DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

B.Sc. Chemistry

(As per NEP 2020)

3rd TO 4th SEMESTER

2024–2025

2024-2025

Scheme of Courses- Bachelor of Chemistry

Credit Details			
S.No.	**Course Category**	**Course Category Abbreviation**	**3-Yr B.Sc chemistry / (Credits)**
1.1	Discipline Specific Courses-Core	DSC	58
1.2	Discipline Specific-Skill Enhancement Courses- Core	DS-SEC	5
1.3	Discipline Specific-Value Added Courses-Core	DS-VAC	0
Total of Discipline Specific Core Courses			63
2.1	Minor Courses	MC	
OR			
2.2	Interdisciplinary Courses	IDC	22
3	Multidisciplinary Courses	MDC	9
4	Ability Enhancement Course-Common	AEC-C	8
5	Value Added Courses-Common	VAC-C	6
6.1	Skill Enhancement Courses-Common	SEC-C	8
6.2	Skill Enhancement Courses-Summer Internship	SEC-SI	4
Total of Skill Enhancement Courses			
Total Credits			**120**

Scheme of Courses- Bachelor of Honours in Chemistry/(Hons/(Hons. with Res.)

Credit Details				
S.No.	**Course Category**	**Course Category Abbreviation**	**4-Yr B.Sc Chemistry (Hons.)/(Credits)**	**4-Yr B.Sc Chemistry (Hons. with Res.) / (Credits)**
1.1	Discipline Specific Courses-Core	DSC	98	86
1.2	Discipline Specific-Skill Enhancement Courses-Core	DS-SEC	5	5
1.3	Discipline Specific-Value Added Courses-Core	DS-VAC	0	0
	Total of Discipline Specific Core Courses		103	91
2.1	Minor Courses	MC		
OR				
2.2	Interdisciplinary Courses	IDC	22	22
3	Multidisciplinary Courses	MDC	9	9
4	Ability Enhancement Course- Common	AEC-C	8	8
5	Value Added Courses-Common	VAC-C	6	6
6.1	Skill Enhancement Courses- Common	SEC-C	8	8
6.2	Skill Enhancement Courses-Summer Internship	SEC-SI	4	4
6.3	Skill Enhancement Courses- Research Project/Dissertation	SEC-RP	--	12
Total of Skill Enhancement Courses				
Total Credits			**160**	**160**

Semester 1

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1.	CHM101	Physical Chemistry-I	3	-	2	4	DSC
2.	CHM102	Organic Chemistry-I	2	-	2	3	DSC
3.	PHS152	Modern Physics (Physics)	3	-	2	4	IDC
4.		Multidisciplinary Courses	-	-	-	3	MDC
5.		Ability Enhancement Course-Common	-	-	-	2	AEC- C
6.		Skill Enhancement Courses-Common	-	-	-	2	SEC-C
7.		Value Added Courses-Common	-	-	-	3	VAC-C
						21	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 2

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	CHM111	Inorganic Chemistry-I	3	-	2	4	DSC
2	PHS153	Optics and Lasers (Physics)	3	-	2	4	IDC
3		Multidisciplinary Courses	3	-	-	3	MDC
4		Ability Enhancement Course- Common	-	-	-	2	AEC- C
5		Skill Enhancement Courses-Common	-	-	-	3	SEC-C
6		Value Added Courses-Common	-	-	-	3	VAC-C
						19	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 3

			In hours				
S. No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	CHM201	Physical Chemistry-II	3	-	2	4	DSC
2	CHM202	Organic Chemistry-II	3		2	4	DSC
3	MAT160	Mathematics for Chemists I	3	-		3	IDC
4		Multidisciplinary Courses	-	-	-	3	MDC
5		Ability Enhancement Course- Common	-	-	-	2	AEC- C
6		Skill Enhancement Courses- Common	-	-	-	3	SEC-C
						19	

L- Lectures T- Tutorial P- Practical Cr.- Credits

Semester 4

			In hours				
S.No	**Paper Code**	**Course Title**	**L**	**T**	**P**	**Cr.**	**Course Category**
1	CHM203	Organic Chemistry-III	3		2	4	DSC
2	CHM204	Inorganic Chemistry-II	3		2	4	DSC
3	CHM205	Physical Chemistry-III	3	-	2	4	DSC
4	CHM206	Polymer Chemistry	2		2	3	DS-SEC
5	PHS351	Wave and Mechanics (Physics)	3	-	2	4	IDC
6		Ability Enhancement Course- Common	-	-	-	2	AEC-C
						21	

L- Lectures T- Tutorial P- Practical Cr.- Credits

<table>
<tr><td>Course Code</td><td colspan="7">CHM201</td></tr>
<tr><td>Course Title</td><td colspan="7">Physical Chemistry -II</td></tr>
<tr><td>Hours</td><td colspan="7">L:3, T:0, P:2</td></tr>
<tr><td>Credits</td><td colspan="7">4</td></tr>
<tr><td>Type</td><td colspan="7">Core</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On the completion of the course, the student will gain the following knowledge and skills:
CO1: Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties and derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for ideal gases under different conditions.
CO2: Explain the concepts of chemical equilibrium.
CO3: Explain the concept of partial molar properties and explain the thermodynamic basis of colligative properties and applications in surroundings.
CO4: Apply the concepts of thermodynamics, solutions, and colligative properties while studying other chemistry courses and everyday life.</td></tr>
<tr><td>Examination Type</td><td colspan="7">Theory + Practical</td></tr>
<tr><td>Assessment Tools</td><td>Written Quiz</td><td>Assignment/Project Work</td><td>MSE</td><td>MSP</td><td>ESE</td><td>ESP</td><td>ABL/PBL</td></tr>
<tr><td>Weightage</td><td>10%</td><td>-</td><td>25%</td><td>-</td><td>35%</td><td>25%</td><td>5%</td></tr>
<tr><td>Examination Mode</td><td colspan="6">Theory + Practical</td><td></td></tr>
<tr><td>Syllabus</td><td colspan="6">Unit 1: Chemical Thermodynamics
• Intensive and extensive variables; state and path functions; isolated, closed and open systems
• Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule.
• First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Joule's law; Joule-Thomson coefficient and inversion temperature.
• Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; effect of temperature (Kirchhoff’s equations) and pressure on enthalpy of reactions.
• Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of</td><td>CO1</td></tr>
</table>

	thermodynamics; Calculation of entropy change for reversible and irreversible processes. • Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state, Statement of third law	
	Unit 2: Chemical Equilibrium • Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. • Equilibrium constants and their quantitative dependence on temperature, pressure and concentration; Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier's principle.	**CO2**
	Unit 3: Systems of Variable Composition and Colligative Properties • Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases; concept of fugacity and activity. • Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws, Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute.	**CO3**
	Unit 4: Practical • To determine the heat of solution of given salt. • Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. • Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts. • To study the effect of concentration of solute on elevation of boiling point of water. • To Determine the Molecule Weight of given compound by Freezing Point Depression Method • To study the elevation in boiling point on adding same concentrations of electrolyte and non-electrolyte to a specific volume of water.	**CO4**

Text Book/s

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.

2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

3. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.

4. Kapoor, K.L. (2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.

5. McQuarrie, D. A.; Simon, J. D. (2004), Molecular Thermodynamics, Viva Books Pvt. Ltd.

5. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.

6. Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.

7. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

Reference Book/s

1. Levine, I.N.(2010),Physical Chemistry, Tata Mc Graw Hill.

2. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S.(2011),Commonly asked Questions in Thermodynamics. CRC Press.

3. Halpern, A. M. and McBane, G. C. Experimental Physical Chemistry 3rdEd.; W.H. Freeman & Co.: New York, 2003.

Course Code	**CHM202**						
Course Title	**Organic Chemistry -II**						
Hours	L:3, T:0, P:2						
Credits	4						
Type	**Core**						
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Understand the chemical reactions and mechanism of alkynes and arenes** **CO2: Understand the chemistry of halogenated hydrocarbons and their mechanisms** **CO3: Understand the reactions and mechanism of Alcohols, Phenols, Ethers and Epoxides functional groups** **CO4: Gain the practical knowledge of determining presence of functional groups and their chemical reactions**						
Examination Type	Theory + Practical						
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	ESP	ABL/PBL
Weightage	**10%**	**-**	**25%**	**-**	**35%**	**25%**	**5%**
Examination Mode	Theory + Practical						
Syllabus	**Unit 1: Alkynes and Arenes** Alkynes: Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation, Hydrogenation and polymerization. **Arenes and Aromaticity**: Nomenclature of benzene derivatives, aryl group, Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromatic electrophilic substitution – general pattern of the mechanism, role of σ-and πcomplexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituent's, orientation and ortho/para ratio. Side chain reactions of benezene derivatives. Birch reduction. Methods of formation and chemical reactions of alkyl benzenes and biphenyl.						**CO1**
	Unit 2: Chemistry of Halogenated Hydrocarbons Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with						**CO2**

	energy profile diagrams and stereochemical aspects, and effect of substrates structure, nucleophiles and solvent etc. Aryl halides: Preparation, including preparation from diazonium salts. Nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Nucleophilic substitution vs. elimination. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions, synthesis and uses of DDT and BHC Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.	
	Unit 3: Alcohols, Phenols, Ethers and Epoxides **Alcohols:** Nomenclature, preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; preparation and properties of glycols: Oxidation by periodic acid and lead tetra acetate, Pinacol-Pinacolone rearrangement. **Phenols**: Nomenclature, physical properties, acidity of phenols and substituent effects, comparative acidic strengths of alcohols and phenols; preparation and reaction of phenols: ring substitution reactions, Reimer–Tiemann reaction, Gatterman synthesis, Kolbe's–Schmidt Reactions, Hauben-Hoesch reaction, Fries and Claisen rearrangements; oxidation of phenols, Dakin oxidation. **Ethers and Epoxides**: Nomenclature, preparation and reactions: the Williamson ether synthesis, acid catalyzed cleavage of ethers, Zeisel test; preparation of epoxides, Conversion of vicinal halohydrins to epoxides, reactions of epoxides with alcohols, ammonia derivatives, LiAlH4 and with Grignard and organolithium reagents.	**CO3**
	Unit 4: Organic Chemistry Lab II 1. Functional group tests for alcohols 2. Distinguishing Tests for Primary, Secondary and tertiary Alcohols (Lucas test) 3. Functional group test for phenols 4. Organic preparations: Acetylation of one of the following compounds: phenols, beta-naphthol by any one method: 5. Using conventional method. 6. Using green approach 7. Schotten-Baumann reaction of the following phenols (β-naphthol, resorcinol, p-cresol). 8. Oxidation of ethanol/ isopropanol (Iodoform reaction) 9. Tests for Unsaturation (Bromine -water test, Baeyer's test) 10. Oxidation of alkenes/alkynes with KMnO4 (Cis-diol formation) 11. Zeisel test for determination of ether group	**CO4**

	12. Selective reduction of meta dinitrobenzene to m-nitroaniline.	

Text Book/s

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.Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

Reference Book/s

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 OrganicChemistry, 5th Ed., Pearson, 2012

3.Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry 2000.

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

Course Code	**CHM203**						
Course Title	**Organic Chemistry -III**						
Hours	L:3, T:0, P:2						
Credits	4						
Type	**Core**						
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Learn about the reactivity of aldehydes and ketones and their important reactions** **CO2: Learn about the Chemical reactions of carboxylic Acids and their Derivatives** **CO3: Learn about the chemical reactions of Sulphur containing compounds and polynuclear hydrocarbons** **CO4: Gain the practical knowledge of chemical reactions of Aldehydes, Ketones and Carboxylic acids**						
Examination Type	Theory + Practical						
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	ESP	ABL/PBL
Weightage	**10%**	**-**	**25%**	**-**	**35%**	**25%**	**5%**
Examination Mode	Theory + Practical						
Syllabus	**Unit 1: Aldehydes and Ketones** Structure, reactivity and preparation; Nucleophilic additions, hydration of aldehydes and ketones, cyanohydrin formation, acetal formation; Nucleophilic addition-elimination reactions with ammonia derivatives; Addition of Grignard reagents and organolithium reagents to aldehydes and ketones; Addition reactions of unsaturated carbonyl compounds: Michael addition, Robinson annulation. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate. Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt condensation, Perkin reaction, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, substitution reactions, α-haloform reaction; Oxidation of aldehyde/ketone, Baeyer-Villiger oxidation; and reduction reactions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, and MPV).						**CO1**
	Unit 2: Carboxylic Acids and their Derivatives Preparation, physical properties and reactions of monocarboxylic acids: carboxylation of Grignard reagents, oxidation of alkyl benzenes, oxidation of primary alcohols,						**CO2**

	aldehydes, hydrolysis of nitriles; Hell-Volhard-Zelinsky reaction, Reduction of carboxylic acids; Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation, Curtius rearrangement and Schmidt reaction.	
	Unit 3: Sulphur Containing Compounds and Polynuclear Hydrocarbons **Sulphur containing compounds**: Preparation and reactions of thiols, thioethers and sulphonic acids. **Polynuclear Hydrocarbons** Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.	**CO3**
	Unit 4: Organic Chemistry Lab III 1. Functional group tests for carbonyl group. 2. Functional group tests for carboxylic acid group. 3. Oxime preparation of ketones and aldehydes 4. Hydrazone preparation of aldehydes and ketones 5. Bromination of any one of the following: 6. Acetanilide by conventional methods 7. (b) Acetanilide using green approach (Bromate-bromide method) 8. Aldol condensation using either conventional or green method 9. Reduction of p-nitrobenzaldehyde by sodium borohydride. 10. Hydrolysis of esters. 11. Benzil-Benzilic acid rearrangement 12. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde 13. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid) 14. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds.	**CO4**

Text Book/s

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.Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

Reference Book/s

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 OrganicChemistry, 5th Ed., Pearson, 2012.

3.Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry 2000.

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

Course Code	**CHM204**						
Course Title	**Inorganic Chemistry -II**						
Hours	L:3, T:0, P:2						
Credits	4						
Type	**Core**						
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Understand various models of Acid-base theories, the relative strength of acids and bases. Types of acid-base reactions and leveling solvents. Hard and Soft Acids and Bases (HSAB) and its application.** **CO2: Understand the chemistry and applications of s- and p-block elements and their important compounds.** **CO3: To identify the location of the noble gases on the periodic table, describe the physical properties of the noble gas elements and structure of some noble gas compounds, describe the sources and uses of the noble gases.** **CO4: They will use titration as a skill for quantitative analysis. The course will help them to understand the synthetic routes/methodologies to synthesize inorganic compounds. They will also learn to use iodometry as an analytical tool for quantitative estimation of various species.**						
Examination Type	Theory + Practical						
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	ESP	ABL/PBL
Weightage	**10%**	**-**	**25%**	**-**	**35%**	**25%**	**5%**
Examination Mode	Theory + Practical						
Syllabus	**Unit 1: Acids and Bases** • Brönsted-Lowry concept of acid-base reactions, solvated proton, , • Relative strength of acids, types of acid-base reactions, leveling solvents, • Lewis acid-base concept, Classification of Lewis acids • Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.						**CO1**
	Unit 2: Chemistry of s and p Block Elements • Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. • Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial.						**CO2**

	• 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, borohydrides (diborane), Borazines carboranes and graphitic compounds, Silicates and silanes. • Polyphosphazines. Oxides and oxo acids of nitrogen, Phosphorus, and chlorine, Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens	
	Unit 3: Noble Gases • Occurrence and uses, • rationalization of inertness of noble gases, • Clathrates; Structures of XeF_2, XeF_4 and XeF_6; and oxides of Xenon. • Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2)	**CO3**
	Unit 4: Inorganic Chemistry Lab • Iodo / Iodimetric Titrations: (i) Estimation of Cu(II) in a solution of $CuSO_4.5H_2O$. (ii) Determination of the strength of sodium thiosulphate solution using standardized $K_2Cr_2O_7$ (iii) Estimation of available chlorine in bleaching powder iodometrically. • Inorganic preparations: (i) Cuprous Chloride, Cu_2Cl_2 (ii) Preparation of tris(acetylacetonato)manganese(III) (iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum. (iv) Preparation of potassium trioxalatochromate(III). (v) Preparation of tris(thiourea)copper(II) sulphate.	**CO4**

Text Book/s

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)

2. Principles of Inorganic Chemistry by B.R. Puri, L.R. Sharma, K.C. Kalia

3. Bassett, J., Denney, R. C., Jeffery, G. H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman, 1978.

Reference Book/s

1. Inorganic Chemistry (5th Edition) by Gary L. Miessler, Paul J. Fischer, Donald A. Tarr

2. Shriver and Atkins' Inorganic Chemistry, 5th Edition.

3. Advanced Inorganic Chemistry: A Comprehensive Text Book by F. Albert Cotton and Geoffrey Wilkinson.

4. Concepts and Models of Inorganic Chemistry by Bodie E. Douglas; Darl H. McDaniel; John J. Alexander Pearson - Inorganic Chemistry, 5/E - Catherine Housecroft

5. http://symmetry.otterbein.edu/tutorial/index.html

6. https://nptel.ac.in/courses/113105024/

7. Svehla G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman,1996.

Course Code	**CHM205**						
Course Title	**Physical Chemistry III**						
Hours	L:3, T:0, P:2						
Credits	4						
Type	**Core**						
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation.** **CO2: Understand the working of electrochemical cells, galvanic cell, corrosion and happenings in surroundings related to electrochemistry.** **CO3: Explain the chemistry of conductance and its variation with dilution, migration of ions in solutions and Learn the applications of conductance measurements.** **CO4: Apply the concepts of phase equilibrium, electrochemical cells and conductance while studying other chemistry courses and everyday life.**						
Examination Type	Theory + Practical						
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	ESP	ABL/PBL
Weightage	**10%**	**-**	**25%**	**-**	**35%**	**25%**	**5%**
Examination Mode	Theory + Practical						
Syllabus	**Unit 1: Phase Equilibria** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid liquid, liquid-vapour and solid-vapour equilibria. Phase diagram for one component systems (H_2O and S), with applications. A comparison between the phase diagram of CO_2 and H_2O. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.						**CO1**
	Unit 2: Electrochemical Cells Rules of oxidation/reduction of ions based on half-cell potentials, Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.						**CO2**

	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 and glass electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations	
	Unit 3: Conductance Quantitative aspects of Faraday's laws of electrolysis, 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-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rule. Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, determination of transference number using Hittorf's 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.	**CO3**
	Unit 4: Practical Determination of cell constant. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid. Perform the following conductometric titrations: i. Strong acid vs. strong base, ii. Weak acid vs. strong base, iii. Mixture of strong acid and weak acid vs. strong base, iv. Strong acid vs. weak base. Determination of critical solution temperature and composition at CST of the phenol water system and to study the effect of impurities of sodium chloride and succinic acid on it. Distribution of acetic/benzoic acid between water and chloroform or cyclohexane.	**CO4**

Text Book/s

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.

2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

3. Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.

4. Kapoor, K.L. (2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.

5. McQuarrie, D. A.; Simon, J. D. (2004), Molecular Thermodynamics, Viva Books Pvt. Ltd.

5. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
6. Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.
7. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

Reference Book/s

1. Levine, I.N. (2010),Physical Chemistry, Tata Mc Graw Hill.
2. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S.(2011),Commonly asked Questions in Thermodynamics. CRC Press.
3. Engel, T.; Redi, P. (2013),Physical Chemistry, 3rd Edition, Pearson Education.
4. Halpern, A. M. and McBane, G. C. Experimental Physical Chemistry 3rdEd.; W.H. Freeman & Co.: New York, 2003.

Course Code	**CHM206**						
Course Title	**Polymer Chemistry**						
Hours	L:2, T:0, P:2						
Credits	3						
Type	**Core**						
Course Outcomes	On the completion of the course, the student will gain the following knowledge and skills: **CO1: Know the basics of polymeric materials, their functionalities and importance** **CO2: Understand the kinetics and mechanism of copolymerization, degree of crystallinity and structure-property relationships** **CO3: Determine the molecular weight and glass transition temperatures of polymers** **CO4: To learn the preparation of various polymers**						
Examination Type	Theory + Practical						
Assessment Tools	Written Quiz	Assignment/Project Work	MSE	MSP	ESE	ESP	ABL/PBL
Weightage	**10%**	**-**	**25%**	**-**	**35%**	**25%**	**5%**
Examination Mode	Theory + Practical						
Syllabus	**Unit 1: Introduction; Functionality and kinetics of Polymer Materials** • Classification and nomenclature of polymers, • Molecular forces and chemical bonding in polymers • Relationships between functionality • Extent of reaction and degree of polymerization • Bi-functional systems, Poly-functional systems. • Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) • Coordination polymerizations, Mechanism and kinetics of copolymerization,						**CO1**
	Unit 2: Determination of Molecular Weight and Glass Transition Temperature (Tg) of Polymers • Viscometry, light scattering and osmotic pressure methods. • Molecular weight distribution and its significance. • determination of Tg, • WLF equation, Free volume theory, • Factors affecting glass transition temperature (Tg).						**CO2**
	Unit 3: Properties of Polymers (Physical, Thermal, Flow & Mechanical Properties)						**CO3**

	• Brief preparation, structure, properties and application of the following polymers: polyolefin's, 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)].	
	Unit 4: Polymer Chemistry Lab 1. Polymer synthesis: 1 Preparation of nylon 66 2. 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 • Polymer characterization 1. Determination of molecular weight by viscometry: (b) Polyacrylamideaq.NaNO2 solution(Poly vinyl proplylidine (PVP) in water 2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH)and the fraction of "head-to-head" monomer linkages in the polymer. 3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group). 4. Testing of mechanical properties of polymers. 5. Determination of hydroxyl number of a polymer using colorimetric method. • Polymer analysis 1. Estimation of the amount of HCHO in the given solution by sodium sulphite method 2. IR studies of polymers 3. DSC analysis of polymers 4. Preparation of polyacrylamide and its electrophoresis *at least 7 experiments to be carried out	**CO4**

Reference Books:

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

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

In hours			
L	**T**	**P**	**Credit**
3	0	2	4

Course Code	PHS152						
Course Title	Modern Physics						
Course Outcomes	On the completion of the course, the student will be able to CO1: Know the main aspects of the inadequacies of classical mechanics and understand the historical development of quantum mechanics and the ability to discuss and interpret experiments that reveal the dual nature of matter CO2: Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, probability density and the normalization techniques, skill development on problem-solving e.g. one-dimensional rigid box, tunnelling through a potential barrier, step potential, rectangular barrier. CO3: Knowledge about properties of the atomic nucleus, liquid drop model and nuclear shell model and radioactivity, radioactive decay like alpha, beta, and gamma decay. CO4: Correlate between theory and experimental results of basic quantum physics and apply knowledge to find out planck's constant, ionization potential, e/m ratio etc.						
Examination Mode	Theory+ Practical						
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Wave Particle Duality**							
	Quantum theory of light, X-rays and their diffraction, Compton effect, particle diffraction, uncertainty principle and its applications. Pair production, Wave Properties of Particles; de Broglie waves, Waves of probability, the wave equation, phase and group velocities							1
Unit 2	**Quantum Mechanics**							
	Difference between classical and quantum mechanics, wave function and wave equations, Schrodinger's equation, time dependent and steady state forms, Expectation values, Particle in a box, reflection and transmission by a barrier, tunnel effect, harmonic oscillator.							2
Unit 3	*Atomic Nucleus and Radioactivity*							
	Nuclear Properties: The neutron, stable nuclei, nuclear sizes and shapes, binding energy, meson theory of nuclear forces, Nuclear Models: liquid drop model, shell model, Radioactivity:							3

	Radioactive decay, Half-life, radioactive dating, radioactive series, alpha decay and its theory, beta decay, gamma decay, radiation hazards and radiation units	
Unit 4	**Modern Physics Laboratory experiments:**	
	1. Determination of Planck's constant using photocell. 2. To find half-life period of a given radioactive substance using GM counter 3. To determine charge to mass ratio (e/m) of an electron by Millikan Oil Drop Method. 4. Study of excitations of a given atom by Franck Hertz set up. 5. To find the ionization potential of mercury using gas filled diode 6. Study of C.R.O. as display and measuring device, Study of Sinewave, square wave signals. 7. To find conductivity of given semiconductor crystal using four probe method. 8. To determine the Hall coefficient and mobility of given semiconductors. 9. Study of Solar Cell characteristics	4
Text Books	1. Shaweta MOHAN and Kulwanr S. Thind , Elements of Modern Physics, Vishal Publications, 2021 2. B.Sc. Practical Physics eBook : CL Arora	
Reference Books	1. A. Beiser, Concepts of Modem Physics: McGraw Hill, 1987 2. Ghatak and Loknatham. Quantum Mechanics:(Springer), 2004. 3. K. Hyde, Basic ideas and Concepts in Nuclear Physics: (Institute of Physics), 2004	

In hours			
L	T	P	Credit
3	0	2	4

Course Code	PHS153							
Course Title	Optics and Lasers							
Course Outcomes	On the completion of the course the student will be able to CO1:To impart students' knowledge of interference and gain insights about the Fraunhoffer diffraction in detail. CO2 To understand the concept of polarization, and its applications in day to day life. CO3 To understand the concept of LASER, its working mechanism and various types and applications. CO4: To have hand on training of various optics experiments.							
Examination Mode	Theory+ Practical							
Assessment Tools					**MSE**	**MSP**	**ESE**	**ESP**
	Quiz	**Assignment**	**ABL/PBL**	**Lab Performance**				
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Interference and Diffraction**							
	Types of interference, Young's double slit experiment, Fresnel's biprism, thickness of thin transparent sheet, Interference in thin films, Newton's rings and their application, Application of thin film interference Franunhoffer diffraction at a single slit and its discussion, Fraunhoffer diffraction at double slit, Diffraction of N slits and its discussion Missing orders, dispersive power, Rayleigh Criterion for resolving power, resolving power of a diffraction grating.							1
Unit 2	**Polarization**							
	Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization, Polarization by transmission and reflection, polarisers and analyzers; Malus Law, Brewster's Law ,Theory of double refraction, Quarter wave and half wave plates, Elliptically and circularly polarized light production Optical activity, specific rotation. Half shade polarimeter;							2
Unit 3	**LASERs**							
	Interaction of light with matter; Einstein relations; light amplification population inversion; active medium, pumping; metastable states; principle pumping schemes; optical resonant cavityHe-Ne Laser, Ruby							3

	Laser, laser beam characteristics and applications, shape and width of spectral lines, line broadening mechanism, natural, collision and Doppler broadening.	
Unit 4	**Laboratory experiments**	4
	1. To determine the wavelength of light using Newton's ring set up. 2. To determine the wavelength of laser source using diffraction of single slit. 3. To study the specific rotation of sugar solution Laurent's half shade polarimetermethod 4. Study of C.R.O. as display and measuring device, Study of Sinewave, squarewave signals (half wave and full wave rectification) 5. To compare the focal length of two lenses by Nodal slide method. 6. Determination of Plank's constant using photoelectric effect. 7. To measure beam divergence of He-Ne Laser. 8. To determine the refractive index of the material of a given prism using Sodium light	
Text Books	1. Subramanayam, N.; Lal, B. and Avadhamulu; M. N. Textbook of Optics. New Delhi: S. Chand & Company, 2006. 2. B.Sc. Practical Physics, C. L. Arora.	
Reference Books	1.Jenkins, F.A.; White, H.E. Fundamentals of Optics. USA: McGrawHill Publication, 2. Ghatak,A. Optics. New Delhi:Tata McGraw Hill Publication, 2008	

In hours			
L	**T**	**P**	**Credit**
3	0	2	4

Course Code	PHS351							
Course Title	Mechanics and waves							
Course Outcomes	On the completion of the course the student will be able to CO1: understand mechanics of non-inertial frame CO2: Understand motion in central forces CO3: Understand the features of wave motion CO4: To have hand on training of various mechanics and wave experiments							
Examination Mode	Theory+ Practical							
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	**Fundamentals of Dynamics and Mechanics in Non-inertial frame**							
	Reference frames. Inertial frames; Galilean transformations;Galilean invariance. Centre of mass. Principle of conservation of momentum. Conservative and non-conservative forces. Potential Energy. Force as gradient of potentialenergy. Cartesian and spherical co-ordinate systems, components of velocity and acceleration in different coordinate systems, Non-inertial frame of reference, uniformly rotating frame, fictitious force, Coriolis force and its applications.							1
Unit 2	**CENTRAL FORCES and Simple Harmonic motion**							
	Conservative and Non-conservative forces, two particle central force problem, reduced mass Nature of motion under central force and differential equation of motion under central force, Kepler's laws Simple harmonic motion, differential equation of S.H.M. and its solution, velocity and acceleration of S.H.M., Energy of a simple harmonic oscillator, examples of simple harmonic motion, similarities between electrical and mechanical oscillators.							2
Unit 3	***Wave motion***							

	Type of waves, the wave equation and its solution, Characteristic impedance of a string Reflection and transmission of waves in a string, Energy of progressive waves , Impedance matching qualitatively Standing waves on a string of fixed length, Mathematical analysis for the formation of stationary waves	3
Unit 4	**Practicals**	
	1. To determine the value of g using Bar Pendulum. 2. To determine the value of g using Kater's Pendulum. 3. To determine the height of a building using a Sextant. 4. To determine the Moment of Inertia of a Flywheel. 5. To determine the frequency of AC mains using a sonometer and an electromagnet. 6. To determine the frequency of a tuning fork using a sonometer. 7. To verify the laws of transverse vibrations of stretched strings using a sonometer.	4
Text Books	1. Analytical mechanics, S. K. Gupta, A. Gupta, Modern Publishers, 2005 2. Vibrations, waves and E. M. Theory, R. C. Lakhanpal and A. Sharma, Modern Publishers, 2005. 3. B.Sc. Practical Physics, C. L. Arora	
Reference Books	1. D. Kleppner, R.J. Kolenkow, An introduction to mechanics, New Delhi: McGraw-Hill, 1973. 2. C.Kittel, W.Knight, et.al. Mechanics, Berkeley Physics, vol.1, New Delhi: TataMcGraw-Hill, 2007. 3. Resnick, Halliday and Walker, Physics, 8/e. Wiley, 2008. 4. G.R. Fowles and G.L. Cassiday, Analytical Mechanics, New Delhi: CengageLearning, 2005.	

In hours			
L	T	P	Credit
3	0	2	4

Course Code	PHS251							
Course Title	Electricity, Magnetism & Electronics							
Course Outcomes	On the completion of the course the student will be able to **CO1:** Knowledge of electric field and electric potential formulation of different charge distributions **CO2:** Gain knowledge in magnetostatics and electromagnetic induction and knowledge of conduction mechanism in semiconductors **CO3:** Qualitative theory of PN junction diode and VI characteristics, Application of PN junction diodes as rectifiers, filters and photodiodes **CO4:** Hands on training for carrying out precise measurements and handling sensitive equipments of electronics like diodes, transistors, solar cells etc.							
Examination Mode	Theory + Practical							
Assessment Tools	**Quiz**	**Assignment**	**ABL/PBL**	**Lab Performance**	**MSE**	**MSP**	**ESE**	**ESP**
Weightage	**10**	**-**	**5**	**-**	**25**	**-**	**35**	**25**
Syllabus								**CO Mapping**
Unit 1	***Electric Charges and Field***							
	Electric Charges, Conductors, Insulators and Induced Charges, Coulomb Law, Electric Field and Forces, Electric field Calculations, Electric field lines, ElectricDipoles, Gauss's law & Electric Flux and calculations, Electric Potential Energy and Potential Gradient.							1
Unit 2	***Magnetism & conduction in semiconductors***							
	Magnetic field, Magnetic field lines and flux, motion of charges particle in Magnetic field, BioSavart's law, Ampere's law, Magnetic Materials, Faraday's Law, Maxwell equations Electromotive force & Circuits, Mutual Inductance, Self-Induction and Inductors, Electrons and holes in semiconductor, carrier concentration, donor and acceptor impurities, charge densities, Fermi Level in semiconductors, diffusion, carrier lifetimes							2
Unit 3	***Semiconductor diodes and applications***							
	Qualitative theory of pn junction, pn diode, band structure of an open circuit diode, current components, qualitative theory of diode currents, VI Characteristics, Half Wave rectifier, ripple factor, full wave rectifier, filters, photoconductivity, Photodiode							3
Unit 4	***Practical experiments***							

	1. To study the characteristics of pn junction diode. 2. To study the Forward and Reverse characteristics of a Zener Diode and to study its use as a Voltage Regulator. 3. To study the Characteristics of a Photodiode. 4. To determine the Characteristics of pn junction of a Solar Cell. 5. To study the characteristics of Junction Field Effect Transistor. 6. To study the characteristic of Metal Oxide Semiconductor Field Effect Transistor 7. To study the magnetic field produced by a current carrying solenoid using a pickupcoil/Hall sensor and to find the value of permeability of air 8. To determine the frequency of A.C. mains using sonometer. 9. Determination of given inductance by Anderson's bridge 10. To determine the value of an air capacitance by deSauty Method and to findpermittivity of air.	4
Text Books	1. 1.Sears's University Physics with Modern Physics,Hugh D Young and Roger A Freedman, 12thEdition Pearson Education, 2008. 2. Fundamentals of |Physics, Resnick&Hlleday, 8th Edition Wile 3. Electronic Devices and Circuits: J. Millman and C.C. Halkias Tata McGraw Hill, 1991	
Reference Books	1. Electrodynamics by DJ Griffiths 2. Pradeep's Electricity & Magnetism by A. K. Sikri 3. Modern's Electricity & Magnetism by S.L. Gupta	