course Outcome:

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DBS
Cham Akash
S. P. Singh
Dr. P. S.



After this course students will be able to separate compounds by chromatographic techniques & solvent extraction, analyze soil and use of spectrophotometry techniques.

Reference Books:

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

PRACTICALS- DSE-II LAB-I: BIOCHEMISTRY CHEMISTRY LAB (PSCHDS0502P)

Identification and estimation of the following:

1. Carbohydrates – qualitative and quantitative.
2. Lipids – qualitative.
3. Proteins – qualitative.
4. Isolation of protein.
5. Determination of protein by the Biuret reaction.

Course Outcome:

After this course students will be able identify and estimate carbohydrates, lipids & proteins.

Reference Books:

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

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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.

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 (M_n , M_w , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance.

Polydispersity index.

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

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.

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

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

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

Course Outcome:

After completion of the course, the learner can be able to understand:

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- The mechanism of polymer material formation.
- Molecular weight and structure property relationship
- Polymerization procedure and Zigler-Nattacatalysis.
- Characterization of polymers

Reference Books:

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

**CHEMISTRY PRACTICAL - DSE LAB: POLYMER CHEMISTRY
(PSCHDS0604P)**

60 Lectures

1. Polymer synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
 - a. Purification of monomer
 - b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutyronitrile (AIBN)
2. Preparation of nylon 66/6
1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
 - a. Preparation of IPC
 - b. Purification of IPC
 - c. Interfacial polymerization
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry:
 - (a) Polyacrylamide-aq.NaNO₂ solution
 - (b) (Poly vinyl propylidene (PVP) in water

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2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

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

Course Outcome:

After this course students will be able to synthesize, characterize & analyze different types of polymers.

Reference Books:

- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
- Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
- Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
- Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
- Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
- Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

PRACTICAL-DSE V LAB: APPLICATIONS OF COMPUTERS IN CHEMISTRY (PSCHDS0605P)

60 Lectures

Computer programs based on numerical methods for:

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

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3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.

4. Matrix operations. Application of Gauss-Siedel method in colourimetry.

5. Simple exercises using molecular visualization software.

Course Outcome:

After this course students will be able to learn computer programs based on numerical methods.

Reference Books:

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

**CHEMISTRY PRACTICAL - DSE – VII LAB: GREEN CHEMISTRY
(PSCHDS0607P)**

1. Safer starting materials

Preparation and characterization of nano particles of gold using tea leaves.

2. Using renewable resources

Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil

3. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

4. Alternative sources of energy

Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Course Outcome:

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Cham Arora *S. P. Singh* *Deepa*



After this course students will be able to learn safer starting materials, using renewable resources, use of enzymes & alternate sources of energy.

Reference Books:

1. Anastas, P.T and Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press, 1998
2. Kirchoff, M. and Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC, 2002
3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC, 2002
4. Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. *Green Chemistry Experiments: A monograph*, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7, 2013
5. Cann, M.C. and Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society, 2008
6. Cann, M. C. and Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society, 2008
7. Lancaster, Mike *Green Chemistry: An introductory text. 2nd Ed.* RSC publishing, ISBN 978-1-84755-873-2
8. Pavia, D.L., Kriz, G.S., Lampman, G.M. and Engels, R.G. *Introduction to Organic Laboratory Techniques – a Microscale Approach* 4th Ed., Brooks-Cole Laboratory Series for Organic Chemistry, 2006

SKILL ENHANCEMENT COURSE

SEC-1: BASIC ANALYTICAL CHEMISTRY

(Theory 02 Credits; Practicals 02 Credits)

Total 30 Lectures

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Dr. H. H. S. *Dr. S. S.*
Cham Akash *S. S. S.* *Dr. S.*



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

- Determination of pH of soil samples.
- Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

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

- Determination of pH, acidity and alkalinity of a water sample.
- Determination of dissolved oxygen (DO) of a water sample.

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

- 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.

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

- Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).
- To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

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

Analysis of cosmetics: Major and minor constituents and their function

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

Suggested Applications (Any one):

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

Suggested Instrumental demonstrations:

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- Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
- Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
- Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Course Outcome:

After this course students will be able to understand analysis of soil, water, cosmetics & food products, chromatographic techniques.

Reference Books:

- Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
- Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
- Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
- Freifelder, D. *Physical Biochemistry 2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
- Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
- Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
- Vogel, A. I. *Vogel's Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.
- Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

SEC-3: GREEN METHODS IN CHEMISTRY

(Theory 02 Credits; Practicals 02 Credits)
Total 30 Lectures

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

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

- A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy).
- Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO₂ for precision cleaning and dry cleaning of garments.

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- 3 Environmentally safe antifoulant.
- 4 CO₂ as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
- 5 Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.
- 6 A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
- 7 Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
- 8 Development of a fully recyclable carpet: cradle to cradle carpeting.

PRACTICALS

1. Preparation and characterization of biodiesel from vegetable oil.
2. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
3. Mechanochemical solvent free synthesis of azomethine.
4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II)

Course Outcome:

After completion of the course, the learner shall be able to understand:

- Green chemistry and its principles.
- Green synthesis and reactions.
- Green chemistry for sustainable solutions.
- Understanding design of chemical reactions/chemical synthesis using green chemistry principles.
- Atom economy and design of chemical reactions using the principle.
- Understanding the use of green chemistry principle and processes in laboratory reactions.

Reference Books:

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

SEC-4: PHARMACEUTICAL CHEMISTRY

(Theory 02 Credits; Practicals 02 Credits)

Total 30 Lectures

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents

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Cham Akash

S. S. S. S.

Dr. S.S.



(Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

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

Practicals

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

Course Outcome:

Students will be well versed with biologically active molecules, details of fermentation process & preparations of few drugs.

Reference Books:

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

SEC-5: CHEMISTRY OF COSMETICS & PERFUMES

(Theory 02 Credits; Practicals 02 Credits)

Total 30 Lectures

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

Practicals

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

Handwritten signatures and names:
A. K. Singh, A. S. S., Cham Akash, S. G. S., D. S. S.



Course Outcome:

Students will be well versed with chemistry of cosmetics & perfumes & preparations of few cosmetic products.

Reference Books:

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

SEC-6: PESTICIDE CHEMISTRY

(Theory 02 Credits; Practicals 02 Credits)
Total 60 Lectures

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

Practicals

- 1 To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.
- 2 Preparation of simple organophosphates, phosphonates and thiophosphates

Course Outcome:

Students will be well versed with chemistry of pesticides & preparations of few pesticides.

Reference Book:

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

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BSS

Cham Akash

S. S. S.

Dr. H. H. S.



Outcomes of teaching-learning:

Students will learn about the structure and characterizations of different types of materials such as Semiconductors, Organic and Non linear materials.

Books recommended:

1. A.R. West, *Solid State Chemistry and its Applications*, John Wiley & Sons, Singapore (1984)
2. C.N R. Rao and J. Gopalkrishnan, *New Directions in Solid State Chemistry*, Cambridge Univ. Press (1997).
3. T. V. Ramakrishnan and C.N. Rao, *Superconductivity Today*, Wiley Eastern Ltd., New Delhi (1992).
4. P. Ball, *Designing the Molecular World: Chemistry at the Frontier*, Princeton Univ. Press, (1994).

CMP-409: Projects

Credits : 6

Topic selection in consultation with the teacher; literature search from different reference books, scientific journals and using internet search; Bench work, typed write-up with proper tables, structures, figures and literature to be submitted; seminar lecture on this topic to be delivered in presence of all the teachers.

Teaching and Learning: The term courses also include a dissertation a research-based thesis project enhancing the students understanding.

Outcomes of learning:

- formulating and solving problems in the laboratory
- The principles and applications of modern chemical instrumentation, experimental design, and data analysis
- the underlying chemical and physical of instrumental methods of analysis, searching scientific journals and using internet search etc.
- how to work with others as part of a team to solve scientific problems
- how to communicate scientific information clearly and accurately, both in oral and in written forms
- the composition of written laboratory reports that summarize experimental procedures and the accurately present and interpret data