COURSE CURRICULUM BOOK

FIVE YEAR INTEGRATED M.Sc. CHEMISTRY
2024-2029

Pandit Deendayal Energy University School of Energy Technology

COURSE STRUCTURE

SEMESTER I								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Course Hours**	**Credits**
DSC -I	Core	24BSC101T	Inorganic Chemistry-I	3	0	0	3	3
DSC - I (P)	Core	24BSC101P	Inorganic Chemistry Lab-I	0	0	2	2	1
DSC - II	Core	24BSC102T	Organic Chemistry-I	3	0	0	3	3
DSC - II (P)	Core	24BSC102P	Organic Chemistry Lab-I	0	0	2	2	1
DSE/EM - I	EM		Choose from Minor Subject Basket	3	1	0	4	4
		24MAS101T	Mathematics I (For A Group)					
		24MAS104T	General Mathematics I (For B Group)					
		24BSP101T	University Physics I	3	0	0		
		24BSP101P	University Physics I Lab	0	0	2		
MDC- I	MDC	24BSC103T	Introduction to bioorganic chemistry and chemical biology	**4**	0	0	4	4
AEC - I	AEC	24ENGST10T	Communication Skills (English Communication)	2	0	0	2	2
SEC- I	SEC	24ENGS102T	Foreign Language I	2	0	0	2	2
VAC - I	VAC/IKS	24GSS101T	Yoga & Meditation	2	0	0	2	2
				20	**1**	**4**	**24**	**22**
SEMESTER II								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
DSC -III	Core	24BSC104T	Physical Chemistry-I	3	0	0	3	3
DSC - III (P)	Core	24BSC104P	Physical Chemistry Lab-I	0	0	2	2	1
DSC - IV	Core	24BSC105T	Analytical chemistry-I	3	0	0	3	3
DSC - IV (P)	Core	24BSC105P	Analytical chemistry Lab-I	0	0	2	2	1
DSE/EM - II	EM		Choose from Minor Subject Basket	3	1	0	4	4
		24MAS102T	Mathematics I (For A Group)					
		24MAS106T	General Mathematics I (For B Group)					
		24BSP104T	University Physics II	3	0	0		
		24BSP104P	University Physics II Lab	0	0	2		
MDC - II	MDC	24BSC106T	Fundamentals of Biotechnology	4	0	0	4	4
AEC - II	AEC	24GSS102T	Leadership & Management	2	0	0	2	2
SEC- II	SEC	24ENGS103T	Foreign Language II	2	0	0	2	2
VAC - II	VAC/IKS	24GSS103T	Ethics & Values	2	0	0	2	2
				20	**1**	**4**	**24**	**22**

SEMESTER III								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
DSC- V	Core	24BSC201T	Inorganic Chemistry-II	3	0	0	3	3
DSC - V (P)	Core	24BSC201P	Inorganic Chemistry Lab-II	0	0	2	2	1
DSC- VI	Core	24BSC202T	Organic Chemistry-II	3	0	0	3	3
DSC - VI (P)	Core	24BSC202P	Organic Chemistry Lab-II	0	0	2	2	1
DSE/EM - III	EM		Choose from Minor Subject Basket	4	0	0	4	4
		24BSC203T	Heterogeneous Catalysis					
		24BSC204T	Supramolecular Chemistry					
MDC - III	MDC	24PHS201T	Introduction To modern Physics (Subsidiary)	4	0	0	4	4
AEC - III	AEC	24BSM232T	Advance excel	2	0	0	2	2
SEC- III	SEC		Workplace Communication	2	0	0	2	2
VAC - III	VAC/IKS	24BSC205T	Elements of Environmental Studies	2	0	0	2	2
				20	**0**	**4**	**24**	**22**
SEMESTER IV								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
DSC -VII	Core	24BSC206T	Analytical Chemistry-II	3	0	0	3	3
DSC - VII (P)	Core	24BSC206P	Analytical Chemistry Lab-II	0	0	2	2	1
DSC - VIII	Core	24BSC207T	Physical Chemistry-II	3	0	0	3	3
DSC - VIII(P)	Core	24BSC207P	Physical Chemistry Lab-II	0	0	2	2	1
DSE/EM - IV	EM		Choose from Minor Subject Basket	4	0	0	4	4
		24BSC208T	Environmental Chemistry					
		24BSC209T	Petroleum Chemistry					
		24BSC210T	Polymer					
MDC -IV	MDC	24BSP210T	Introduction to Astronomy & Astrophysics	4	0	0	4	4
AEC - IV	AEC	24BSM222T	Financial Literacy	2	0	0	2	2
SEC- IV	SEC	24BSP211T	Renewable Energy and Energy Harvesting	2	0	0	2	2
VAC - IV	VAC/IKS	24BSM222T	Cyber Security	2	0	0	2	2
				20	**0**	**4**	**24**	**22**
SEMESTER V								

Category Code as per NEP	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
DSC - IX	Core	24BSC301T	Inorganic Chemistry-III	3	0	0	3	3
DSC - IX (P)	Core	24BSC301P	Inorganic Chemistry Lab-III	0	0	2	2	1
DSC - X	Core	24BSC302T	Organic Chemistry-III	3	0	0	3	3
DSC - X (P)	Core	24BSC302P	Organic Chemistry Lab-III	0	0	2	2	1
DSE/EM - V	EM		Choose from Minor Subject Basket	4	0	0	4	4
		24BSC303T	Green Chemistry					
		24BSC304T	Chemistry of Paints and Dyes					
		24BSC305T	Chemistry of Materials					
MDC- V	MDC	24BSC306T	Smart Materials	4	0	0	4	4
SEC - V	Internship	24INT361	Industrial Internship (Summer)	0	0	8	8	4
OJT-I	On job training	24BSC307P	Instrumental Methods for Chemical Analysis-I	0	0	4	4	2
				14	**0**	**16**	**30**	**22**
SEMESTER VI								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
DSC – XI	Core	24BSC308T	Analytical Chemistry-III	3	0	0	3	3
DSC - XI (P)	Core	24BSC308P	Analytical Chemistry Lab-III	0	0	2	2	1
DSC - XII	Core	24BSC309T	Physical Chemistry-III	3	0	0	3	3
DSC - XII (P)	Core	24BSC309P	Physical Chemistry Lab-III	0	0	2	2	1
DSC- XIII	Core	24BSC310T	Natural Products	4	0	0	4	4
DSE/EM – VI	EM		Choose from Minor Subject Basket	4	0	0	4	4
		24BSC311T	Introduction to Fuel Cell Science and Technology					
		24BSC312T	Chemistry of Cosmetics & Perfumes					
		24BSC313T	Nanochemistry					
MDC – VI	MDC	24BSC314T	Cheminformatics	4	0	0	4	4
OJT-II	On job training	24BSC315P	Instrumental Methods for Chemical Analysis-II	0	0	4	4	2
				18	**0**	**8**	**26**	**22**
SEMESTER VII								

Category Code as per NEP	Category Code	Course Code	Course Name	Theory	Tutorial	Practical	Hrs	Credits
DSC- XIV	Core	24BSC401T	Organic Chemistry-IV	3	0	0	3	3
DSC - XIV (P)	Core	24BSC401P	Organic Chemistry Lab-IV	0	0	2	2	1
DSC- XV	Core	24BSC402T	Physical Chemistry-IV	3	0	0	3	3
DSC - XV (P)	Core	24BSC402P	Physical Chemistry Lab-IV	0	0	2	2	1
DSC – XVI	Core	24BSC403T	Analytical Chemistry-IV	3	0	0	3	3
DSC - XVI (P)	Core	24BSC403P	Analytical Chemistry Lab-IV	0	0	2	2	1
DSE/EM – VII	EM	24BSC404T	Computer Application in Chemistry	4	0	0	4	4
SEC – VII	SEC	24ENGS401T	Communication and Technical Writing Skills	2	0	0	2	2
AEC – V	AEC	24PROC451	Research Project/On the job training	0	0	8	8	4
		24PROC452	Research Internship					
				15	**0**	**6**	**21**	**22**
SEMESTER VIII								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
DSC- XVII	Core	24BSC405T	Organic Chemistry-V	3	0	0	3	3
DSC - XVII (P)	Core	24BSC405P	Organic Chemistry Lab-V	0	0	2	2	1
DSC- XVIII	Core	24BSC406T	Inorganic Chemistry-IV	3	0	0	3	3
DSC - XVIII (P)	Core	24BSC406P	Inorganic Chemistry Lab-IV	0	0	2	2	1
DSC - XIX	Core	24BSC407T	Analytical Chemistry-V	3	0	0	3	3
DSC - XIX (P)	Core	24BSC407P	Analytical Chemistry Lab-V	0	0	2	2	1
DSC – XX	Core	24BSC408T	Theoretical & Computational Chemistry	3	1	0	4	4
SEC – VIII	SEC	24BSC409T	Research Methodology & IPR	2	0	0	2	2
Project	Pro	24PROC453	Research Project	0	0	8	8	4
				14	**1**	**6**	**21**	**22**
SEMESTER IX								
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**

DSC- XXI	Core		*Specialization Electives from basket 5*3 = 15	3	0	0	3	3
DSC- XXII	Core			3	0	0	3	3
DSC- XXIII	Core			3	0	0	3	3
DSC- XXIV	Core			3	0	0	3	3
DSC- XXV	Core			3	0	0	3	3
DSC – XXVI	Core		Specialization Lab according to elective 2 credit	0	0	2	2	1
Project Phase -I	Pro	24PROC551	Minor Project	0	0	8	8	4
				15	**0**	**10**	**25**	**20**
			SEMESTER X					
Category Code as per NEP	**Category Code**	**Course Code**	**Course Name**	**Theory**	**Tutorial**	**Practical**	**Hrs**	**Credits**
Project Phase -II	Pro	24PROC552	Major Project	0	0	0	20	20
				0	**0**	**0**	**20**	**20**
								216

*Note- The students will choose the respective specialization streams in Sem-IX. Each specialization has 5 course and one specialization lab. Further, the project phase- I & II will be in line with specialization chosen by the student**.**

Minor Subject Basket

Elective Minor (EM)	Minor Stream			
Sem I	Mathematics - I (A & B)	Calculus and Analytical Geometry-I (A)	General Mathematics (B)	
Sem II	Mathematics - II (A & B)	Calculus and Analytical Geometry-II (A)	General Mathematics (B)	
SEM III	Mathematics - III (A & B)	Ordinary Differential Equations	Basic Mathematics III	
SEM IV	Environmental Chemistry		Petroleum Chemistry	Polymer
SEM V	Green Chemistry	Heterogeneous Catalysis	Chemistry of Paints and Dyes	Chemistry of Materials
SEM VI	Introduction to Fuel Cell Science and Technology	Supramolecular Chemistry	Chemistry of Cosmetics & Perfumes	Nanochemistry
SEM VII	Computer Application in Chemistry			
Minor Specialization	Environmental Chemistry		Industrial Chemistry	Materials Chemistry

Stream Electives Theory

Analytical Chemistry		
I.	24MSC606T	Atomic & Molecular Spectroscopy
II.	24MSC607T	Advanced Instrumental Techniques-I
III.	24MSC608T	Advanced Instrumental Techniques-II
IV.	24MSC609T	Electro Analytical and Radio Analytical Methods of Analysis
V.	24MSC610T	Method Development and Validation
Medicinal Chemistry		
I.		Chemical Biology
II.		Medicinal Chemistry-I
III.		Medicinal Chemistry-II
IV.		Pharmaceutical Chemistry and Biochemistry
V.		Formulation Development
Industrial Chemistry		
I.	24MSC601T	Paints, pigments & cosmetics
II.	24MSC602T	Polymer Chemistry & Composite Materials
III.	24MSC603T	Materials and Nano Chemistry
IV.	24MSC604T	Fine chemicals (Petrochemicals, oil, soap, and pesticides)
V.	24MSC605T	Petroleum Chemistry & Catalysis

Organic Chemistry		
I.	24MSC611T	Reagents and organic synthesis
II.	24MSC612T	Stereochemistry and Photochemistry
III.	24MSC613T	Heterocycles and vitamins
IV.	24MSC614T	Chemistry of Natural Products
V.	24MSC615T	Asymmetric synthesis/catalysis

Stream Elective Lab

Course Code	**Subject**
24MSC617P	Analytical Chemistry Lab
--	Pharmaceuticals Chemistry Lab
24MSC616P	Industrial Chemistry Lab
24MSC618P	Organic Chemistry Lab

24BSC101T					Inorganic Chemistry - I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Determine the structure and its features of inorganic compounds by hybridisation and VSEPR.
2. Comprehend the chemistry of D block elements.
3. Understand the colour, magnetism of the inorganic complexes.
4. Know the chemistry of lanthanide metal.

UNIT I: CHEMICAL BOND **11 Hrs.**

The Lewis theory, Sidgwick-Powell theory, Valence Shell Electron Pair Repulsion (VSEPR) Theory, effect of lone pair, effect of eletronegativity, isoelectronic principle, some examples using VSEPR Theory, valence bond theory (VBT), hybridization involving s and p orbitals (sp, sp^2, sp^3), Molecular orbital method, examples of molecular orbital treatment for homonuclear diatomic molecules H_2^+, H_2, He_2^+, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^-, O_2^{-2} and F_2

UNIT II: CHEMISTRY OF D-BLOCK ELEMENTS **11 Hrs.**

Introduction, position of d-block elements in the periodic table, electronic configurations and definition, classifications of d-block elements in 3d, 4d, 5d and 6d series, physicochemical properties: atomic radii, Ionic radii, metallic character and related properties, atomic volumes and densities, melting and boiling points, Ionization energies, standard reduction potential values, variable oxidation states, colour of transition metal complex ions, magnetic properties of transition metal ions and their complexes, tendency of transition metals to form complex compounds.

UNIT III: VBT AND CFT OF INORGANIC COMPLEXES **10 Hrs.**

Valence bond theory of complexes, principle and its application to determine structure and magnetic properties of complexes, limitation of VB theory, postulate of CFT, d-orbital splitting of octahedral and tetrahedral complexes in strong and weak field, effect and application of crystal field splitting, magnetic properties of high and low spin complexes, thermodynamic properties of crystal field splitting.

UNIT IV: LANTHANIDES **10 Hrs.**

Electron configuration, oxidation states, magnetic properties, color and absorption spectra of lanthanide ions, lanthanide contraction, separation and purification of lanthanides: Ion-exchange and solvent extraction methods.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Obtain** good understanding Chemical Bond Theories including Lewis, Sidgwick-Powell, VSEPR Theory, Valence Bond Theory (VBT) & Hybridization

CO2 : **Grasp** important concepts in the Molecular Orbital Method to explain structure of homonuclear diatomic molecules

CO3 : **Understand** the chemistry of D-block elements explaining electronic configurations, physicochemical properties.

CO4 : **Understand** the physicochemical properties, structure, reactivity and isomerism exhibited by transition metal complexes.

CO5 : **Obtain** deep knowledge of VBT and CFT of inorganic complexes including structure, magnetic properties, CFT postulates.

CO6 : **Get deep insight** into lanthanides electron configuration, oxidation states, magnetic, color properties, separation methods.

TEXT/REFERENCE BOOKS

1. FA Cotton, G Wilkinson, "**Inorganic Chemistry"**, (Rev. by GH Jeffery and others). The English Language Book Society of Longman.
2. J D Lee, "**Concise Inorganic Chemistry"**, Wiley India Ltd.
3. Satyaprakash, G D Tuli, S K Basu, R D Madan, "**Advanced Inorganic Chemistry"** S. Chand and company Ltd.

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration

24BSC101P					Inorganic Chemistry-I Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				50	50	100

COURSE OBJECTIVES

1. Learn proper safety precaution while working in the laboratory.
2. Knowledge on sampling methods for laboratory purpose.
3. Able to calculate the unknown concentration or mass through different analytical procedure.
4. Apply the laboratory concept of chemistry for industrial and domestic use.
5. To enhance the thinking capabilities in line with the modern trends in science and technology.

LIST OF EXPERIMENTS

1. Determination of amount of Na_2CO_3 and $NaHCO_3$ in a mixture with standard HCl.
2. Determination of alkali content of antacid tablets.
3. To determine the purity of given ascorbic acid by titrating against standard (N/10) iodine solution.
4. To determine the dissolved oxygen in given water sample.
5. To verify Lambert-Beer law and determine concentration of an unknown solution.
6. Preparation of sodium ferri-oxalate and determination of its melting point.
7. Determination of the amount of Calcium and Magnesium in milk powder by EDTA complexometry.
8. To determine the concentration of KCl present in the given solution by conductometric titration.
9. Estimation of Iron as ferric oxide in Mohr's salt.
10. Estimation of Iron in Portland cement.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : **Capability** to design new experimental method for unknown experiment.
CO2 : **Able** to calculate the alkali content in anta acid.
CO3 : **Analyze** the purity of organic compound through titration techniques.
CO4 : **Justify** the Lambert-Beer law
CO5 : **Realisation** of theoretical background of complexometric titration to calculate hardness limit in drinking water
CO6 : **Understand** the conductometirc titration for determination of unknown concentration

TEXT/REFERENCE BOOKS

1. A. I. Vogel, **A text book of quantitative Inorganic Analysis**, ELBS.
2. A. K. Nad, B. Mahapatra & A. Ghosal, **An Advanced Course in Practical Chemistry**, New Central, 2007. Vogel's Text Book of PracticalOrganic Chemistry (5th Edn).
3. Finar, I. L. **Organic Chemistry** (volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

SEMESTER EXAMINATION PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

LW(Daily lab performance plus journal maintain each 25 marks) 50 Marks
LE (Viva-voce plus Lab examination each 25 marks) 50 Marks

24BSC102T					Organic Chemistry-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the fundamentals concepts of organic chemistry
2. To understand the types of organic reactions and their mechanism
3. To understand the importance stereochemistry
4. To the concept of stereochemistry

UNIT I: BASICS OF ORGANIC CHEMISTRY-I **10 Hrs.**

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electrometric, resonance and mesomeric effects, Hyperconjugation and their applications; Dipole moment; Hemolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Organic acids and bases; their relative strength.

UNIT II: BASICS OF ORGANIC CHEMISTRY-II **12 Hrs.**

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reaction; Direct displacement process: SN2 reactions, carbonium ion process: SN1 reactions, stereochemistry of substitution reactions, neighbouring group participation, SNi reactions, and factors affecting reactivity in substitution reactions. Electrophilic addition and nucleophilic additions reaction, addition of carbine; β-eliminations, α-eliminations, thermal eliminations; factors affecting elimination vs substitution.Aliphatic Nucleophilic Substitution: The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The SNi mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinyl carbon. Electrophilic Substitution: Aliphatic: Bimolecular mechanisms: SE1, SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Aromatic: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Aromatic Nucleophile Substitution: The SNAr, SN1, benzyne and SRN1 mechanisms. Elimination Reactions: The E2, E1 and E1cB mechanisms and their spectrum. Generation, structure, stability, and reactions involving Carbocations, Carbanions, Radicals, carbenes, carbenoids and nitrenes. The Hammett equation and linear free energy relationship (sigma-rho) relationship, Taft equation.

UNIT III: BENZENE AND HOMOLOGUES: EFFECT OF SUBSTITUENTS **10 Hrs.**

Benzene and Homologues: Structure of benzene, resonance energy of benzene, aromaticity, Huckel rule, annulenes, mechanism of substitution reactions, halogenation of benzene: mechanism, nitration of benzene: mechanism, sulphonation of benzene: mechanism, Friedel-Crafts alkylation: mechanism, Friedel-Crafts acylation: mechanism, guidelines: writing mechanism of electrophilic substitution reactions, side-chain halogenation: mechanism, styrene.

Directive effects of substituents, ortho-para and meta directing groups, effect of substituents on reactivity, theory of directive effects, theory of activating ad deactivating effects, guidelines: determining the orientation effect and activating (or deactivating) effect of various substituents.

UNIT IV: HETEROCYCLIC CHEMISTRY **10 Hrs.**

Introduction to hetero cyclic compounds, structural features, and stability, nomenclature, basicity, Hückel's rule, aromaticity of hetero cyclic compounds. Preparation, properties and chemical reactions of 3, 4 membered heterocyclic compounds (Aziridines, Epoxides, Azetidine, oxetanes). Preparation, properties and chemical reactions of five membered hetero cyclic compounds (Pyrrole, Furan, Thiophenes). Preparation, properties and chemical reactions of six membered hetero cyclic compounds (Pyridines, Pyrylium salt), Introduction to fused, other heterocyclic: nomenclature, types, reactions and properties of selected heterocyclics (Indoles, benzofurans, pyrazines, quinolines) Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S). Synthesis and reactions of Three membered and four membered Heterocycles i.e. aziridines, oxiranes, thiranes, azetidines, oxitanes and thietanes. Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes. Synthesis and reactivity of furan, thiophene, pyrrole, pyridine, quinoline, isoquinoline and indole; Skraup synthesis, Fisher indole synthesis.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: **Comprehend** the basic concepts of organic chemistry
CO2: **Understand** the types of organic reactions and their mechanism
CO3: **Analyse** the importance stereochemistry
CO4: **Implement** the principles of stereochemistry
CO5: **Elucidate** the concept of reaction and its mechanism.
CO6: **Apply** the concepts of organic reactions and its stereochemistry

TEXT/REFERENCE BOOKS

1. J. March, John **"Advanced Organic Chemistry"** Wiley & Sons.
2. E. J. Eliel,**"Stereochemistry of Carbon Compounds"** McGraw Hill.
3. D. Nasipuri, **"Stereochemistry of Organic Compounds"** Wiley.
4. P.Y. Bruice, **"Organic Chemistry"** Prentice Hall.
5. P.S. Kalsi, **"Organic Reaction and their Mechanism"** New Age.
6. L. Fleming, John **"Frontier Orbital and Organic Chemical Reactions"** Wiley.
7. T. R. Gilchrist, Longman **"Heterocyclic Chemistry**.
8. P.S. Kalsi, **"Stereochemistry**: Conformation and Mechanism

SEMESTER EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

24BSC102P					Organic Chemistry-I Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical/Viva		Total Marks
					MS	ES	IA	MS	ES	

COURSE OBJECTIVES

1. To apply theoretical organic chemistry concepts to practical scenarios.
2. To develop proficiency in identifying various functional groups present in organic molecules through practical exercises.
3. To acquire the knowledge and skills necessary to categorize organic compounds into different classes and subclasses based on their structural characteristics.
4. To cultivate a culture of safety, responsibility, and efficiency in the laboratory environment by adhering to best practices, protocols, and safety measures.

LIST OF EXPERIMENTS

1. Purification of organic compounds by crystallization using the following solvents: Water/Alcohol.
2. Determination of the melting points of above compounds and unknown organic compounds electrically heated melting point apparatus).
3. Alkaline Hydrolysis tests for the presence of amides and esters.
4. Benedict's test for the presence of aldehydes.
5. Chromic Acid tests for the presence of primary alcohols, secondary alcohols, and aldehydes.
6. 2, 4-Dinitrophenylhydrazine tests for the presence of aldehydes and ketones.
7. Ferric Hydroxamate test for the presence of esters..
8. Hinsberg's test for classifying amines as primary, secondary or tertiary..
9. Lucas's test for classifying alcohols as primary, secondary, or tertiary.
10. Tollen's test for the presence of aldehyde.

COURSE OUTCOMES

Upon completion of the course, student will be able to

CO1 : **Recall** the theoretical concepts of Organic Chemistry to recognize and identify different functional groups such as aldehyde, ketone, amide, ester, and alcohol.

CO2 : **Understanding** the rationale behind the selection of reagents and reactions for qualitative analysis of organic compounds.

CO3 : **Apply** knowledge of organic chemistry principles to distinguish between three types of amines by selecting and using appropriate reagents and reaction conditions.

CO4 : **Analyze** the chemical reactions to categorize different types of alcohols based on their structural characteristics, elucidating the differences between primary, secondary, and tertiary alcohols through their chemical reactions.

CO5 : **Evaluate** the molecular weight of an unknown carboxylic acid using the neutralization equivalent test

CO6 : **Develop** the strategies and methodologies for the comprehensive study of unknown organic compounds

REFERENCE BOOKS:

1. Mann, F.G. and Saunders, B.C. **"Practical Organic Chemistry"**, Pearson Education.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, **"A.R. Practical Organic Chemistry"**, Pearson.
3. Vogel, A.I. **"Quantitative Organic Analysis"**, Part 3, Pearson.
4. Ahluwalia, V.K. and Aggarwal, R. **"Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis"**, University Press.

SEMESTER EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

24BSP101T					University Physics-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To acquire the basic knowledge of inadequacies of classical physics & other concepts of modern physics
2. To understand and analyze the motion of the particle under central forces.
3. To demonstrate the basic understanding of kinematics and dynamics.
4. To explain the basic concepts of waves and heat.

UNIT I: INTRODUCTION TO PHYSICAL SCIENCE **12 Hrs.**

Introduction to various branches of Physics, Fundamental laws of classical and quantum physics, Failures of classical Physics: Ultraviolet catastrophe, Photoelectric effect, Compton effect, atomic spectra, general rules for scalars and vectors, vector algebra.

UNIT II: INTRODUCTION TO LASER AND SEMICONDUCTOR PHYSICS **12 Hrs.**

Introduction to LASER, constraints for normal light, spontaneous emission, metastable state, population inversion, stimulated emission, three and four level pumping schemes, conditions for light amplification, optical resonator, applications of LASER.

Energy Band, classification of solids, Electron distribution function, Fermi Dirac distribution function, Fermi level in N type and P type semiconductor, Effect of temperature on energy band, P-N Junction diode, forward and reverse biased connection.

UNIT III: MOTION UNDER FORCES **08 Hrs.**

Applications of Newton's laws, Work, friction, energy, power, momentum, examples and applications, conservation law: force and energy, non-conservative forces and energy dissipation, Rotational Kinematics, dynamics and statics, torque, angular momentum, moments.

UNIT IV: BASIC CONCEPTS OF WAVES AND HEAT **10 Hrs.**

Introduction to waves, Description of Wave motion, types of waves: mechanical, electromagnetic, matter and standing, wave propagation in a medium, Concept of heat and temperature, Kinetic theory of gases, specific heat, thermodynamic processes; concept of entropy. .

MAX HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Identify the experimental results incompatible with classical physics and concepts of quantum theory.
CO2 : Understand the important concepts of modern physics.
CO3 : Apply basic concepts of LASER and semiconductor physics in real time applications.
CO4 : Illustrate an ability to apply the concepts of kinematics.
CO5 : Validate underlying principles of physics for waves and heat.
CO6 : Solve the numerical based on the various concepts of physics.

TEXT/REFERENCE BOOKS

1. Resnick, Halliday and Krane, Physics part I and II, 5th Edition John Wiely (2002).
2. Heat and Thermodynamics by Brij lal and N Subramaniyam, (S Chand & Co. Ltd, New Delhi).
3. Concepts of Physics by H.C Verma Vol-I and II, Bharati Bhawan Publishers.

24BSP101P					University Physics-I Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand the working of various electrical, mechanical and optical instruments in the laboratory.
2. To gain practical knowledge in Physics through experiments.
3. To understand basics concepts of Physics and be able to apply in performing the experiments.

LIST OF EXPERIMENTS	
1	To study the principle of hall effect and to determine (a) Hall voltage and (b) Hall coefficient.
2	To demonstrate/investigate phenomenon of resonance using forced oscillations.
3	To determine the angle of reflection and prove angle of incidence is equal to angle of reflection using ultrasonic waves.
4	To find the slit width of single slit, blade slit and aperture width of the double slit.
5	To measure the linear thermal expansion coefficient for Copper and Brass rod.
6	To understand the principle of Heat pump and its applications.
7	To observe the waveform produced by output of half and full wave rectifier.
8	To plot V-I characteristics of P-N junction diode and calculate various associate parameters.
9	To find the energy band gap of the Germanium semiconductor chip using Four Probe Method.
10	To demonstrate the use of cathode ray oscilloscope and its various functions.
11	To determine the electrical conductivity of the Copper and Aluminium rods.
12	To determine the wavelength of monochromatic light source using Newton's rings apparatus.
13	To demonstrate/investigate the working principle of solar cell.

COURSE OUTCOMES

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

CO1	:	Apply and analyse the concepts of electricity and magnetism.
CO2	:	Understand the various concepts of kinematics.
CO3	:	Demonstrate and implement the phenomenon related to waves.
CO4	:	Investigate the electrical properties of a given semiconductor device.
CO5	:	Examine the heat transfer mechanism in heat pump based devices.
CO6	:	Design and analyse the circuits applications based on semiconductor diode.

TEXT/REFERENCE BOOKS

1. Kittel, Knight and Ruderman, Mechanics - Berkeley Physics Course, Vol. 1, Tata McGraw-Hill.
2. Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
3. Brij Lal, N. Subrahmanyam, Heat and Thermodynamics, S. Chand & Company, Ltd
4. Halliday, Resnick, Walker, Fundamentals of Physics (Wiley)

24BSC103T					Introduction To Bioorganic Chemistry/Chemical Biology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the fundamentals concepts of bioorganic chemistry
2. To understand its importance and application in living systems.
3. To understand the role and function of bioorganic molecules, enzymes and sensors in our living system.
4. To learn the basic concepts of interactions in bioorganic molecules.
5. To know about the trace metals of life.

UNIT 1: INTRODUCTION **14 Hrs.**

Introduction to Biological chemistry, Chemical biology and Bioorganic Chemistry, Difference between Biological chemistry and Bioorganic chemistry, Bioorganic Chemistry, and its multiple origin, Classification and Nomenclature of organic compounds, IUPAC rules, Isomerism, Stereoisomerism, Nomenclature of Enantiomers (Cahn-Ingold-Prelog rule), Molecules with more than one stereocenter, Diastereomers, Electronic effects: Inductive and mesomeric electronic effects, Resonance effect, Resonance (mesomeric) effect, Hydrogen bond: intermolecular and intramolecular interactions.

UNIT 2: BIOORGANIC MOLECULES **14 Hrs.**

Macromolecules in living cells: Carbohydrates, Lipids, Proteins, and Nucleic acid: their composition, monomers, polymers, examples, and functions. Carbohydrates: Sugar and Starch, Proteins: Peptide Formation, Structure of protein: Primary, Secondary and Tertiary Structures, Lipids: Fatty acids, Oils and Waxes, Triacyl glycerides and other derivatives: Cholestrol, Nucleic acids: DNA, RNA, comparison of DNA and RNA, Nitrogenous base: Purine and Pyrimidines.

UNIT 3: NON-COVALENT INTERACTIONS **14 Hrs.**

Non-Covalent Interactions: van der Waals interactions, Polar-Polar Interaction, Hydrogen bond, Importance of weak non-covalent interactions in Molecular Recognition, Weak forces in Molecular Recognition: Electrostatic interactions, Hydrogen bonding, stereo-electronic interaction, π–stacking interactions, Hydrophobic interaction and steric interactions, Importance of week interactions in understanding the structure of the biomolecules and functions of many bioprocesses.

UNIT 4: ESSENTIAL AND TRACE ELEMENTS IN BIOLOGICAL PROCESSES **14 Hrs.**

Essential and trace elements in biological process: Essential elements (Macro elements and Micro/elements) and Non-essential elements, Biological functions of trace elements: Fe, Cu, Zn, Mn, Co, I, and Se, Metalloporphyrins: haemoglobin and myoglobin, Structure and function of haemoglobin, Structure and function of myoglobin, Cooperative effect, Oxygen binding curve, Difference between haemoglobin and myoglobin, Biological importance of alkali and alkaline earth metals: Na^+, K^+ and Ca^{2+}

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : **Recall** the fundamental principles of bioorganic chemistry
CO2 : **Understanding** the role of various bioorganic molecules in living systems
CO3 : **Identifying** and explain the interactions among various biomolecules
CO4 : **Analyzing** the role of metal ions as important integral part of living system
CO5 : **Evaluating** the impact of deficiencies in bioorganic molecules on human health
CO6 : **Define** and classify bioorganic molecules, including proteins, carbohydrates, lipids, and nucleic acids.

TEXT/REFERENCE BOOKS

1. **Introduction to Bioorganic Chemistry and Chemical Biology**; By David Van Vranken and Gregory A. Weiss.
2. **Inorganic Chemistry** by Catherine Housecraft and Alan G. Sharpe (The trace metals of life)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration:3 Hrs**

Part A/Question: 10 questions of 2 marks each with internal choice 20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice 80 Marks

24ENGST10T					Communication Skills (English Communication)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

Unit I: Introduction to Communication (7 hrs)

- The Fundamentals of Language and Communication
- Significance of the English Language
- Types of Communication
- Barriers to effective Communication
- Digital Communication

Unit II: English Grammar and Vocabulary (8hrs)

- Tenses, Articles, prepositions, active voice, passive voice, and concord
- Tools for vocabulary building
- Homophones, homonyms, one word substitution, antonyms, synonyms, Root Words, Prefixes and Suffixes, Connotations. Collocations, Idioms. Phrases

Unit III: Receptive Skills (8 hrs)

- Listening Skills: Difference between listening and hearing, Active listening and passive listening
- Types of listening, Traits of good listener
- Reading Skills: Why reading is important, Effective reading techniques, Speed Reading, The SQ3R Method

Unit IV: Compendium Skills (7 hrs)

- Note Taking and Note Making: physical, digital, collective
- Summarizing
- Creating e-content

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 :
CO2 :
CO3 :
CO4 :
CO5 :
CO6 :

TEXT/REFERENCE BOOKS

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. Communication Skills for Engineers and Scientists. Sharma, Sangeeta and Binod Mishra. New Delhi: PHI Learning Pvt. Ltd., 2009.
4. Business Communication. Kaul, Asha. Delhi: Prentice-Hall of India, 2006

24ENGS102T					Foreign Language I (FRENCH)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To introduce French language at the beginner's level.
2. To enable students to form and understand basic sentences.
3. To enable students to read and write simple sentences in French.
4. To develop the ability to communicate the basics in the French language
5. To enable students to listen and comprehend conversations about topics regularly encountered in daily life and classroom situations
6. To enable students to recognise key words in conversation

UNIT 1 DISCOVERING THE FRENCH LANGUAGE **7 Hrs.**

- To introduce oneself and someone else
- To know names of different countries
- To count
- To ask and to give personal information
- To know days, months and seasons along with climate of France

UNIT 2 KNOWING FRENCH LANGUAGE **7 Hrs.**

French definite and indefinite articles, demonstrative adjectives, verbs of preferences (to like, to adore, to hate) and sentence formation with the same.

UNIT 3 WE LEARN FRENCH.... **7 Hrs.**

- To greet and to bid someone goodbye
- To learn the difference between formal and informal conversations
- To get introduced to question words
- To know the different forms of the question word “which” in French
- To know the subject pronouns along with the verb “to be” (être)
- Vocabulary — nationalities and professions
- To learn basic complex sentences with “because” and “for” along with proper pronunciation
- To learn politeness in French culture

UNIT 4 Introduction to conversations **7 Hrs.**

- To be able to understand conversations of daily life eg: talking to a classmate, ordering at a restaurant, explaining a route
- To recognize and to use different typical French sounds like [y] and [z] To understand the system of “liason” with several subject pronouns and verbs

TOTAL HOURS: 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Reading, writing, and speaking on personal information
CO2 : Identify beginner's sentences
CO3 : Get introduced to French culture and manners
CO4 : To understand the usage of basic verbs grammatically in a conversation
CO5 : To gather basic vocabulary needed at a beginner's level
CO6 : To understand and be able to grasp French accent

TEXT/REFERENCE BOOKS

1. Saison l Méthode de Français by Élodie Heu, Catherine Houssa, Emilie Kasazian,
2. Delphine Ripaud
3. Saison 1 Cahier d'activités by Marion Alceraz, Dorothee Escoufier, Camille Gomy, Mathilde Landier, Francine Quemener, Delphine Ripaud

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration:3 Hrs**

Part A/Question: 10 questions of 2 marks each with internal choice 20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice 80 Marks

24BSC104T					Physical Chemistry I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the knowledge about fundamental of laws of thermodynamics
2. To provide the concept of entropy and its relation to other thermodynamic parameters
3. To develop the knowledge about the chemical and phase equilibrium
4. To provide the knowledge about the thermodynamics of ions.

UNIT I: STATES OF MATTER **10 Hrs**

Describing the states of a system: variable of state and equations of state; phase changes; kinetic molecular model of a gas; Van der wals equation of state, Maxwell speed distribution and its features, virial equation of state, critical constant of real gas, qualitative treatment of the structure of the liquid state; nature of the solid state.

UNIT II: THERMODYNAMICS **12 Hrs.**

Zeroth and 1st law of Thermodynamics: intensive and extensive variables, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics; concept of heat, work, and internal energy, enthalpy H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and vander Waals) under isothermal and adiabatic conditions, Joule's experiment and its consequence; Thermochemistry and its application

Heat engines, Carnot's principle; The Second Law, Definition of entropy, Entropy changes accompanying heating, phase transition, chemical reactions; Absolute entropies and the Third Law of Thermodynamics. Boltzmann formula of entropy, relation between thermodynamic and statistical entropy; Residual entropy; The spontaneity of chemical reactions.

UNIT III: EQUILIBRIUM: CHEMICAL AND PHASE **10 Hrs.**

Entropy and Equilibrium: Gibbs and Helmholtz energy, Work and the Gibbs energy change. Estimating a change in Gibbs energy for a metabolic process, Action of adenosine triphosphate (ATP); Variation of Gibbs energy with pressure, temperature Condition of stability; Thermodynamics of phase transition, Phase diagrams, phase boundaries, characteristic point; Chemical potential, Chemical potential of gas, solvent and solute. Real solutions, Concept of activity and fugacity. Maxwell relations. Thermodynamic description of mixtures.

UNIT IV: THERMODYNAMICS OF IONS **10 Hrs.**

Donnan equilibrium, Analyzing Donnan equilibrium, Thermodynamics of dissolving Thermodynamics of ion and electron transport Ions in solution, Transport of ions across biological membranes; Nernst equation, Thermodynamic standard potentials, Variation of potential with pH. The biological standard potential, Converting a standard potential to a biological standard value; Electron transfer reactions, Oxidative phosphorylation, Photosynthesis; Introduction to Statistical Thermodynamics.

42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : **Understand** the concept of thermodynamics and its importance in natural systems.
CO2 : **Acquire** understanding of the relationship between various thermodynamics parameters and their significances.
CO3 : **Apply** theoretical knowledge to quantify efficiency of cycles (e.g., Carnot).
CO4 : **Comprehend** the concept of equilibrium in chemical systems and in phase transition systems.
CO5 : **Appreciate** the distinction between thermodynamic and biological standard potentials, with their applications.
CO6 : **Conceptualize** the role of thermodynamics of ions in biological processes.

TEXT/REFERENCE BOOKS

1. Castellan, G. W. **Physical Chemistry**, Narosa Publishing House
2. Rakshit, P.C., **Physical Chemistry**, Sarat Book House.
3. Atkins, P. W. and Paula J de Atkins, **Physical chemistry**, Oxford University Press.
4. Kapoor K L, **Textbook of Physical Chemistry** (Vol-1,2), McGraw Hill education
5. Ghoshal A., Understand the conductometirc titration for determination of unknown concentration, Books and allied (P) Ltd.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part : 10 Questions, each carrying 10 marks 100 Marks

24BSC104P					Physical Chemistry- I Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

- To Gain experience in determining physical properties of liquids and solids.
- To develop proficiency in using instruments like Ostwald's Viscometer and Stalagmometer.
- To calculate and interpret data to determine molecular and physical properties.
- To enhance problem-solving skills through experimental design, data analysis, and interpretation.
- To Apply experimental methods to solve problems in physical chemistry.

LIST OF EXPERIMENTS

1 To determine the relative and absolute densities of pure liquid.
2 To determine the viscosity of a pure liquid at room temperature using the Ostwald's Viscometer.
3 To determine the percentage composition by volume of the given mixture of liquids A & B by viscosity measurements.
4 To determine the relative molecular mass of polymer from viscosity measurements.
5 To determine the surface tension of pure liquids at room temperature using the stalagmometer.
6 To determine the percentage composition of the given mixture of two components A & B using the stalagmometer.
7 To plot the triangular diagram for a three component liquid system and find the number of phases on the triangular diagram, above it and under it.
8 To determine the solubility of a given salt at room temperature and also draw its solubility curve.
9 To determine the solubility of a given an organic solid (benzoic acid) at 40 °C and also lower then room temperature.
10 To determine the molar mass of a volatile liquid through vapor displacement by Victor Meyer's Method.
11 Determination of heat of solution from solubility measurements
12 Determine the transition temperature of Sodium Sulphate crystal (Glauber's salt) by thermometric method

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

CO1 : Gain a solid **understanding** of laboratory techniques like viscometry and thermometry for measuring physical properties.
CO2 : Apply **fundamental concepts**, such as gas laws and thermodynamics, to explain chemical behavior in experiments
CO3 : Develop strong **analytical skills** in data collection, measurement, and systematic result evaluation.
CO4 : Understand molecular interactions, such as dimerization and intermolecular forces, and their effects on substance properties
CO5 : **Build skills in interpreting** experimental data and connecting outcomes to theoretical principles.
CO6 : **Enhance problem-solving abilities** by applying concepts practically, preparing for advanced research tasks.

TEXT/REFERENCE BOOKS

1. College Practical Chemistry Book by S. Dhingra and V K Ahluwalia, Sunita Dhingra, 2005
2. Engineering Chemistry with Laboratory Experiments by M.S. Kaurav, 2011
3. An Advanced Course in Practical Chemistry by Paperback, A K NAD, B MAHAPATRA, A GHOSHAL, 2007

Semester Exam Pattern

Max Marks 100	Exam Duration
Lab Exam	50
Lab work	50

24BSC105T					Analytical Chemistry - 1					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the fundamental understanding about qualitative and quantitative methods for data analysis.
2. To provide the knowledge about the various optical analytical techniques like UV, IR and electronic spectroscopy.
3. To develop understanding for various electroanalytical techniques like potentiometry and conduct metric techniques
4. To provide the knowledge about various separation techniques like IC, GPC, GC, HPLC.

UNIT I: QUALITATIVE AND QUANTITATIVE ASPECTS OF ANALYSIS **11 Hrs.**

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

UNIT III: SPECTROSCOPIC METHODS OF ANALYSIS: ATOMIC SPECTROSCOPY **11 Hrs.**

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, Choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

UNIT III: SPECTROSCOPIC METHODS OF ANALYSIS: MOLECULAR SPECTROSCOPY

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV- Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Raman Spectroscopy:

UNIT IV: SPECTROSCOPIC METHODS OF ANALYSIS: RAMAN SPECTROSCOPY **10 Hrs.**

Principles of Raman Scattering, Raman Instrumentation, Applications of Raman Spectroscopy Introduction, Raman Effect and Origin of Raman Spectroscopy, Theories of Raman Effect and Raman Spectroscopy, Zero-Point Energy, Vibrational Raman Spectra, Pure Rotational Raman Spectra, Types of Molecules and Rotational Raman Spectra, Vibrational-Rotational Raman Spectra, Polarization of Raman Lines, Rule of Mutual Exclusion, Instrumentation, Sample Handling, Applications of Raman Spectroscopy

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic principle of error analysis and comparison of data sets.

CO2 : **Acquire** new knowledge about the theory and instrumentation of spectroscopic techniques like FT-IR, Raman, and microwave spectroscopy

CO3 : **Understanding** of theoretical and instrumentation aspects of atomic absorption and emission spectroscopy.

CO4 : **Acquire** an overview of miscellaneous electroanalytical techniques with an emphasis on potentiometric techniques.

CO5 : **Explain** the working principles and applications ofUV and IR spectroscopy.

CO6 : **Acquire** theoretical and practical aspects of instrumental techniques Raman spectroscopy.

TEXT/REFERENCE BOOKS

1. Vogel, Arthur I, "**A Text book of Quantitative Inorganic Analysis"**, (Rev. by GH Jeffery and others) 5th Ed. The English Language Book Society of Longman.
2. Willard, Hobert H., "**Instrumental Methods of Analysis"**, 7th Ed. Wardsworth Publishing Company, 3. Christian, Gary D; Analytical Chemistry, 6th Ed. New York- John Willy, 2004.
3. SKoog, D.A. Holler F.J. and Nieman, T.A, "**Principles of Instrumental Analysis"**, Thomson Asia P. Ltd. Singapore.

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 questions of 1 marks each without internal choice	20Marks
Part B/Question: 8 questions of 20 marks each with internal choice.	80 marks

24BSC105P					Analytical Chemistry Lab-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Demonstrate adherence to safety precautions in laboratory settings, emphasizing awareness and application of safety protocols at the application level.
1. Understand the scientific principles underlying laboratory practicals for industrial and domestic applications, demonstrating comprehension and application skills at the conceptual level
2. Comprehend the principles of adsorption and its practical applications, demonstrating understanding and application skills at the conceptual and application levels.
3. Gain hands-on experience with spectroscopic techniques to characterize synthesized complexes, applying knowledge and skills at the application level.
4. Evaluate and adapt to modern trends in science and technology, demonstrating analysis, synthesis, and evaluation skills at the evaluation level.

LIST OF EXPERIMENTS

1 To determine soil pH by using a pH-meter.
2 To determine the strength of given mixture of HCl and CH_3COOH by conductometric titration.
3 Gravimetric determination of Sulphate as Barium Sulphate.
4 Spectrophotometric determination of Iron by complexing with 1,10 –Phenanthroline .
5 Determination of hexavalent chromium by complexing with di-phenyl carbazide, using a spectrophotometer.
6 Estimation of oil and grease from a given sample after solvent extraction.
7 Determination of distribution coefficient of an organic acid between water and an organic solvent.
8 To determine the Chemical Oxygen demand (COD) in a given water sample.
9 Determination of elements (e.g., Cu) in aqueous solutions by Atomic absorption spectrometer.
10 Adsorption of Acetic acid on charcoal.

COURSE OUTCOMES

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

CO1 : **Design** new experiments, demonstrating creativity and synthesis skills at the synthesis level
CO2 : **Comprehend** conductometric titration principles to calculate unknown concentrations, applying knowledge and understanding at the application level
CO3 : **Understand** electrode functionality and utilize it to calculate the pH of unknown solutions, demonstrating comprehension and application skills at the analysis level
CO4 : **Determine** the quantity of oxygen in various water samples and assess its significance, applying knowledge and analysis skills at the application level.
CO5 : **Apply** atomic absorption spectroscopy to investigate solutions in industrial settings, demonstrating application and analysis skills at the application level
CO6 : **Develop** new scientific methodologies for domestic and industrial purposes, illustrating creativity and synthesis skills at the synthesis level

TEXT/REFERENCE BOOKS

1. I. Vogel, A text book of quantitative Inorganic Analysis, ELBS.
2. K. Nad, B. Mahapatra & A. Ghosal, An Advanced Course in Practical Chemistry, New Central, 2007. Vogel's Text Book of Practical Organic Chemistry (5th Edn).

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
LW(Daily lab performance plus journal maintain each 25 marks)	50 Marks
LE (Viva-voce plus Lab examination each 25 marks)	50 Marks

24MAS102T					Mathematics for Sciences – II (Group A)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- ➢ To provide basic understanding of calculus of several variables.
- ➢ To be able to obtain extreme values of multivariate function.
- ➢ To study the multiple integration, understand it geometrically and explore its applications. ➢ To use this basic course in upcoming courses in respective specializations in higher classes.

UNIT 1 FUNCTIONS OF SEVERAL VARIABLES **11 Hrs.**

Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT 2 EXTREMA AND VECTORS **07 Hrs.**

Extrema of functions of two variables, method of Lagrange multipliers, Definition of vector field, gradient, divergence and curl.

UNIT 3 MULTIPLE INTEGRALS **11 Hrs.**

Double integration over rectangular region, double integration over non rectangular region. Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

UNIT 4 LINE, SURFACE AND VOLUME INTEGRALS WITH THEIR RELATIONSHIPS **11 Hrs.**

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, The Divergence theorem.

40 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to

- CO1 : Define Function of several variables along with the concept of its limit, continuity and derivative.
- CO2 : Understand the basics of vector calculus.
- CO3 : Apply the technique of finding multiple integral and their applications–
- CO4 : Analyze the applications of line integrals.
- CO5 : Evaluate the extreme value of multivariate function.
- CO6 : Appraise calculus of several variables and vector calculus to understand various problems of science and engineering.

TEXT/REFERENCE BOOKS:

1. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, 1st ed., Springer (SIE), Indian Reprint, 1993.
2. G. B. Thomas, R. L. Finney, Calculus and Analytic Geometry, 9th ed., Addison-Wesley Publishing Company, 1998.
3. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd ed., Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2007.
4. J. Stewart, Essential Calculus-Early Transcendentals – 2nd ed., Cengage Learning, 2013.
5. H. Anton, I. Bivens and S. Davis, Calculus, 7th ed., John Wiley and Sons (Asia), Pvt. Ltd., Singapore, 2002.

24MAS106T					Basic Mathematics – II (Group B)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to understand the applications of vectors in real world.
- To be able to solve differential equations.
- To be able to classify the data and can measure the central tendency and other
- To study the finite differences and effect of errors in real life situations.

UNIT 1 VECTORS AND COORDINATE GEOMETRY (3D) **10 Hrs.**

Vectors and their algebra. Simple applications to geometry and mechanics. Unit vectors, vectors *i*, *j* and *k* . Components of a vector. Position vector. Direction cosines and direction ratios. Dot and cross products. Projection of a vector on another. Distance between two points. Equations of a line, plane and sphere. Intersections. Distance between two points. Shortest distance between lines.

UNIT 2 ELEMENTARY DIFFERENTIAL EQUATIONS **10 Hrs.**

Definitions of order, degree, linear, nonlinear, homogeneous and non-homogeneous. Solution of first order equations. Complementary function and particular integral. Initial and boundary value problems. Linear differential equations with constant coefficients. Cauchy-Euler equation.

UNIT 3 BASIC STATISTICS **10 Hrs.**

Classification of data. Mean mode, median and standard deviation. Frequency distributions and Measures of Central Tendency, Measures of Dispersion, Skewness and Kurtosis.

UNIT 4 BASICS OF NUMERICAL METHODS **10 Hrs.**

Calculus of finite differences, Difference formula, difference table, Effects of an error in a tabular value, The operator E, Properties of two operators E and Δ, Factorial Notations, Methods of any given polynomial in factorial notation, Leibnitz rule.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Identify the use of 2D and 3D vectors in daily life

CO2 : Understand the concept of basic distance formulas in 1D, 2D and 3D and their applications.

CO3 : Develop the ability to classify differential equations and solve according to various categories and shortcut methods.

CO4 : Analyze the supplied data statistically and measure the results according to the requirement.

CO5 : Appraise the significance of finite differences in all simple calculations and also able to get the idea of errors occurring therein. CO6 : Evaluate problems on the basis of operators and develop a polynomial in factorials.

TEXT/REFERENCE BOOKS

1. Thomas, G. B. and Finney, R. L., Calculus and analytical geometry, 9th Ed., Pearson Education Asia, (2000)
2. NCERT**,** Mathematics Textbook for class XI and XII (2009).
3. Sharma, R.D.**,** Mathematics, Dhanpat Rai Publications, New Delhi (2011).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
Part A: 10 questions of 3 marks each	30 Marks (40 mins.)
Part B: 5 questions 6 marks each	30 Marks (50 mins.)
Part C: 5 questions 8 marks each	40 Marks (90 mins.)

24BSP104T					University Physics-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To foster a foundational comprehension of electricity and magnetism.
2. To offer essential insights into the principles of basic thermodynamics.
3. To explore the concepts of elementary optics, photonics and their practical implications.
4. To provide insight into the inception of modern physics.

UNIT I: CONCEPTS OF ELECTRICITY AND MAGNETISM **10 Hrs.**

Coulomb's law, Electric field, Gauss's law, Electric Potential; Capacitors, Dielectrics, DC and AC circuits, RC-RL-LC circuits, Electric fields in matter, Polarization.

Sources of magnetism, magnetic force on a moving charge, Biot-Savart law, Ampere's law, Induced emf.

UNIT II: BASIC THERMODYNAMICS **10 Hrs.**

Continuum and macroscopic approach, Thermodynamic systems (closed and open), Thermodynamic properties and equilibrium, State of a system, Concepts of heat and work, Different modes of work, Concept of energy and various forms of energy, Internal energy, Enthalpy, Zeroth law of thermodynamics, First Law of Thermodynamics, Second Law of Thermodynamics, Concept of entropy, Applications of the Laws of thermodynamics.

UNIT III: ELEMENTARY OPTICS AND PHOTONICS **12 Hrs.**

Reflection, Refraction, Image formation by mirrors & thin lenses, Optical instruments: Digital camera, Microscope, Telescope, Magnification, Introduction to non-linear optics, Nonlinear polarization; Second harmonic generation; Phase matching; Sum and difference frequency generation; Self-focussing of Light.

UNIT IV: ELEMENTS OF MODERN PHYSICS **10 Hrs.**

Introduction to Quantum Mechanics, Energy, Momentum and Hamiltonian Operators, Time-independent Schrodinger Wave Equation for Stationary States, Planck's Hypothesis, De Broglie's Dual Nature Principle, Introduction to special theory of relativity, Basic idea of twin paradox, time dilation and length contraction.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Gain familiarity with fundamental principles of electricity and magnetism.
CO2 : Comprehend and utilize the principles of basic thermodynamics.
CO3 : Grasp the principles of elementary optics and photonics.
CO4 : Apply the principles of electromagnetism, thermodynamics, and optics to solve numerical problems.
CO5 : Distinguish between classical and quantum physics.
CO6 : Cultivate the comprehension necessary to engage with more advanced courses in physics.

TEXT/REFERENCE BOOKS

1. B B Laud, "**Electromagnetism"**, Wiley eastern limited.
2. K. K. Tiwari, "**Electricity and Magenetism with Electronics",** S. Chand & Company Ltd.
3. Brij lal and N Subramaniyam, "**Heat and Thermodynamics"**, S. Chand & Company Ltd.
4. Brij lal and N Subramaniyam, **"Optics"**, S. Chand & Company Ltd.
5. Robert W. Boyd, **"Nonlinear Optics"**, Elsevier.
6. Arthur Beiser, **"Concepts of modern Physics",** Tata McGraw Hill.

24BSP104P					University Physics-II Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To develop proficiency in using precision measuring determine their least count accurately.
2. To understand the principles and characteristics of instruments related to electricity and magnetism, heat and optics.
3. To understand phenomenon of photoconductivity, charging and discharging of capacitors, and working of power supplies.

LIST OF EXPERIMENTS

1. To determine the Least count of Vernier callipers, Screw gauge and Spectrometer and measure the dimensions of given objects.
2. To study the optical fiber characteristics.
3. To study the phenomenon of photoconductivity.
4. To determine the wavelength of light using Newton's ring experiment
5. To study the charging and discharging of capacitors.
6. To study filters in power supply.
7. To determine the value of "g" using simple pendulum.
8. To study LCR circuits in series and parallel.
9. To study thermal expansion in solids
10. To determine the value of "g" using compound pendulum
11. To verify the Biot Savart's law.
12. To determine the Cauchy's constant.

** Any 10 experiments will be conducted relevant to theory course.

COURSE OUTCOMES

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

CO1 : Interpret experimental data from Vernier callipers, spectrometers, etc., to determine least count.
CO2 : Understand principles of precision measuring instruments and optical fibers, including their applications and limitations.
CO3 : Explain theory behind Newton's ring experiment, photoconductivity, capacitor behavior, and filter operation.
CO4 : Critically evaluate experimental data, identify errors, and propose improvements.
CO5 : Determine the acceleration due to gravity ('g') using experimental data and mathematical analysis.
CO6 : Develop skills in experimental design, data collection, analysis, and interpretation.

TEXT/REFERENCE BOOKS

1. B B Laud, "**Electromagnetism"**, Wiley eastern limited.
2. K. K. Tiwari, "**Electricity and Magenetism with Electronics",** S. Chand & Company Ltd.
3. Brij lal and N Subramaniyam, "**Heat and Thermodynamics"**, S. Chand & Company Ltd.
4. Brij lal and N Subramaniyam, **"Optics"**, S. Chand & Company Ltd.
5. Arthur Beiser, **"Concepts of modern Physics",** Tata McGraw Hill.
6. Walter Fox Smith, **"Experimental Physics Principles and Practice for the Laboratory",** CRC Press.

24BSC106T					Fundamentals of Biotechnology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Students should able to understand the definition, history, importance and modern developments in biotechnology.
2. Students should understand the structure, classification and physiological importance of cell, their evolution & classification.
3. Students should understand about Molecular biology comprises of DNA, RNA & their biotechnology aspects.
4. Students should able to understand the importance of biotechnology & its current need & application

Unit I:- INTRODUCTION TO BIOTECHNOLOGY Hours:-10

History of Earth, Theories of origin of life, Millers experiment, Cell Theory, Cell differentiation, Levels of organization, Nature of the earliest organisms, Evolution of Prokaryotes, Eukaryotes, Mitochondria and Chloroplast Quest for extra-terrestrial life Whittaker's five-kingdom classification.

Unit II:- ANIMAL & PLANT BIOTECHNOLOGY Hours:- 10

Plant tissue culture techniques, in vitro pollination and fertilization, embryo culture and its applications.
Basic techniques in animal cell culture and organ culture, cell lineand isolation of cell line, culture media, contaminations and their laboratory management, cell fusion, cell differentiation and growth of cultured cells, bioreactors for large scale culture of cells.

Unit III:- MOLECULAR GENETICS Hours:- 10

Isolation and Purification of DNA, Chemical synthesis of DNA and Sequencing, Recombinant DNA techniques, Types of vectors, Gene cloning, Restrictions enzymes, Introduction of DNA/Gene into living cell, PCR system and gene amplification, Blotting techniques, RFLP and DNA fingerprinting, Applications in present perspective, Human genome Project, Gene therapy, Microarrays.

Unit IV:- COMMERCIAL APPLICATIONS OF BIOTECHNOLOGY Hours:- 10

Moving Science from the Laboratory into Society-Risks and Regulations -Health Care Applications -Medical Biotechnology in Society - Biotechnology in the Food Industry-Ecology and Evolution in Agriculture-Biotechnology and Sustainable Agriculture-Environmental Sustainability and Biotechnology

Total 40 hours

COURSE OUTCOMES

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

CO1 :
CO2 :
CO3 :
CO4 :
CO5 :
CO6 :

TEXT/REFERENCE BOOKS

1. Biology and Biotechnology: Science, Applications, and Issues, Helen Kreuzer and Adrianne Massey, ASM Press, 2005.
2. The Cell: A molecular approach by Geoffrey M.Cooper.ASM Press, 2007.
3.Cowan K and KP Talaro (2009) Microbiology: A Systems Approach, (2nd Edn), McGraw-Hill

24GSS102T					Leadership and Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop Self-awareness, and strong communication skills
2. To help build relationships and avoid conflict
3. To enhance decision-making skills
4. To understand the group process and effectiveness
5.

Unit 1 **07 Hours**

Who is a Leader? Difference between Leadership and Management.

Unit 2 **07 Hours**

Leadership Theories, Trait theory, behavioral theory, Transformational Leaders

Unit 3 **07 Hours**

Change Management and Decision Making

Unit 4 **07 Hours**

Managing Groups and Teams

Difference between group and team, Managing diversity, Group size, group formation

TOTAL HOURS: 28 Hrs.

COURSE OUTCOMES

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

CO1 : **Develop** a working definition and a distinction between management and leadership.
CO2 : **Apply** Kurt Lewin's leadership typology to identify leadership styles of contemporary leaders.
CO3 : **Differentiate** leadership styles of leaders from their personal traits.
CO4 : **Assess** the role of environment, such as athletics, business, and politics, in shaping leadership.
CO5 : **Analyze** the impact of situations on leadership effectiveness.
CO6 : **Describe** the skills associated with effective leadership.

TEXT/REFERENCE BOOKS

1. Northouse, P. G. (2018). Leadership: Theory and practice. Sage publications.
2. You Are the Team: 6 Simple Ways Teammates Can Go From Good to Great – Michael Rogers
3. Leaders Eat Last: Why Some Teams Pull Together and Others Don't – Simon Sinek
4. Leadership Theory and Practice: Peter G Northhouse, Sage Publication.

24ENGS103T					Foreign Language I (FRENCH)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To make students capable of giving and taking information on one's accommodation
2. To know cities, public places and to know articles, prepositions with the same
3. To form and understand negation
4. To speak about one's professions, hobbies, and dreams
5. To speak about one's family and to describe a person
6. To explain health problems
7. To indicate time and duration
8. To understand the difference between the sounds [e] and [ə], [e] and [ɛ] & the nasal sounds [ɑ̃] [ə] [ɔ̃]

UNIT 1 Knowing French language **7 Hrs.**

French definite and indefinite articles, demonstrative adjectives, verbs of preferences (to like, to adore, to hate) and sentence formation with the same

UNIT 2 Convey information on places, time and transport **7 Hrs.**

To use prepositions of places with countries, cities, and public places and the usage of the verb "to come" and "to go" with "the article contractés", To be able to understand time and hence be capable of indicating duration, describing one's routine, also a travel programme.

UNIT 3 To talk about one's family and describe a person **7 Hrs.**

To give information about one's family and describe a person using physical and psychological adjectives and to understand the difference of gender and singular or plural

UNIT 4 To convey details relating to health problems **7 Hrs.**

To understand, pronounce as well as use in sentences the vocabulary relating to body, health problems and different doctors

TOTAL HOURS: 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Identify More Complex French structures, different pronunciations, and related reading skills
CO2 : Identify and be able to use complex French grammar
CO3 : Identify & Explore French Hobbies, Sports, Movies, Music, and Culture.
CO4 : Solve the French Grammar Complex form of Verbs, Adverbs, Adjectives, Articles, and connecters.
CO5 : Get used gradually to complex grammar easily in day-to-day life
CO6 : Identify More Complex French structures, different pronunciations, and related reading skills

TEXT/REFERENCE BOOKS

1. Saison 1 A1 Plus and Saison A2 plus by Marie Noeille Cocton

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration:3 Hrs**

Part A/Question: 10 questions of 2 marks each with internal choice 20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice 80 Marks

24BSC201T					Inorganic Chemistry II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

6. To understand the concepts of coordination compounds and their properties.
7. To relate isomerism, reactivity and stability of coordination compounds to their structure.
8. To assimilate the concepts of structure and bonding in coordination compounds.
9. To predict variation in properties in the coordination compounds and realize applications.

UNIT I: INTRODUCTION TO COORDINATION CHEMISTRY **10 Hrs.**

Double salts and coordination compounds, Werner's theory, more recent methods of studying complex, Effective atomic number, Shape of d-orbital, nomenclature of coordination compounds.

UNIT II: ISOMERISM, REACTIVITY AND STABILITY **10 Hrs.**

Determination of configuration of cis- and trans-isomers by chemical methods; Spectrochemical series of ligands, Labile and inert complexes, substitution reaction on square planar complexes, trans effect (examples and applications); Stability constants of coordination compounds and theirimportance in inorganic analysis.

UNIT III: STRUCTURE AND BONDING **11 Hrs.**

VB description and its limitation; elementary crystal field theory; splitting of d^n configuration in octahedral, square planar and tetrahedral fields; Crystal field stabilization energy in weak and strong fields; pairing energy; Jahn-Tellar distortion; Metal-ligand bonding (MO concept-elementary idea), sigma- and pi- bonding in octahedral complexes (qualitative pictorial approach).

UNIT IV: MAGNETISM AND COLOR **11 Hrs.**

Orbital and spin magnetic moments, spin only moments of d^n ions and their correlation with effective magnetic moments, including orbital contribution; quenching of magnetic moments; super-exchange and anti-ferromagnetic interactions (elementary idea with examples only); d-d transitions; L-S coupling; qualitative Orgel diagrams for $3d^1$-$3d^9$ ions and their spectroscopic ground states; selection rules for electronic spectral transitions; spectrochemical series of ligands, charge transfer complex (elementary idea).

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts in coordination chemistry
CO2 : **Comprehend** isomerism in coordination compounds, their reactions
CO3 : **Apply** theories such as CFT and MOT to predict molecular structure and properties
CO4 : **Analyze** spectroscopy, color and magnetism of coordination compounds
CO5 : **Elucidate** the chemistry of coordination compounds and infer their relevance in industry
CO6 : **Appreciate** the importance of coordination compounds and their uses in chemical industry

TEXT/REFERENCE BOOKS

1. J. D. Lee; "Concise Inorganic Chemistry" Oxford University Press.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, "Inorganic Chemistry: Principles of Structure and Reactivity", Pearson Publishers.
3. D. F. Shriver, P. W. Atkins and C. H. Langford; "Inorganic Chemistry", Oxford University Press, New York.
4. F. A. Cotton, G. Wilkinson, C. M. Murillo and M. Bochmann; "Advanced Inorganic Chemistry", Wiley Publications.

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

~~Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks~~
~~Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks~~

24BSC201P					Inorganic Chemistry Lab – II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To comprehend the theoretical knowledge of Inorganic chemistry into practical application.
2. To train and appraise about the skill for quantitative estimation of inorganic compounds.
3. To develop the skills for synthesis of pure inorganic complexes and their crystals.
4. To ascertain good and safe laboratory practices.

LIST OF EXPERIMENTS

1 Quantitative estimation of Ni^{2+} as Ni-dimethyl glyoxime.
2 Preparation of cuprous chloride.
3 To prepare pure crystals of Tetra amine copper (II) sulphate.
4 Determination of amount of Ferrous iron in Mohr's salt by titration against standard $KMNO_4$ solution.
5 Estimation of copper in a given solution.
6 Preparation of Prussian blue from iron fillings.
7 To prepare pure crystals of chrome alum.
8 Estimation of Barium in a salt solution.
9 To determine the percentage purity of the given sample of $MgSO_4.7H_2O$ and also determine the percentage of magnesium in it byprovided N/20 EDTA solution.
10 Estimation of Cu(II) using standard sodium thiosulphate solution (Iodimetrically).

COURSE OUTCOMES

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

CO1 : **Articulate** the theoretical knowledge of Inorganic Chemistry in quantification & synthesis of inorganic compounds
CO2 : **Demonstrate** the skills for quantitative estimation of ions viz. Ni2+, Cu2+, Ba2+, Fe2+ in salt or solution
CO3 : **Synthesize** the metal salts and complexes
CO4 : **Formulate** the synthetic procedure for pure crystals of inorganic compounds.
CO5 : **Assess** and **evaluate** the percentage purity and percentage of Mg in a given unknown sample.
CO6 : **Develop** the aptitude for research & development in analytical and synthetic Inorganic Chemistry.

TEXT/REFERENCE BOOKS

1. Mendham, J., **Vogel's Quantitative Chemical Analysis** Sixth Edition, Pearson, 2009.
2. Svehala, G. and Sivasankar, B., **Vogel's Qualitative Inorganic Analysis**, Pearson, India, 2012.
3. Marr, G. and Rockett, B. W., **Practical Inorganic Chemistry**. John Wiley & Sons 1972.''
4. Gulati Shikha , Sharma Gulati JL and Manocha, Shagun, **Practical Inorganic Chemistry**, 1stEdn., CBS Publishers & Distributors Pvt Ltd., (2017).

SEMESTER EXAMINATION PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

~~LW (Daily lab performance plus journal maintain each 25 marks)~~ ~~50 Marks~~
~~LE (Viva-voce plus Lab examination each 25 marks)~~ ~~50 Marks~~

24BSC202T					Organic Chemistry-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the fundamentals of alkanes, alkenes and alkynes.
2. To understand the structure, properties and reactions and importance of Alcohols and Ethers.
3. To understand the basics of aldehydes and ketones
4. To learn and understand the basics of carboxylic acids and epoxides.

UNIT I: ALKANES, ALKENES, ALKYNES **11 Hrs.**

Structure of alkanes, preparation of alkanes, Wurtz reaction, Corey-House Alkane synthesis, physical properties of alkanes, chemical properties of alkanes, halogenation of alkanes: mechanism, conformations of alkanes, petroleum refining, synthetic petrol, octane number, petrochemicals,orbital structure of ethylene, preparation of alkenes, physical properties of alkenes, chemical properties of alkenes, mechanism of electrophilic addition, Markovnikov rule: mechanism, peroxide effect: mechanism, orbital structure of acetylene, acidity of acetylene and terminal alkynes, nomenclature of alkynes, preparation of alkynes, physical properties of alkynes, chemical properties of alkynes, acetylides.

UNIT II: ALCOHOLS, POLYHYDRIC ALCOHOLS, PHENOLS AND ETHERS & EPOXIDE **11 Hrs.**

Preparation, Identification of primary, secondary and tertiary alcohols; properties of alcohols, glycols and phenols mechanism manufacture of alcohol, polyhydric alcohols. Acidic nature, electrophilic substitution reactions halogenation, nitration and sulphonation, Reimer – Tiemann reaction. Structure, nomenclature, preparation of Ethers and epoxide, physical and chemical properties of ethers, diethyl ether and crown ether, reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4.

UNIT III: ALDEHYDE AND KETONES **10 Hrs.**

Nature of carbonyl group; Nucleophilic addition to >C=O group, relative reactivities of aldehydes and ketones; Important reactions such addition reactions (addition of HCN, NH3 and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen hydrogen, aldol condensation, Cannizzaro reaction, Hatoform reaction; Chemical tests to distinguish between aldehydes and Ketones.

UNIT IV: CARBOXYLIC ACIDS AND THEIR DERIVATIVES **10 Hrs.**

General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Type dicarboxylic acids, hydroxyl acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comp nucleophilicsustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reform Hofmann- bromamide degradation and Curtius rearrangement..

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: **Comprehend** the fundamentals of alkanes, alkenes and alkynes.

CO2: **Understand** the structure, properties and reactions and importance of Alcohols and Ethers.

CO3: **Analyse** structure, properties and reactions and importance of Alcohols and Ethers.

CO4: **Implement** the basics of aldehydes and ketones

CO5: **Elucidate** (Interpret) structure, properties and reactions and importance of carboxylic acids and its derivatives.

CO6: **Apply** the concepts reaction and their mechanism

TEXT/REFERENCE BOOKS

1. R. T. Morrison, R. N. Boyd, **"Organic Chemistry"**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. I. L. Finar, **"Organic Chemistry (Volume 1)"**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. T.W. Graham Solomons, **"Organic Chemistry"**, John Wiley & Sons, Inc.

SEMESTER EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

24BSC202P					Organic Chemistry-II Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	

COURSE OBJECTIVES

1. List of laboratory techniques
2. Extend theoretical knowledge of Organic Chemistry into practical application.
3. Utilizations of separation techniques for purification.
4. Analyse different types of organic compounds in the form of simple drugs
5. Measures for good and safe laboratory practices.

LIST OF EXPERIMENTS

1. Neutralization Equivalent test for the determination of the molecular weight of your unknown and the number of carboxylic acids present in the unknown.
2. Iodoform test to determine the establishment of alcohol or a ketone.
3 Thin layer chromatography of plant pigments (spinach extraction and identification of component mixture by TLC) (1 slot)
4 Separation, purification and identification (by m.p, IR and UV) of the components of a binary mixture (2 slot)
5 Organic synthesis/derivative and identification by spectroscopy technique (2 slot)
6 Introduction to the laboratory techniques: Fractional distillation (conventional and using rotary evaporator), Recrystallization, Drying of organic solvents.
7 Determination of melting point using visual melting point apparatus
8 Introduction to GLP and safety: Basics of Good laboratory practices and safety concepts
9 Extraction of Natural product Caffeine from Tea leaves
10 Preparation of Dibenzalacetone from acetone.

COURSE OUTCOMES

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

CO1 : **List** of laboratory technique

CO2 : **Extend** theoretical knowledge of Organic Chemistry into practical application.

CO3 : **Utilizations** of separation techniques for purification.

CO4 : **Analyse** different types of organic compounds in the form of simple drugs

CO5 : **Measures** for good and safe laboratory practices.

CO6 : **Modified** synthesis for dyes drug.

TEXT/REFERENCE BOOKS

1. I. Vogel., **"A text book of practical organic chemistry",** ACS Publishers.
2. Mann and Saunders. **"Practical organic chemistry"** British Library Cataloguing in Publication Data.
3. H. T. Clarke., **"A handbook of quantitative and qualitative analysis"**, Digital Library of India Item.
4. Blat,"**Organic Synthesis Collective Volumes"**, ACS Publishers.

SEMESTER EXAM PATTERN

Max Marks 100 **Exam Duration: 3 Hrs.**

24BSC203T					Heterogeneous Catalysis (Elective))					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts, principles and mechanism of catalysis.
2. To learn the features of solid heterogeneous catalysts.
3. To learn the basic concepts of physicochemical characterization methods.
4. To understand application of catalysts.

UNIT I: INTRODICTION **10 Hrs.**

Introduction - Types of Catalysis, Industrial Importance of Catalysis, History of Catalysis; Principles and Concepts - Sabatier's Principle, Active Sites, Surface Coordination Chemistry, Modifiers and Promoters, Active Phase - Support Interactions, Spillover Phenomena, Shape- Selectivity Concept, Catalytic Cycle.

UNIT II: SOLID CATALYSTS **10 Hrs.**

Development of Solid Catalysts, Classification of Solid Catalysts Unsupported (Bulk) Catalysts - Metal Oxides, Metals and Metal Alloys, Carbides and Nitrides, Carbons, Ion-Exchange Resins and Molecularly Imprinted Catalysts, Metal – Organic Frameworks Metal Salts. Supported Catalysts - Supports, Metal Oxide Catalysts, Surface-Modified Oxides, Metal Catalysts, Sulfide Catalysts, Hybrid Catalysts, Ship- in-a-Bottle Catalysts, Polymerization Catalysts Zeolitic Materials – Composition, Synthesis, Zeolite catalysis, Isomorphously substituted zeolites, Mesoporous molecular sieves.

UNIT III: CHARACTERIZATION **10 Hrs.**

Physical Properties - Surface Area and Particle Size and Dispersion, Structure and Morphology, Chemical Properties – Surface Chemical Composition, Valence States and Redox Properties, Acidity and Basicity Mechanical Properties – Bulk density, Crush Strength, Abrasion and Attrition Resistance, etc.

UNIT IV: APPLICATION **10 Hrs.**

Catalytic Reactors - Classification of Reactors, Laboratory Reactors, Industrial Reactors, Reactor Types and Processes. Catalyst Deactivation

and Regeneration. Industrial Application of Catalysis - Synthesis Gas and Hydrogen, Ammonia Synthesis, Fischer-Tropsch Synthesis, Petroleum and related Hydrocarbon Transformations, Environmental Catalysis - Catalytic Reduction of Nitrogen Oxides from stationary Sources, Automotive Exhaust Catalysis, Catalytic application of zeolites and related materials.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts of heterogeneous catalysis.
CO2 : **Understand** different methods of catalyst preparation and formation.
CO3 : **Interpret** mechanism of catalysis by different models.
CO4 : **Conceptualize** the basic need of heterogeneous catalysis.
CO5 : **Analyse** the physico-chemical properties of solid catalysts.
CO6 : **Elucidate** the application of heterogeneous catalysis in chemical industries.

TEXT/REFERENCE BOOKS

1. DK Chakrabarty & B Viswanathan**, Heterogeneous Catalysis**, New Age International Publishers.
2. Charles N. Satterfield, **Heterogeneous Catalysis in Industrial Practice**, 2nd ed McGraw-Hill Book Company.
3. Bruce E Leach, **Applied Industrial Catalysis**, Volume 1, Academic Press.
4. Roger Arthur Sheldon, Isabel Arends. **Green Chemistry and Catalysis**

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 10 questions of 2 marks each with internal choice	20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice	80 Marks

24BSC204T					Supramolecular Chemistry(Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge about types of supramolecules and structure.
2. Analyse the different weak interactions that are exist within the framework.
3. Understand the structural feature dictate different properties i.e. devices developed.
4. Comprehend the supramolecular in biological aspects.

UNIT 1 CONCEPTS OF SUPRAMOLECULAR CHEMISTRY **06 Hrs.**

Definition, nature of supramolecular interactions, host-guest interaction, molecular recognition, types of recognition, receptor design, principles of assembly, porphyrin and other tetrapyrrollic macrocycles, coenzymes, neurotransmitters, DNA and biochemical self-assembly.

UNIT 2 SUPRAMOLECULAR INTERACTIONS **14 Hrs.**

Concepts, ion-ion interactions; ion-dipole interactions; dipole-dipole interactions; hydrogen bonding; cation-π-interactions; π-π-interactions; van derwaals interactions; hydrophobic effect; metal-coordination bonds, cation receptors, crown ethers, cryptands, spherands, calixarens, siderophores, cyclophanes, cyclodextrins, catenanes and rotaxanes, selectivity of cation complexation, macrocyclic and template effects.

UNIT 3 APPLICATIONS OF SUPRAMOLECULAR CHEMISTRY **12 Hrs.**

Rational Design, molecular maneling, supramolecular reactivity and catalysis, nanoscience applications. crystal engineering of hydrogen bonded and metal-organic framework solids, molecular electronic devices, molecular wires, molecular rectifiers, molecular switches and molecular logic gates, examples of recent developments in supramolecular chemistry from current literature.

UNIT 4 SUPRAMOLECULAR CHEMISTRY IN BIOLOGY **08 Hrs.**

Membranes, macrocyclic systems, photosynthesis, oxygen transport, biological mimics, enzymes, metallobiosites, heme analogues, transportation of anions and cations across transmembrane channels.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1– Understand the basic concept of supramolecular chemistry.

CO2– Comprehand the structural property relationship i.e. molecular recognition, molecular separation etc. CO3– Analysis the supramolecular structure in solid and solution by using modern spectroscopic techniques. CO4– Molecular recognition and nature of bindings involved in biological systems.

CO5– Applications of supramolecules in miniaturization of molecular devices.

CO6– Create a new molecular architecture on the basis of basic supramolecular polymer.

TEXT/REFERENCE BOOKS

1. J. M. Lehn, Supramolecular Chemistry, Concepts and Perspectives, VCH, 1995.
2. H. Dodziuk, Introduction to Supramolecular Chemistry, Kluwer Academic, 2002.
3. F. Vogtle, Supramolecular Chemistry, An Introduction, John Wiley & Sons, 1991.
4. J. W. Steed, J. L. Atwood, Supramolecular Chemistry, A Concise Introduction, John Wiley, 2000.
5. A. Bianchi, K. B. James, E. G. Espana, Supramolecular Chemistry of Anions, Wiley-VCH, 1997.
6. M. Fujita, Molecular Self-assembly, Organic Versus Inorganic Approaches, Springer, 2000..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration:3 Hrs**

Part A/Question: 10 questions of 2 marks each with internal choice 20 Marks

Part B/Question: 8 questions of 10 marks each with internal choice 80 Marks

24PHS201T					Introduction to Modern Physics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the fundamental understanding of Materials
- To provide the knowledge of thermal and magnetic properties of solid materials
- To provide the understanding of electrical conduction in solids and devices

UNIT 1 ATOMIC SPECTROSCOPY **15 Hrs.**

Basics of Quantum Physics: Postulates and operators. Introduction to hydrogen atom spectrum, Bohr Magneton Larmor's precession, Stern Gerlach experiment, Electron Spin and gyro magnetic ratio, Vector atom model, spin orbit interaction and fine structure, total angular momentum for many e atom; L-S & J-J coupling(in brief), Zeeman Effect and Stark Effect

UNIT 2 CRYSTALLOGRAPHY **13 Hrs.**

Crystalline and amorphous solids-Fundamental crystallographic parameters-primitives-inter Facial or interaxial angles-Bravais lattices and crystal systems-Miller indices-Characteristics of unit cell-Simple cubic, BCC and FCC structures-Atomic radius-Co-ordination number-Hexagonal close-packed structure-Number of atoms per unit cell-continuous and characteristic x-rays-X-ray diffraction and Bragg's law in crystals. Problem solving.

UNIT 3 BASIC ANALYTICAL INSTRUMENTATION **15 Hrs.**

Classification of analytical methods - Spectroscopic Characterizations: Introduction to Spectroscopic Techniques - UV-Vis Infra-Red and FTIR, AAS, NMR Spectroscopy, X-ray Diffraction (XRD). Microscopic Characterizations: Basic principle, Electron -matter interaction. Instrumentation and Applications of SEM, TEM and AFM. Thermal Characterization: The basis of thermal analysis-DTA, DSC and TGA.

UNIT 4 PHYSICS OF NANOMATERIALS **13 Hrs.**

Nanoscale-Surface to volume ratio- Quantum Size effect- Electron confinement - one two and three dimensional Nanoparticles - Properties of Nanomaterials - Disadvantages of Nanomaterials - Carbon Nano Tubes(CNT) - structure of CNT - Synthesis of CNT - Arc Discharge Method - Pulsed Laser Deposition CVD- Properties of CNT- Applications of CNT.

Max. 56 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand of atomic structure and crystal structure.

CO2 - Develop the knowledge of solid imperfections and their thermal behaviour.

CO3 - Explain the thermal and magnetic properties of materials

CO4 - Correlate and apply the obtained knowledge to understand and evaluate the material's electrical properties.

CO5 – Develop a fundamental understanding of the basic phenomenon of materials.

CO6 - Develop the skills in solving various real-world problems in material science and engineering aspects.

TEXT/REFERENCE BOOKS

1. V. Raghavan, "**Materials Science and Engineering**", Prentice-Hall of India Private Limited (2015).
2. W.F. Smith, "**Principles of Materials Science and Engineering**", McGraw Hill, New York (1995).
3. W.D.Callister, "**An Introduction to Materials Science & Engineering**", John Wiley & Sons (2013).
4. L.H. Van Vlack, "**Elements of Materials Science and Engineering**", Addison Wisley, New York (2002).
5. J.F. Shackelford and M.K. Muralidhara, "**Introduction to Materials Science for engineers**", Pearson Education (2017).
6. S. O. Pillai. "**Solid State Physics**", NEW Age internationl publishers (2022)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Part A: 10 Questions each carrying 5 marks	50 Marks
Part B: 5 Questions each carrying 10 marks	50 Marks

24BSC206T					Analytical Chemistry II					
Teaching Scheme					Examination Scheme					
L					T					
L	T	P	C	Hrs/Week	Theory			Practical		Total
3	0	0	3	3	MS	ES	IA	LW	LE/Viva	Marks

COURSE OBJECTIVES

1. Gaining the factual knowledge of surface analysis techniques.
2. Acquiring basic principles applied for spectroscopic measurements.
3. Learning the fundamental principal of various thermal techniques.
4. Attaining necessary basic knowledge of chromatographic separation and difference in various kind of chromatographic techniques.
5. Learning the basic instrumentations of various analytical techniques comprising instruments used in surface analysis, spectroscopic analysis, thermal analysis and chromatographic analysis.
6. Acquiring in-depth knowledge about various electrochemical techniques.

UNIT I: SURFACE ANALYSIS **10 Hrs.**

Optical Microscopy, Electron Microscopy-Principles of electron microscopy, instrumentation, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy.

BET surface area technique- Brunauer-Emmett-Teller (BET) theory, the physical adsorption of gas molecules on a solid surface, measurement of the specific surface area of materials.

UNIT II: Optical and Diffraction Techniques **11 Hrs.**

Principles of Diffraction- Origin of X-Ray Spectra, Energy Levels in Atoms, Moseley's Law, X-Ray Methods, X-Ray Absorption Process, X-Ray Fluorescence Process, X-Ray Diffraction Process.

X-Ray Diffraction- Single-Crystal X-Ray Diffractometry, Crystal Structure Determination, Powder X-Ray Diffractometry, Applications of XRD, Analytical Limitations of XRD.

X-Ray Photoelectron Spectroscopy- Basics principles of XPS, application of XPS.

Infra-red Spectroscopy- Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques.

Raman Spectroscopy- Principles of Raman Scattering, Raman Instrumentation, Applications of Raman Spectroscopy.

Ultra-violet and Visible Spectroscopy- Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principles of quantitative analysis. Application of UV in various industries.

UNIT III: THERMAL TECHNIQUES **10 Hrs.**

Thermogravimetry- TGA Instrumentation, Analytical Applications of Thermogravimetry, Derivative Thermogravimetry, Sources of Error in Thermogravimetry

Differential Thermal Analysis- DTA Instrumentation, Analytical Applications of DTA

Differential Scanning Calorimetry- Basics principles of DSC, Difference between DSC and DTA, DSC Instrumentation, Applications of DSC.

UNIT IV: Electrochemical Techniques **11 Hrs.**

Electrochemical Techniques: introduction, simple measurement and cell impedance, electrochemical impedance spectroscopy: introduction, instrumentation, conditions of measurement, measurement of resistance and capacitance, applications.

Accyclic voltammetry: Introduction, chemical analysis by ac voltammetry, applications.

Diffuse Reflectance Spectroscopy: Principle, instrumentation, band gap analysis, and applications.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Learn** the theoretical aspects of X-ray and can differentiate various X-ray instrumentation techniques for material characterization.
CO2 : **Explain** the working principal of thermal analysis.
CO3 : **Develop** the understanding on the principal of microscopy and surface analysis and will be able to explain the working mechanism of electron microscopy.
CO4 : **Construct** a deep sense of understanding on the technique to analyze surface area and can differentiate between topographic techniques and surface area analysis.
CO5 : **Perceive** the knowledge on the theoretical aspects of X-ray and can differentiate various X-ray instrumentation techniques for material characterization.
CO6 : **Develop** understanding in applying, and interpreting electrochemical measurements.

TEXT/REFERENCE BOOKS

1. Vogel, Arthur I, **"A Test book of Quantitative Inorganic Analysis"** (Rev. by G.H. Jeffery and others) 5th Ed, The English Language Book Society of Longman.
2. Willard, Hobert H. et al., **"Instrumental Methods of Analysis"**, 7th Ed., Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D, **"Analytical Chemistry"**, 6th Ed., John Wiley & Sons, New York, 2004.
4. Harris, Daniel C, **"Exploring Chemical Analysis"**, New York, W.H. Freeman, 2001.
5. Robinson, James W., Eileen Skelly Frame, and George M. Frame II., **"Undergraduate instrumental analysis"**, CRC press, 2014.
6. Srivastava. A.K. and. Jain, P.C, **"Instrumental Approach to Chemical Analysis"**, 4th Edition, S Chand and Company Ltd, New Delhi, 2012.
7. Chatwal. G. R., Anand, Sham K., **"Instrumental Methods of Chemical Analysis"** 5th Edition, Himalaya Publishing House, 2005.
8. Bard, Allen J., Larry R. Faulkner, and Henry S. White. **"Electrochemical methods: fundamentals and applications"**, John Wiley & Sons, 2022.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs.
Part A/Question: 10 multiple choice questions 1 mark each	10 Marks
Part B/Question: 10 Questions of 2 marks each with internal choice	20 Marks
Part C/Question: 4 Questions of 15 marks each with internal choice	60 Marks
Part D/Question: 1 Questions of 10 marks comprising a figure of an instrument for labelling and identifying its various parts	10 Marks

24BSC206P					Analytical Chemistry Lab-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

5. To prepare and standardize analytical solutions and quantitatively determine metal ions using volumetric techniques.
6. To perform complexometric, redox, precipitation, and back-titration methods for quantitative chemical analysis.
7. To investigate chemical kinetics and equilibrium behavior through iodination reactions and partition coefficient studies.
8. To analyze environmental and unknown samples accurately while following laboratory safety practices and proper data interpretation methods.

LIST OF EXPERIMENTS

1 Preparation of standard $ZnSO_4$ solution, standardization of EDTA solution and determination of Zn^{2+} in the given solution.
2 Determination of copper in crystallised copper sulphate.
3 Estimation of NH_4Cl and NH_3 in the polluted water sample.
4 Volumetric analysis of given sample of Brass alloys.
5 To estimate the amount of Mg^{2+} from unknown solution.
6 Kinetic study the Iodination of Acetone.
7 Determine experimentally the partition coefficient of I_2 in CCl_4 and water.
8 Estimation of Fe (II) and oxalic acid using standardized $KMNO_4$ solution.
9 Determination of Aluminium in a given solution by EDTA Back Titration.
10 Identification of given compound using ^1H NMR Spectroscopy

COURSE OUTCOMES

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

CO1 : Recall the principles, reactions, and indicators used in volumetric and physico-chemical analysis.
CO2 : Explain the chemistry behind complexometric, redox, precipitation, and back-titration methods.
CO3 : Prepare and standardize solutions and apply titrimetric techniques to determine metal ions and analytes.
CO4 : Analyze experimental data to calculate concentrations, partition coefficients, and reaction rates.
CO5 : Evaluate accuracy, precision, and experimental errors in the analysis of alloys, salts, and environmental samples.
CO6 : Design and perform analytical experiments for unknown samples following safety and good laboratory practices.

TEXT/REFERENCE BOOKS

3. Vogel's text book of quantitative chemical analysis (5^{th} edition).
4. Vogel's Textbook of quantitative inorganic analysis (4^{th} edition).

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
LW (Daily lab performance plus journal maintain each 25 marks)	50 Marks
LE (Viva-voce plus Lab examination each 25 marks)	50 Marks

24BSC207T					Physical Chemistry II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the kinetics and mechanism of chemical reactions, different models of kinetics.
2. To learn the theory of reaction rates with reaction mechanisms.
3. To learn the fundamentals of heterogeneous catalysis.
4. To understand the basic concepts of different methods of catalyst preparation and characterization.

UNIT I: SOLUTIONS AND COLLIGATIVE PROPERTIES	**8 Hrs.**
Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications; 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. Applications in calculating molar masses of normal, dissociated and associated solutes in solution	
UNIT II: CHEMICAL KINETICS	**14 Hrs.**
Rate of reactions, rate law, order, molecularity, Integrated rate laws: zero order reactions, First order reactions, Second order reactions, Third order reactions, Rate law for nth order reaction, Pseudo-unimolecular reactions, Half life time; Methods of determination of order of a reaction, Factors affecting the rate of a reaction. Types of Chemical Reactions, Collision theory, collision requirements, Energy of Activation, Factors that cause more collisions, Collision frequency, Transition state theory, Potential-Energy Diagrams for Reactions, Collision Theory and the Arrhenius Equation, Reaction Mechanisms, Elementary Reactions, Rate determining step.	
UNIT III: CATALYSIS – FUNDAMENTAL	**10 Hrs.**
Theory of catalysis, Acid base catalysis, Homogeneous and Heterogeneous Catalysis, Biocatalysis, Positive catalyst, Negative catalyst, Catalyst promoters, Catalyst poisons, Auto Catalyst. Different methods of catalyst preparation	
UNIT IV: CATALYSIS – INDUSTRIAL APPLICATION	**10 Hrs.**
Catalyst Characterization - Surface area measurements, BET Theory, Pore size distribution, Porosimetry Chemisorption techniques, Crystallography and surface analysis techniques, XRD, XPS, NMR, Surface acidity and Activity, Life time, Bulk density, Thermal stability. Industrial applications of catalyst, Catalysts in Petroleum Refining, Catalytic converter	
	TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts of heterogeneous catalysis
CO2 : **Understand** chemical kinetics and its application to find rate, order and molecularity.
CO3 : **Analyse** and correlate the physicochemical properties of catalysts.
CO4 : **Conceptualize** the basic need of homogeneous and heterogeneous catalysis.
CO5 : **Have** depth knowledge of industrial applications of catalysis in industry
CO6 : **Elucidate** the mechanism of catalysis with the help of knowledge of characterization techniques.

TEXT/REFERENCE BOOKS

1. Charles N Shatterfield, **Heterogeneous Catalysis in Industrial Practice**, , Krieger Publishing, 2nd Edn. 1996
2. K. J. Laidler, **Chemical Kinetics**, 3rd edition, , Pearson India
3. Peter Atkins, Julio De Paula, **Physical Chemistry**, 9th edition, , Oxford University Press
4. A. Bahl, B.S. Bahl, G.D. Tuli, **Essentials of Physical Chemistry**, S Chand Publication

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 10 questions of 2 marks each with internal choice	20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice	80 Marks

24BSC207P					Physical Chemistry Lab- II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand the working principle of pH meter, conductivity meter and potentiometer
2. To learn titrimetric method for chemical analysis
3. To learn the basic concepts of buffer solution and pKa
4. To understand the basic concepts adsorption and chemical kinetics.
5. To know the significance of analytical chemistry in qualitative and quantitative analysis

LIST OF EXPERIMENTS

1 To determine the composition of mixture of acids by Conductometrically.
2 Determination of pKa values of orthophosphoric acid using pH meter.
3 Determination of pH of a buffer solution by colour matching of indicator.
4 Potentiometric titration of a standard solution of KCl against $AgNO_3$ solution.
5 Study of chemical kinetics of Methyl acetate ester (acid) hydrolysis.
6 To determine the concentration of HCl + CH_3COOH + $CuSO_4$ by Conductometrically
7 To determine the concentration and dissociation constants of a dibasic acid (oxalic acid).
8 To determine the normality and dissociation constant of the given acid.
9 To determine the concentration of each halide in the mixture of halides by potentiometric titration with $AgNO_3$
10 To determine the heat and entropy of vaporization of a given liquid by kinetic approach.
11 To determine the partial molar volume and the composition of unknown mixture of ethanol/methanol and water.
12 To determine the concentration of an unknown solution of optically active compound
13 Find out the amount of Ni+2 in the given solution by colourimetry method.
14 Find out the amount of Fe+3 in the given solution by colourimetry method.

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

CO1 : **Understand** the use of different instrumental techniques such as pH, conductivity & potentiometers.
CO2 : **Interpret** the results obtained from the instrumental techniques.
CO3 : **Conceptualize** the analytical methods for chemical applications.
CO4 : **Analyse** the interaction of materials present in ionic medium.
CO5 : **Analyse** and demonstrate the applications of analytical tools in chemical industry.
CO6 : **Elucidate** the ionic behaviour of different solutions with the knowledge of physico-analytical methods.

TEXT/REFERENCE BOOKS

1. P S Sindhu, **Practicals in Physical Chemistry**, Macmillan, 2005.
2. J. M. Wilson, R. J. Newcombe, A. R. Denaro, **Experiments in Physical Chemistry** 2nd Edition, Pergamon Press.
3.

Semester Exam Pattern

Max Marks 100	Exam Duration
Lab Exam	50
Lab work	50

24BSC208T					ENVIRONMENTAL CHEMISTRY (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the fundamentals concepts of environmental chemistry.
2. To know about the different kinds of pollutants present in the atmosphere, hydrosphere, and lithosphere.
3. To provide understanding of chemistry of rock, soil, sediment, water, air and living organisms.
4. To provide a sound scientific background for understanding environmental problems and for monitoring, controlling, managing and cleaning up pollution.

UNIT 1 ATMOSPHERIC COMPOSITION AND PRINCIPLES OF CONTAMINANT BEHAVIOR
14 Hrs.

Concept of Environmental chemistry-Scope and importance of environment–- Natural resources – Renewable Resources – Solar and biomass energy and Nonrenewable resources – Thermal power and atomic energy – Reactions of atmospheric oxygen and hydological cycle, atmosphere of Earth, chemical speciation. chemical processes in the formation of inorganic and organic particulate matters, organic pollutants

UNIT 2 AIR POLLUTION AND AIR POLLUTION CONTROL TECHNIQUES
14 Hrs.

Definition – Sources of air pollution – Classification of air pollution – Acid rain – Photochemical smog – Green house effect – Formation and depletion of ozone Controlling methods of air pollution. Factors responsible for air pollution. Instrumental Techniques to monitor Pollution. Air pollution control Techniques, Bhopal gas disaster.

UNIT 3 WATER POLLUTION
14 Hrs.

Water quality and criteria for finding of water quality – Introduction: Ground and subsurface water contamination, – Dissolved oxygen – BOD, COD, Suspended solids, total dissolved solids, alkalinity – Hardness of water – Methods to convert temporary hard water into soft water – Methods to convert permanent hard water into soft water , Ground water pollution,: Eutrophication, Acid Mine Drains, Pesticides and Fertilizers, dye Industries, Water treatment , Supercritical water oxidation Sewage treatment Trace Contaminants.

UNIT 4 SOIL POLLUTION
14 Hrs.

Soil around us, organic and inorganic components of soil, soil-water characteristics, soil erosion, soil & pollution, Water resources: Irrigation and wetlands, Soil pollution management . Contaminants and their natural pathways of degradation and their abatement- Carbon Cycle, Nitrogen Cycle, Sulphur Cycle, Phosphorus Cycle. Nuclear waste management, solid waste management.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understanding** the basic concepts of environmental chemistry.
CO2 : **Relating** the components of natural environment and their interaction within and between them.
CO3 : **Categorizing** the different types of pollutants, their sources and sinks.
CO4 : **Explaining** the conversion of pollutants natural environment & are transferred from one component to the other.
CO5 : **Developing** knowledge about various pollution abatement technique and pollution control equipment.
CO6 : **Building** concepts about latest trend of environmental issues

TEXT/REFERENCE BOOKS

1. Manahan, E. Stanley, **"Fundamentals of Environmental Chemistry"**, CRC Press LLC, 2001
2. R. Eugene, "**Weiner Applications of Environmental Chemistry",** CRC Press, LLC, 2000

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration:3 Hrs**
Question: 10 questions of 10 marks with / without internal choice 100 Marks

24BSC209T					Petroleum Chemistry (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts of crude oil and hydrocarbon chemistry.
2. To learn the basic concepts of physico-chemical properties of crude oil.
3. To understand crude oil and catalyst characterization techniques
4. To understand the basic concepts of petroleum refining.

UNIT I: INTRODICTION **14 Hrs.**

Introduction –Origin of crude oil, basic building blocks, Major petrochemical processes & catalysts, Overview of refining process, Properties and General Characteristics of Hydrocarbon, Composition, Molecular types in Petroleum.

UNIT II: CHARACTERIZATION **14 Hrs.**

Characterization and Analytical Techniques for Crude Oil: Physical properties, Thermal properties, Electrical properties, Optical properties, Chromatographic techniques, Spectroscopic methods (Principles and Applications of UV Visible, IR, and NMR Spectroscopy), Characterization of formation water. SARA Separation methods, Metals and Heteroatoms in Heavy crude oil.

UNIT III: PHYSICAL PROCESSES **14 Hrs.**

Processing and Refining of crude oil: Physical Processes Desalting/dehydration, Crude distillation, Propane deasphalting, Solvent extraction and dewaxing, Blending.

UNIT IV: CATALYTIC PROCESSES **14 Hrs.**

Fluidized Catalytic Cracking (FCC), Hydrocracking, Reforming, Alkylation Polymerization processes, Solvent process, Knocking, Octane number and Cetane number, Additives to improve the quality of Diesel and Petrol, Catalysis and Applications of Catalysts (like Zeolite and other catalysts) in separation processes and also in petroleum industries Treatment of refinery gases.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts of petroleum and hydrocarbon chemistry.
CO2 : **Analyze** and correlate the physicochemical properties of crude oil
CO3 : **Conceptualize** the basic need of petroleum refining.
CO4 : **Elucidate** the physical processes involved during refining
CO5 : **Correlate** physical properties of hydrocarbon with its application
CO6 : **Elucidate** the industrial application of petroleum refining with the help of knowledge of characterization techniques.

TEXT/REFERENCE BOOKS

1. J.G. Speight, **The Chemistry and Technology of Petroleum**, 2014 CRC Press.
2. George A. Olah & Arpad Molnar, **Hydrocarbon Chemistry**, Wiley-Interscience, 2nd Edition May 2008.
3. J.G. Speight, **Handbook of Petroleum Product Analysis**, 2nd Edition 2015.
4. William D. McCain, **The Properties of Petroleum Fluids**, Penn Well Publication, 3rd Edition 2017.
5. H. Scott Fogler. **Elements of Chemical Reaction Engineering**, Fourth Edition,

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 10 questions of 2 marks each with internal choice	20 Marks
Part B/Question: 8 questions of 10 marks each with internal choice	80 Marks

24BSC210T					Polymers (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the fundamental understanding on polymer chemistry.
2. To provide the knowledge about structural features, synthesis, properties of various polymers
3. To develop the knowledge and skills for different characterization techniques of polymers.
4. To provide the knowledge about the role of polymers in modern engineering applications.

UNIT I: INTRODUCTION TO POLYMERS **14 Hrs.**

Introduction, Nomenclature, Types of polymerization: Addition polymerization, Condensation polymerization, ring-opening polymerization, Copolymerization and their mechanism. Classification of Polymers based on source, structure, synthesis, growth polymer chain, thermal response, tacticity, number of monomers and application; water-soluble polymers, gels and hydrogels Synthesis, properties and applications of some commercially important polymers: HDPE, LDPE, PVC, Teflon.

UNIT II: RUBBER **14 Hrs.**

Rubber, Vulcanization of rubber, Compounding of Rubber, Synthetic Rubber: Styrene rubber, Nitrile rubber, Butyl Rubber, their preparation, properties and application; Engineering Plastics: Polyamides (Nylon-6 & Nylon-6,6), Polycarbonates, Polyurethane and Teflon. Resins: Phenol-formaldehyde resin, Urea-formaldehyde resin, Epoxy resin, Melamine-formaldehyde resin, their synthesis properties and application.

UNIT III: PROPERTIES OF POLYMERS **14 Hrs.**

Conducting Polymers: Classification, Factors affecting conductivity, Preparation and application; Molecular weight of polymers and its determination: Types (M_n, M_w, M_v and M_z) and their mathematical expressions, Degree of polymerization (DP), Kinetics of polymerization. Thermodynamics of polymer solution: Polymer conformation, Glass Transition Temperature (T_g) and melting temperature (T_m) of Polymers; Plastic Processing: Molding, Extrusion, Thermoforming, Casting, Coating, Winding, Laminating; Effect of polymer properties on process technique.

UNIT IV: BIOPOLYMERS **14 Hrs.**

Polymers and Petroleum industry, Green Polymer Synthesis

Biopolymers: Types of biopolymers: Polynucleotide, Polysaccharides, Polypeptide

Biomaterials: Types of Biomaterials: Natural, Synthetic, Biodegradable, and Biocompatibility of biomaterials, Standardization of Biomaterials, Performance, Properties & application of biomaterials. Application of polymers in medicine, nanotechnology, and electronics, Characterization of Polymers: XRD, SEM, TGA-DSC, Mechanical characterization: Stress/Strain

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Identify** structural features and properties of different classes of polymers
CO2 : **Understand** other advanced polymers like biopolymers, and conducting polymers
CO3 : **Apply** the skills by understanding various instrumental techniques for characterisation of polymers
CO4 : **Classify** the key concepts in polymer chemistry viz. molecular weight, thermodynamics and kinetics and laterally ponder over the applications of such concepts in engineering challenges
CO5 : **Appraise** the important insights into the industrial application of different types of polymers via analysing mechanisms of polymerization
CO6 : **Formulate** the knowledge on the role of polymers in various modern engineering applications

TEXT/REFERENCE BOOKS

1. S. Koltzenburg, M. Maskos, O. Nuyken, **"Polymer Chemistry",** Springer
2. Charles E. Carraher Jr., **"Introduction to Polymer Chemistry",** 4th Edition, CRC Press
3. M.S. Bhatnagar, **"A textbook of polymer chemistry",** S Chand Publication
4. G. Odian, **"Principles of Polymerization",** 4th edition, John Wiley and Sons, Inc. 2004;
5. L. H. Sperling **"Introduction to Physical Polymer Science",** 4th Edition, Wiley, 2006

SEMESTER EXAM PATTERN

Max Marks 100	Duration (3 Hr
Part A/Question: 20 objective questions of 1 mark each with choice Part B/Question: 8 questions of 10 marks each with choice	**20** **80**

24BSC301T					Inorganic Chemistry III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1.To develop the concept of arranging elements in periodic table and trends for the variation of properties
2. To provide the knowledge on the physical and chemical properties of s and p block elements in the periodic table
3. To understand the feature structure and reaction mechanism of organometallic compounds
4. To provide the knowledge on the scope, diversity, and application of organometallic compounds

UNIT 1: GROUP CHEMISTRY (Hydrogen, Group-I, II, III, IV) **11 h**

Classification of elements on the basis of electronic configuration: position of s-, p-, d- and f-block elements in periodic table. Group-I: Hydrogen, physical and chemical properties, different strategies to synthesize hydrogen, hydrides; Alkali metals, physical and chemical properties, compounds like oxide, peroxide, superoxide, carbonates; Group-II: Alkaline earth metals, physical and chemical properties and important compounds like oxide, peroxide, superoxide, carbonates; Group-III: synthesis, structure bonding, properties and uses of borane, carborane, borazine, boron nitride, boric acid, borax, aluminium chloride, industrial importance of the these compounds. Group-IV: common oxidation states, inert pair effect, allotropy of carbon; properties and features of diamond, graphite, graphene, fullerene, carbon nano-tube; synthesis and properties type of silicones, carbides, Freons and depletion of ozone layer by Freon.

UNIT 2 GROUP CHEMISTRY (Group-V. VI, VII, VIII) **11 h**

Group-V: Physical and chemical properties, important compounds like nylon-6, nylon-66, phophazenes: preparation, properties, structure and bonding, different oxides of nitrogen, acid strength of different phosphorous acid. Group-VI: reactivity and properties of the different compounds belong in this group, different kind of silicate structure, variety of sulphur acid, acid rain, tetrasulphur tetranitride, polythiazyl preparation structure and properties. Group-VII: Inter-halogen compounds, hypervalent iodine compounds and their reactivity etc. Group-VIII: noble gases elements and their compounds occurrence, synthesis, properties, structure and bonding, clathrates, industrial application of thenoble gas.

UNIT 3 ORGANOMETALLIC CHEMISTRY-I **10 h**

Different types of organometallic compounds, 18 electron rule and its application, effective atomic number, metal carbonyl compounds: discrete, dimeric, trimeric, tetrameric, reactivity, synthesis, properties; Metal Carbonyls; Nitrosyls; Carbonyl Hydrides; Isolobal Analogy; Dioxygen and Dinitrogen Compounds, Metal Alkyls; Carbenes; Carbynes; Alkenes; Alkynes; and Allyl Complexes. Hydrides, Metal Arene Complexes; Carbonylate Anions.

UNIT 4 ORGANOMETALLIC CHEMISTRY-II **10 h**

Reactivity of organometallic compounds: Oxidative, Addition and Reductive Elimination; Insertion and Elimination Reactions; Homogeneous and Heterogeneous Catalysis; Metal-Metal bonding. Metallocenes; Ferrocene: synthesis, properties, reaction and application; Reaction: oxidative addition, reductive elimination, Insertion, reaction, several examples in each case and their explanation.

TOTAL HOURS: 42 h

COURSE OUTCOMES

CO1: **Relating** the concept of arranging elements in periodic table and trends for the variation of properties
CO2: **Remembering** the physical and chemical properties of s and p block elements in the periodic table
CO3: **Understanding** about the industrially important compounds of s and b block elements
CO4: **Explaining** the definition of organometallic chemistry and stability of organometallic compounds.
CO5: **Analyzing** feature structure and reaction mechanism of organometallic compounds.
CO6: **Developing** the knowledge scope, diversity, and application of organometallic compounds.

TEXT/REFERENCE BOOKS

N.N. Greenwood, A. Earnshaw, "**Chemistry of the Elements**", Elsevier
J.D. Lee, "**Concise Inorganic Chemistry"**, John Wiley & Sons, Inc., Hoboken, New Jersey
R. Sarkar, "**General and Inorganic Chemistry- Part-II**", New Central Book Agency
H. R. Crabtree, "**The Organometallic Chemistry of the Transition Metals",** John Wiley & Sons, Inc., Hoboken, New Jersey

END-SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 h**

~~Question: 10 questions of 10 marks with / without internal choice~~ ~~100 Marks~~

24BSC301P					Inorganic Chemistry Lab- III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Knowledge on safety rule while working in the laboratory
2. Developed scientific methodology for industrial and domestic use
3. Apply the knowledge for the solutions of a problems encountered in an experiment
4. Experience for the synthesis of the different inorganic complexes

LIST OF EXPERIMENTS

1 Potassium tris-oxalatoferrate(III): synthesis and spectral analysis.
2 Preparation of K2[Cu(C2O4)2].2H2O :Synthesis and spectral analysis
3 Preparation of hexamminenickel(II) chloride
4 Preparation of K3[Cr(C2O4)3].3H2O :Synthesis and spectral analysis
5 Synthesis and characterization of ferrocene and acetylferrocene.
6 Estimation of Iron(III) and Cu(II) in a mixture by titration procedure (dichromatometry and iodometry).
7 Preparation of Mohr Salt.
8 Preparation of Tetraamine Cupric Sulphate.
9 Preparation of Sodium tris(oxalate) ferrate(III) Complex.
10 Preparation of tri(thiourea) cuprous chloride.

COURSE OUTCOMES

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

CO1 : **Capable** of designing new sets of experiment.
CO2 : **Summarize** findings in writing in a clear and concise manner.
CO3 : **Critically evaluate** data collected to determine the identity, purity, and yield of products.
CO4 : **Evaluate** scientific method to create, tests, and evaluate a hypothesis.
CO5 : **Apply** synthesis technique to prepare inorganic compounds.
CO6 : **Create** a new scientific method to be use in the industrial purpose.

TEXT/REFERENCE BOOKS

1. Mendham, J.A., **Quantitative Chemical Analysis**, Pearson.
2. A. I. Vogel, **A text book of quantitative Inorganic Analysis**, ELBS
2. A.K. Nad, B. Mahapatra, A Ghosal, An Advanced Course in Practical Chemistry, New Central
4. Finar, I. L**. Organic Chemistry** (volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Max Marks 100	Exam Duration
~~Lab Work~~	~~50 marks~~
~~Lab Exam~~	~~50 marks~~

24BSC302T					Organic Chemistry-III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Name of oxidizing reducing reagents in organic chemistry
2. Explain name reactions with mechanism involved in organic synthesis
3. Develop synthesis and apply different types of reagents.
4. Function of organometallic reagents
5. Importance of intra and intermolecular rearrangements.
6. Development for current industrial reagents over regular reagents

UNIT I: NAME REACTIONS OF CARBONYL COMPOUNDS **12 Hrs.**

Clemmensen reduction, Wolff-Kishner reduction, Meerwein-Ponndorf-Verley reduction, Aldol condensation, Perkin reaction, Benzoin condensation, Benzil-Benzilic acid rearrangement, Mannich reaction, Michael addition, Darzens glycidic ester synthesis, Wittig reaction, Reformatsky, Baeyer-Villiger oxidation, Claisen condensation, Stobbe condensation, Dickmann condensation, Knoevenagel, Pinacol, Favorskii, Dienone-phenol rearrangement, Beckmann rearrangement, Wolff, Hofmann, Curtius, Schmidt, Lossen, Fries. Claisen rearrangement, Cope rearrangement, Chugaev reaction, Demjanov rearrangement, Wagner-Meerwein rearrangement, Reimer-Tiemann reaction, Jones oxidation, Swern oxidation, Birch reduction, Vilsmayer-Haack reaction, Grignard reaction, Friedel-Crafts, Diels-Alder reaction, Mitsunobu reaction, Suzuki reaction, Buchwald Hartwing reaction, Sonogashira coupling.

UNIT II: ORGANOMETAALIC COMPOUNDS **10 Hrs.**

Introduction, organomagnesium halides-Grignard Reagent, reactions of Grignard reagent, limitations, reactions of organolithiums, reactions of lithium dialkylcuprates (Gilman reagent), reduction reactions, reduction by catalytic hydrogenation, reduction by metal hydrides, oxidation reaction.

UNIT III: REARRANGEMENTS **10Hrs.**

General mechanistic considerations, nature of migration, migratory aptitude, and memory effects in respect of following. (1) Carbon to Carbon migration of R, H and Ar (i) Pinacol- Pinacolone rearrangement (ii) Favorskii rearrangement (2) Carbon to Nitrogen migrations: (i) Curtius rearrangement (ii) Schmidt rearrangement (3) Carbon to oxygen migration of and Ar (i) Baeyer- Villiger rearrangement (ii) Rearrangement of hydroperoxide.

UNIT IV: REAGENTS **10 Hrs.**

Oxidizing & Reducing agents, organometallic reagents, ylides of sulfur, phosphorous and nitrogen, Tebbe's reagent. complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide, 1,3-dithiane (reactivity Umpoloung), trimethylsilyl iodide, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, osmium tetroxide, DDQ, selenium dioxide, Phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker's Yeast.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Name** of oxidizing reducing reagents in organic chemistry

CO2 : **Explain** name reactions with mechanism involved in organic synthesis To understand the importance of basic named reaction there: synthesis, mechanism and application.

CO3 : **Develop** synthesis and apply different types of reagents.

CO4 : **Function** of organometallic reagents

CO5 : **Importance** of intra and intermolecular rearrangements.

CO6 : **Development** for current industrial reagents over regular reagents.

TEXT/REFERENCE BOOKS

1. J. March, "**Advanced Organic Chemistry: Reactions Mechanism and Structure"**, John-Wiley and Sons.
2. J. Wade and S Singh, "**Organic Chemistry"**, Pearson Edu. (LPE).
3. Clayden, Greeves, Warren and Wothers, "**Organic Chemistry"**; Oxford.
4. J. M. Coxan, "**Principles of Organic Synthesis"**, Thomson Science.
5. D. Nasipuri, "**Stereochemistry of Organic Compounds"**, Wiley India Pvt. Limited.
6. Ernest L. Eliel, "**Stereochemistry of Organic Compounds"** Wiley India Pvt. Limited.
7. P.S. Kalsi, "**Organic Reaction and their Mechanism"** Wiley India Pvt. Limited.

SEMESTER EXAM PATTERN

Max Marks 100 **Exam Duration: 3 Hrs.**

24BSC302P					Organic Chemistry-III Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	

COURSE OBJECTIVES

- List the precautionary measures while working in the in laboratory
- Explain the different types of chromatographic technique for the separation.
- Method development for Separation, purification and identification of binary mixtures
- Analyse and identification by spectroscopy technique.
- Explain the Importance of chromatography, separation and purification techniques.
- Elaborate properties of synthesized organic molecule by melting point, IR and UV.

LIST OF EXPERIMENTS

1 Detection of Functional Groups or Class Determination (eight different functional groups) (4 slot)
2 Qualitative single detection of some common organic compounds by chemical methods (10 different) (4 slot)
3 Estimation of functional groups: Alcohol, carbonyl, Amide, Sugar and Amino acids

COURSE OUTCOMES

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

CO1 : **List** the precautionary measures while working in the in laboratory

CO2 : **Explain** the different types of chromatographic technique for the separation.

CO3 : **Method** development for Separation, purification and identification of binary mixtures
CO4 : **Analyse** and identification by spectroscopy technique.

CO5 : **Importance** of chromatography, separation and purification techniques.

CO6 : **Elaborate** properties of synthesized organic molecule by melting point, IR and UV.

TEXT/REFERENCE BOOKS

1. Mendham, J., A. I. Vogel's "**Quantitative Chemical Analysis"** Pearson Publishers.
2. A. I. Vogel, "**A text book of quantitative Inorganic Analysis**" Longman Publishers.
3. A. K. Nad, B. Mahapatra & A. Ghosal, "**An Advanced Course in Practical Chemistry"**, New Central.
4. Vogel's Text **"Book of Practical Organic Chemistry"** Long man Publishers.
5. Finar, I. L. **"Organic Chemistry (volume 1)",** Dorling Kindersley (India) Pvt. Ltd., (Pearson Education).

SEMESTER EXAM PATTERN

Max Marks 100 **Exam Duration: 3 Hrs.**

24BSC303T					Green Chemistry (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the importance of green chemistry in laboratory and industrial processes.
2. To provide knowledge about the definition, principles of green chemistry.
3. To understand the concept for prevention of waste, safety, green solvents, green reagents and green synthesis and techniques.
4. To know microwave, electrochemical, sonochemical reactions as a greener route for synthesis of chemicals.

UNIT 1: INTRODUCTION TO GREEN CHEMISTRY

14 Hrs.

History, definition, importance of green chemistry, principles of green chemistry and their detailed explanation with examples, hazard/waste substance, classification of hazard, hazard assessment in chemistry laboratory and chemical industries, approaches to design of green synthesis.

UNIT 2: GREENER SOLVENTS AND GREENER APPROACHES TO PREPARE IMPORTANT CHEMICALS 14 Hrs.

Organic solvents, Ionic liquids, water as solvent, solvent less reactions, examples, traditional and green approaches for preparation of Ibuprofen, adipic acid, ammonia, sulfuric acid, indigo dye.

UNIT 3: GREENER CHEMICALS AND APPROACHES

14 Hrs.

Green reagents, catalysis, biocatalyst, enzymatic reactions, electrochemical reactions, combinatorial chemistry, AI powered synthesis, new generation methods in green synthesis.

UNIT 4: ALTERNATIVE TECHNIQUES FOR GREENER SYNTHESIS

14 Hrs.

Microwave technology: definition, principle, working mechanism, advantage and limitations, examples of synthesis, industrial prospective. Sonochemistry: Definition, principle, working mechanism, advantage and limitations, examples of synthesis, industrial prospective, future of green chemistry.

TOTAL HOURS: 56

Hrs.

COURSE OUTCOME

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

CO1 : **Remembering** the basic concepts, importance of green chemistry.
CO2 : **Understanding** the green synthesis, properties and application.
CO3 : **Developing** the concept of prevention of waste, safety, green solvents, greener reagents and green synthesis.
CO4 : **Analyzing** the, enzymatic reactions, electrochemical reactions, combinatorial chemistry
CO5 : **Evaluating** the importance of microwave and sonochemical methods for green synthesis.
CO6 : **Assessing** hazards in chemical laboratory and design greener approaches for synthesis of chemicals.

TEXT/REFERENCE BOOKS

1. P.T. Anastas and J.C. Warner, **"Green Chemistry: Theory and Practice"**, Oxford University Press.
2. M. Lancaster, **"Green Chemistry: Introductory Text"**, Royal Society of Chemistry (London)
3. M.A. Ryan and M.Tinnes, **"Introduction to Green Chemistry"**, American Chemical Society (Washington).
4. M.C. Cann, M.E. Connelly, **"Real world cases in Green Chemistry"**, American Chemical Society (Washington).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

Question: 10 questions of 10 marks with / without internal choice 100 Marks

24BSC304T					Chemistry of Paints and Dyes (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the definition, basic concepts, importance, chemistry of dyes and paints.
2. To classify the structure, classification, nomenclature of dyes.
3. To explain various aspects, theories involved in designing of suitable dyes and paints.

UNIT I: DYES AND PIGMENTS-I **14 Hrs.**

Introduction, nomenclature and classification of synthetic dyes. History of dyes and natural pigments. Colour and constitution - chromospheres and auxochromes with suitable examples. Bathochromic and hypsochromic effects. Colour, the relation between colour and chemical constitution: Witt's theory, Armstrong's theory, Nietzki's theory, Valence bond theory, Molecular orbital theory. Classification of dyes based on chemical constitution and method of applications and examples.

UNIT II: DYES AND PIGMENTS-II **14 Hrs.**

Introduction to pigments, history, natural pigments, extraction. Synthesis properties and applications of Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane
Dyes - Malachite Green, Rosaniline and Crystal Violet; Phthalein Natural dyes: haemoglobin, chlorophyll, bilirubin.

UNIT III: DYES AND PAINTS-I **14 Hrs.**

Fluorescent Dyes – the concept of fluorescence and phosphorescence. Interaction of organic molecules with electromagnetic radiation. Energy diagram. Activation and deactivation of organic molecules by light. Synthesis, properties and application of Phenolphthalein and Fluorescein. Introduction to paints, surface coating compounds. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint).

UNIT IV: DYES AND PAINTS-II **14 Hrs.**

Introduction to laser dyes. Synthesis of Oligophenylenes. Oxazoles and benzoxazoles. Stilbenoid compounds, Coumarin laser dyes, Rhodamine laser dyes. Analytical tools to evaluate characterise dyes and paints. Quality control parameters. Application of dyes and paints in various industries. Formulation of paints.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** Chemistry of paints and dyes.
CO2 : **Interpret** various mechanism for deactivation and activation of organic molecule
CO3 : **Utilize** dyes and pigments on commercial basis
CO4 : **Analyse** the physico-chemical properties of dyes and pigments
CO5 : **Explain** mechanism for the synthesis of dyes and pigments
CO6 : **Elucidate** the industrial application of dyes and pigments.

TEXT/REFERENCE BOOKS

1. Venkataraman, "**The Chemistry of Synthetic Dyes"**, Vol. I to VII, Academic Press, New York.
2. E. N. Abrahart."**Dyes and their intermediates"**
3. K. M. Shah, "**Handbook of Synthetic Dyes and Pigments"**, Vol. I & II
4. Klans Hunger , "**Industrial Dyes by Germany"** Wiley-VCH
5. Anthony J. O'Lenick Jr.; Thomas G, "**Organic chemistry for cosmetic Chemists"** by. O'Lenick, Carol Stream, IL: Allured Publishing,

SEMESTER EXAM PATTERN

Lab Work	**50**
Lab Exam	**50**

24BSC305T					Chemistry of Materials (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the knowledge about fundamental of materials.
2. To provide the knowledge about the metallic and ceramic crystalline structure.
3. To develop the knowledge about the phases of metallic alloy systems.
4. To provide the knowledge about the different properties of materials.

UNIT I: FUNDAMENTAL ABOUT MATERIALS **14 Hrs.**

Introduction of materials, classification of materials, atomic structure and interatomic bonding in materials, covalent, ionic and metallic bonding, periodic properties, electron affinity, electronegativity, factors affecting nature of elements in periodic table, coordination number, factors affecting structure. different ionic structures according to anion packing: AX, AX2, A2X, AmEnXp structures; Rock salt, Rutile, Zinc blende, Antifluorite, Wurtzite, Corundum, CsCl, Perovskite, Spinel (normal-inverse)

UNIT II: STRUCTURE AND CORROSIONS IN MATERIALS **14 Hrs.**

Grain boundaries, interface boundaries, description of surface structure, surface crystallography, surface relaxation and reconstruction, and crystal growth. Corrosion-Introduction, definition, Types, corrosion rate, factors affecting corrosion rate, nature of corrosion, Environmental factors-Temperature, pH of the medium, humidity, and presence of impurities.

UNIT III: PHASE DIAGRAM OF MATERIALS **14 Hrs.**

Phase rule, phase diagram, Gibbs's phase rule, interpretation of mass fractions using Lever's rule, Hume Rothery rules-binary iso-morphous system, binary eutectic alloy system (lead-tin System), binary peritectic alloy system (iron-nickel system).

UNIT IV: PROPERTIES OF MATERIALS **14 Hrs.**

Electronic properties of materials, insulator, semiconductor, conductor, band diagram, dielectrics; optical properties of materials, transparent, transluscent, opaque materials, luminescence; magnetic properties of materials, ferromagnetic, ferromagnetic, antiferromagnetic; mechanical behaviour of materials.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the materials and their chemical bonding.
CO2 : **Demonstrate** the knowledge about the crystalline structure of materials.
CO3 : **Knowledge** on the defectes and dislocations in materials.
CO4 : **Apply** the knowledge about the phases of metallic alloy systems.
CO5 : **Explain** the diffusion phenomenon in solids.
CO6 : **Illustrate** the different properties of materials.

TEXT/REFERENCE BOOKS

1. W.D.Callister, An **Introduction to Materials Science & Engineering**, John Wiley & Sons (2007).
2. MW Barsoum, **Fundamental of Ceramics**, IOP publishing (2003).
3. V. Raghavan, **Materials Science and Engineering**, Prentice-Hall of India Private Limited (2003).
4. W.F. Smith, **Principles of Materials Science and Engineering**, McGraw Hill, New York (1994).

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 10 Questions each carrying 5 marks 50 Marks
Part B/Question: 5 Questions each carrying 10 marks 50 Marks

24BSC308T					Analytical Chemistry III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand advanced spectroscopy as a tool for molecular structure determination.
2. Acquiring basic principles applied for mass spectrometry measurements.
3. To estimate how chemical reactions like fragmentation in mass assist in spectral analysis.
4. Learning the fundamental principal of photoelectron spectroscopy.
5. Acquiring the knowledge of basic theory of nuclear magnetic resonance spectroscopy and able to interpret basic NMR spectra.
6. To be acquainted with molecular structures, identify functional groups, and determine chemical compositions.

UNIT I: FLUORSENCE SPECTROSCOPY **10 Hrs.**

Introduction to Fluorescence, Instrumentation for Fluorescence Spectroscopy, Time-Domain Lifetime Measurements, Solvent and Environmental Effects, Fluorescence Quenching, Fluorescence Anisotropy, Energy Transfer, Single-Molecule Fluorescence.

UNIT II: MASS SPECTROMETRY **11 Hrs.**

Some Fundamentals of Mass Spectrometry

Introduction of mass spectrometry- The Mass Spectrometer, The Mass Spectrum- Ion Fragments, The Base Peak, The Molecular or Parent Ion (M+), The (M + 1)+ Ion , Isotopic Fragments , High-Resolution Mass Spectrometry; Depicting Mass Spectral Data; The Molecular or Parent Ion; Predicting the Formation of M+; The Nitrogen Rule ; Metastable Ions; Doubly Charged Ions; The General Fragmentation Process; The Fragmentation of a Hypothetical Molecule; Identifying the Molecular Ion; Chemical Ionization; The Fragmentation of M+; Determining the Molecular Ion from the Fragments; General Rearrangement; Skeletal Rearrangement; The McLafferty Rearrangement; The Loss of Neutral Fragments; Atomic Weight Determinations; The Isotopes of Carbon; Calculating Relative Intensities; The Experimental Determination of the Carbon Number; Compounds Containing Bromine and/or Chlorine; Compounds Containing Sulfur, The Analysis of Mass Spectra: The Fragmentation Patterns of- Straight-Chain Alkanes, Branched Alkanes, Cycloalkanes, Unsaturated Hydrocarbons, Alkyl Halides, Phenyl Halides, Benzyl Halides, Alcohols and Phenols, Problems in Mass Spectrometry: Introduction: Some General Suggestions for Interpreting Mass Spectra.

UNIT III: PHOTOELECTRON SPECTROSCOPY **10 Hrs.**

Photoelectron spectroscopy-Introduction: The photoelectric effect, Origin of X-ray spectra, Energy levels in atom, electron binding (ionization) energy, UV photoelectron spectroscopy, X-ray photoelectron spectroscopy: Chemical shifts in XPS, Chemical shifts and oxidation states, Analytical applications of XPS, Auger electron spectroscopy: Auger process, mechanism of emission of an Auger electron, Auger Transitions: ionization, relaxation and emission, nomenclature for Auger transitions: ABB transitions, AAB transitions, Coster-Kronig transitions, Examples of Auger Processes, Kinetic Energies of Auger Electrons.

UNIT IV: PROTON NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY **11 Hrs.**

Introduction, Theory: Nuclear spin quantum number, properties of the nuclei, Magnetic moment of a nucleus, Fundamental NMR equation, Larmor precession, spin-spin and spin lattice relaxations, Instrumentation, Sample Handling, Shielding, Deshielding and Chemical Shift, Standard for proton NMR, Tetramethylsilane (TMS) as reference compound, Advantages of TMS as a reference compound, Measurement of Chemical Shift: NMR Scale, δ(or ppm) and τ scale, Factors Affecting chemical Shift: Electronegativity-inductive effect, Anisotropic effects, Hydrogen bonding, van der Waals deshielding Number of PMR Signals: Equivalent and Non-equivalent Protons, Peak Area and Proton counting, Spin-Spin Splitting: Spin-Spin coupling, Multiplicity-Number of Component Peaks (Lines) in Multiplet, Relative Intensities of Component Peaks (Lines) of a Multiplet, Analysis (Interpretation) of NMR Spectra, Applications of PMR Spectroscopy.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Conceptualize** the role of electron, proton and atomic mass, in magnetic resonance spectroscopy, photoelectron spectroscopy and mass spectrometry.

CO2 : **Interpret** the basic H1NMR spectra, differentiate equivalent and non-equivalent protons and identify the splitting of NMR peak by analysing the chemical formulae.

CO3 : **Utilize** chemistry of fragmentation reactions in mass spectroscopy.

CO4 : **Analyze** the interaction of electromagnetic radiation with molecules and apply theoretical principles to investigate molecular structure and dynamics.

CO5 : **Estimate** molecular weight by using mass spectra and able to understand various mass spectrometric parameters.

CO6 : **Develop** the understanding on various spectroscopic methods such as XPS, NMR, and Auger spectroscopy and demonstrate their practical application.

TEXT/REFERENCE BOOKS

1. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R., **"Introduction to spectroscopy"**, 2015.
2. Yadav, L. D. S., **"Organic spectroscopy"**, Springer Science & Business Media (2013).
3. Banwell, C. N., & McCash, E. M., **"Fundamentals of molecular spectroscopy"**, Indian Edition (2017).
4. Atkins, P. W., De Paula, J., & Keeler, J., **"Atkins' physical chemistry"**, Oxford university press (2023).
5. Kemp, W., **"Organic spectroscopy"**, Bloomsbury Publishing (2017).
6. Skoog, D. A., Holler, F. J., & Crouch, S. R., **"Instrumental analysis"** (Vol. 47). Belmont: Brooks/Cole, Cengage Learning (2007).
7. McHale, J. L., **"Molecular spectroscopy"** CRC Press (2017).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Part A/Question: 3 Questions from each unit, each carrying 3 marks	36 marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks	64 marks

24BSC308P					Analytical Chemistry Lab-III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To develop practical skills in calibration of laboratory glassware and analytical balances, and to understand sources of experimental errors.
2. To train students in preparation and standardization of solutions using volumetric analytical techniques.
3. To apply classical titrimetric methods such as acid–base, redox, precipitation, and complexometric titrations for quantitative analysis.
4. To introduce statistical and computational tools (Origin software and MS excel) for data analysis and scientific presentation.

LIST OF EXPERIMENTS

1	To calibrate the glass wares (pipette, burette and volumetric flask) and weights (both grams and milligrams) and to use the chemical balance.
2	Application of origin software to draw the calibration curve and estimate the standard deviation and liner regression during the calibration of glasswares
3	Error analysis of the glasswares (performing student T-test and ANOVA analysis).
4	Preparation of standard oxalic acid solution, standardization of NaOH solution and determination of HCl in the given solution.
5	Conductometric titration of a strong acid with a strong base.
6	Preparation of standard Mohr's salt solution, standardization of $K_2Cr_2O_7$ solution, and determination of Fe^{2+} ions in the given solution using an external indicator.
7	Estimate the amount of Aspirin in the given tablet using pH meter.
8	Estimate the amount of glucose present in the whole of the given solution.
9	Estimation of chloride content in water using Mohr's method.
10	Distinguish between reducing and non-reducing sugar using Bendict solution
11	Preparation of standard $ZnSO_4$ solution, standardization of EDTA solution, and determination of Zn^{2+} in the given solution.

COURSE OUTCOMES

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

CO1 : **Recall** techniques to Calibrate laboratory glassware and analytical balances
CO2 : **Explain** the calibration data using software tools, and evaluate accuracy and precision through statistical methods.
CO3 : **Prepare** and standardize primary and secondary standard solutions and perform acid–base titrations for quantitative estimation of analytes
CO4 : **Analyze** experimental data for the determination of metal ions and oxidizing/reducing agents in given samples.
CO5 : **Evaluate** the pharmaceutical and environmental samples using appropriate instrumental and classical analytical methods, with proper error evaluation.
CO6 : **Design** and perform experiments using digital tools for chemical structure representation, data analysis, and result presentation while adhering to laboratory safety and good laboratory practices (GLP).

TEXT/REFERENCE BOOKS

5. Vogel's text book of quantitative chemical analysis (5^{th} edition).
6. Vogel's Textbook of quantitative inorganic analysis (4^{th} edition).

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
LW (Daily lab performance plus journal maintain each 25 marks)	50 Marks
LE (Viva-voce plus Lab examination each 25 marks)	50 Marks

24BSC309T					Physical Chemistry III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the knowledge about fundamentals of electrolytic conduction.
2. To understand conceptually the different theories/models of electrolytic conductance.
3. To provide the concept of how conductance measurements can be used to measure ionization constant, solubility product, ionic product, dissociation constants etc.
4. To provide the knowledge about the electrode potential and electrode kinetics.
5. To understand the application of the above in electrochemical energy devices.

UNIT 1 ELECTROLYTIC CONDUCTION-I **11 Hrs.**

Electrolytic conduction: Arrhenius theory of electrolytic dissociation; Ion conductance; conductance and measurement of conductance, cell constant, specific, molar and equivalent conductance; variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's Law of independent migration of ions; Equivalent and molar conductance at infinite dilution and determination for strong and weak electrolytes; Various application of conductance measurements.

UNIT 2 ELECTROLYTIC CONDUCTION-II **11 Hrs.**

Migration of ions: Transference number; Principle and experimental determination of transport number by Hittorf's and moving boundary methods; transference number and ionic mobility; Debye-Huckel theory of Ion atmosphere (qualitative)-Walden rule, asymmetric effect and electrophoretic effect; Wien effect, Debye-Falkenhagen effect; activities in electrolytic solutions, ionic strength; Debye-Huckel theory of dilute solutions and of concentrated solution.

UNIT 3 ELECTRODE POTENTIAL AND ELECTRODE KINETICS **10 Hrs.**

Reversible and irreversible cells; measurements of EMF of cells, Electrode potential Nernst equation; applications of Nernst equation in estimating thermodynamic properties, spontaneity of cell reaction; Latimer and Frost diagrams, Types of single electrodes; EMF and electrode potentials, Liquid Junction Potentials and concentration cells; some applications of EMF measurements, Significance of Over potential— Activation, Ohmic and diffusion overpotentials, Hydrogen evolution reaction.

UNIT 4 ELECTROCHEMICAL ENERGY SYSTEMS AND INTERFACES **10 Hrs.**

Energy storage devices – batteries and fuel cells, Electrochemical Supercapacitors, electrical double layer –Lippmann equation and modern electrical double layer theory, Adsorption of ions and dipoles.

42 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 : **Apply** knowledge of electrolytic conductance for quantitative determination of equivalent conductance.
CO2 : **Translate** theoretical knowledge to measure chemical parameters such as solubility product, ionic product and dissociation constants.
CO3 : **Apply** theoretical knowledge to quantify the migration of ions in electrolytes.
CO4 : **Calculate** thermodynamic parameters such as enthalpy, entropy etc. from electrode potential values.
CO5 : **Set up** experiments to apply EMF measurements for determining activity coefficient, conduct potentiometric titration
CO6 : **Conceptualize** the role of electrode potential and electrode kinetics in energy storage devices.

TEXT/REFERENCE BOOKS

1. Castellan, G. W. **Physical Chemistry**, Narosa Publishing House
2. Rakshit, P.C., **Physical Chemistry**, Sarat Book House.
3. Glasstone, S. and Lewis, G. N. **Elements of Physical Chemistry**.
4. Atkins, P. W. and Paula J de Atkins, **Physical chemistry**, Oxford University Press.
5. Kapoor K L, **Textbook of Physical Chemistry** (Vol-1,2), McGraw Hill education
6. Ghoshal A., **Numerical problems and short questions on Physical Chemis**try, Books and allied (P) Ltd.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 10 Questions, each carrying 10 marks each 100 Marks

24BSC309P					Physical Chemistry-III: Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	3	1.5	3				50	50	100

COURSE OBJECTIVES

1. To be familiar with the concept of chemical kinetics and rate law concept.
2. To comprehend the factors affecting rate of reaction
3. To use different quantitative and analytical reasoning techniques.
4. To learn different electroanalytical techniques

LIST OF EXPERIMENTS

1. To study the kinetics of ester hydrolysis by acid and base;
2. Determine the order and specific reaction rate of the potassium persulphate-iodide reaction by initial rate method
3. To study primary salt effects in oxidation of iodide ion by persulphate ion.
4. To compare the strengths of two acids by studying acid-catalyzed hydrolysis of an ester.
5. Polarimetric determination of Concentration of unknown sugar solution
6. To study the iodination of acetone using a colorimeter
7. Determination of partition coefficient and equilibrium constant for $KI + I_2 \rightarrow KI_3$.
8. Adsorption of acetic acid on activated charcoal.
9. Determination of concentration of Glucose-fructose in a mixture using polarimeter
10. Conductometric determination of concentrations of KCl, HCl and NH_4Cl in a mixture.
11. Verify the Onsagar equation using KCl, K_2SO_4 and $BaCl_2$ as electrolytes and determine their Λ^0 values.
12. Determination of CMC of a surfactant in aqueous solution by conductometric method.
13. Potentiometric titration of halide mixture (Chloride, Bromide and Iodide).
14. Determine the E^0 value of Ag^+ /Ag electrode and activity coefficients of different aqueous $AgNO_3$ solutions potentiometrically.
15. Determine the standard potential of $[Fe(CN)_6]^{3-}$ / $[Fe(CN)_6]^{4-}$ electrode by potentiometer.
16. Determine the dissociation constants (K_1, K_2, and K_3) of H_3PO_4 by pH meter.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1– Explain and apply concepts of chemical kinetics

CO2– Apply the scientific process in the design, conduct, evaluation and reporting of experimental investigations

CO3–Demonstrate the effect of various factors on rate of chemical reaction and its kinetics

CO4- Derive and construct rate equations from mechanistic data and evaluate reaction mechanisms

CO5–Understand the surface phenomenon of adsorption,

CO6– Comprehend the electrochemistry

TEXT/REFERENCE BOOKS

1. J. B. Yadav, ***Advanced Practical Physical Chemistry*****,** Goel Publications, Meerut, 2003.
2. A. I. Vogel, ***Fundamentals of Quantitative Analysis***, 5th Ed., Addison Wesley Longman., 1989.
3. G. Suehla, ***Vogel's Qualitative Inorganic Analysis***, 6th Ed., Orient Longman, 1989
4. P. Samnani, ***Experiments in Chemistry***, Anmol Publications, New Delhi 2007

EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Laboratory work including maintaining journal book+ mid-sem viva (LW) 50 Marks

End–sem exam and viva (LE/Viva) 50 Marks

24BSC310T					Natural Products					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. List biosynthesis of natural products
2. Classification of natural products.
3. Make a use of natural product chemistry in real life/pharmaceutical and industrial sector.
4. Analyse the structure and stereochemistry of natural products.
5. Importance of natural product as pharmacophore.
6. To demonstrate the basic knowledge of natural product synthesis.

UNIT I: INTRODUCTION TO NATURAL PRODUCTS **14 Hrs.**

Natural Products: Definition, Properties and Function; Classification; Introduction to important secondary metabolites (polyketides, fatty acids, terpenes, steroids, phenyl propanoids and alkaloids) and their roles in different sectors of life; Structure elucidation process by derivation, chemical degradation and spectroscopic techniques.

UNIT II: AMINO ACIDS, PEPTIDES, PROTEINS, ENZYMES AND BETA-LACTAM ANTIBIOTICS **14 Hrs.**

Classification of Amino acids; Zwitter ion structure and Isoelectric point; Overview of Primary, Secondary, Tertiary and Quaternary structure of Proteins; Determination of Primary structure of peptides; Synthesis of simple peptides by N-protection and C-activating groups; Merrifield solid phase synthesis; Overview of enzyme action, coenzymes and cofactors and their role in biochemical reactions; The beta-lactam antibiotics: Penicillins, and other beta-lactams, Antibiotic Resistance.

UNIT III: CARBOHYDRATES **14 Hrs.**

Classification and General Properties; Reducing and Non-reducing sugars; Glucose and Fructose (open chain and cyclic structure), Projection formula; Determination of configuration of monosaccharides; Absolute configuration of Glucose and Fructose; Mutarotation and Anomerism; Reactions of carbohydrates; Structure of disaccharides (Sucrose, Maltose, Lactose) and polysaccharides (Starch, Glycogen and Cellulose) excluding their structure elucidation..

UNIT IV: ALKALOIDS, TERPENES, STEROIDS, POLYKETIDES AND FATTY ACIDS **14 Hrs.**

Natural occurrence; General structural features and properties; Uses; Classification; Isolation; Hofmann's exhaustive methylation, Emde's modification; Structure elucidation and synthesis of Nicotine; Isoprene rule; Elucidation of structure and synthesis of Citral; Medicinal importance of Nicotine, Atropine, Quinine, Morphine, Reserpine and Taxol; Steroids; Cholesterol; Polyketides and Fatty Acids; Prostaglandins

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **List** biosynthesis of natural product.

CO2 : **Classification** of natural products.
CO3 : **Make** a use of natural product chemistry in real life/pharmaceutical and industrial sector.
CO4 : **Analyse** the structure and stereochemistry of natural products.
CO5 : **Importance** of natural product as pharmacophore.
CO6 : **Demonstrate** the basic knowledge of natural product synthesis

TEXT/REFERENCE BOOKS

1. Finar, I. L. "**Organic Chemistry (volume 1)",** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. "**Organic Chemistry (volume 2)",** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Hanson, J. R. "**Natural Products: The Secondary Metabolites**". The Royal Society of Chemistry.
4. Graham Solomons, T. W. and Fryhle, C. B. "**Organic Chemistry"**, John Wiley & Sons, Inc.
5. Singh, J.; Ali, S. M. and Singh, J. "**Natural Product Chemistry"**, Prajati Prakashan
6. V.K. Ahluwalia, "**Chemistry of Natural Products"**

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration (3 Hrs)
10 question each carrying 10 marks	100 marks

24BSC312T					Chemistry of Cosmetic & Perfumes (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts of perfumes and perfume chemistry.
2. To learn the basics of cosmetics, cosmeceuticals and insight into hair-care products.
3. To learn the basic concepts skin care cosmetics.
4. To understand the basic concepts involving the characterization techniques used for cosmetics and perfumes

UNIT I: PERFUMES **16 Hrs.**

Introduction to perfumes, history, classification of perfumes, the concept of aroma, types and physiological effects. Composition, formulation and working mechanism of perfume. Antiperspirants and deodorants: definition, working mechanism, composition, formulation chemistry and comparison. Introduction to perfumery chemicals: Natural sources, natural identical and synthetic compounds. Extraction methods of perfumery chemicals. Examples of some important perfumery chemicals (synthesis, properties and chemistry)

UNIT II: CHEMISTRY OF COSMETICS-I **16 Hrs.**

Introduction to cosmetics: Definition, history and application. Cosmetology, Introduction to cosmeceuticals. Anatomy of skin and hair with respective to cosmetology. Classification of cosmetics. Physiological effects of cosmetics. Cosmeceuticals: definition, classification, chemicals, mechanism of action. Induction to oral care products. Examples chemistry of materials used in skin, nail care productsand their function. Chemistry of materials used in cosmeceuticals.

UNIT III: CHEMISTRY OF COSMETICS-II **12 Hrs.**

Introduction to skin care cosmetics: classification, chemicals, properties, physiological effects. Study chemistry of some skin care products, (creams, foundation, primer, lotions). Chemistry of nail polish and paints. Hair care products: Properties, classification, working mechanism, formulation, safety and chemistry of hair care products (shampoo, conditioner, gels, colouring agents etc.)

UNIT IV: HERBAL AND MODERN COSMETICS **12 Hrs.**

Introduction to herbal cosmetics. Characterisation of cosmetics and perfumes (Chromatography, physical methods, spectroscopy). Safety and testing of cosmetics and perfumes. Regulatory and quality control of cosmetics. Cosmetic surgery and related studies

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** perfume studies including history, classification, aroma concept, physiological effects, composition, and formulation.

CO2 : **Get a deep insight** into the working mechanisms, composition, and formulation chemistry of antiperspirants and deodorants

CO3 : **Gain** new knowledge of perfumery chemicals derived from natural sources, natural identical, synthetic compounds, and extraction methods

CO4 : **Comprehends** the classification and application of cosmeceuticals.

CO5 : **Gain** advanced knowledge of skin care, nail care products, hair care products, formulations, and safety.

CO6 : **Get insight** into the recent developments in herbal cosmetics, characterization, safety testing, regulatory control, and nanotechnology

TEXT/REFERENCE BOOKS

1.Hilda Butler (editor), "**Poucher's Perfumes, Cosmetics, and Soaps"**, 10th edition, Dordrecht: Kluwer Academic Publishers © 2010.

2.D.F. Williams, "**Chemistry and Technology of the Cosmetics and Toiletries Industries"**, Springer International Edition

3.Anthony J. O'Lenick Jr.; Thomas G. O'Lenick "**Organic chemistry for cosmetic chemists"**. Carol Stream, IL: Allured Publishing, © 2008

4.Schueller and Romanowsk "**Beginning Cosmetic Chemistry"**. Allured Pub Corp; 3rd edition, 20089

5.Barel AO, Paye M, Maibach HI. "**Handbook of cosmetic science and technology"**. CRC Press; 2014

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 objective questions of 2 marks each without internal choice	20 Marks
Part B/Question: 8 subjective questions of 10 marks each with internal choice	80 marks

24BSC313T					Nanochemistry (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1.To develop the fundamental understanding about nanomaterials.
2.To provide the knowledge about the strategies for the synthesis of nanomaterials.
3.To develop the skills for phase, microstructural and elemental characterisation of nanomaterials
4.To provide the knowledge about the applications of nanomaterials.

UNIT I: INTRODUCTION TO NANOCHEMISTRY **14 Hrs.**

Introduction to nanochemistry, nanomaterials and nanotechnology, scope of nanochemistry, Importance of nanochemistry in modern science and technology, classification of materials- metallic, ceramic (oxide/ non oxide), polymer, composite nanomaterials. Surface area to volume ratio and aspect ratio. quantum dots and quantum confinement, Classification of nanomaterials (0, 1, 2, 3D), carbonaceous (e.g. carbon nanotubes (CNT), graphene, fullerenes)

UNIT II: STRATEGIES FOR THE SYNTHESIS OF NANOMATERIALS **14 Hrs.**

Top down and bottom up chemical, coprecipitation, sol-gel synthesis, microemulsions synthesis, hydrothermal, solvothermal, self-assembly, reduction methods, template method. Chemical vapour deposition (CVD), green synthesis methods, thin film (dip coating, spin coating, Langmuir blodget film), thick film (casting, doctor blading, electrochemical deposition) technique.

UNIT III: CHARACTERISATION OF NANOMATERIALS **14 Hrs.**

Characterization of nanomaterials using X-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning electron microscopy, elemental mapping (EDAX), atomic force microscope (AFM), scanning tunneling microscope (STM), Raman, Thermal Analysis (TGA-DTA-DSC), N2 adsorption desorption isotherm, FTIR, UV-vis spectrometer.

UNIT IV: APPLICATIONS OF NANOMATERIALS **14 Hrs.**

Photo-voltaic (solar cell), Energy storage and conversion devices- supercapacitor, fuel cell, battery, environmental remediation and sustainability, nanoelectronics, biomedical application, mechanical and lubrication applications.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts and principles of nanochemistry
CO2 : **Demonstrate** the different nanomaterials and their dimensional impact over properties.
CO3 : **Knowledge** on the various synthesis methods
CO4 : **Apply** the knowledge about the process for the fabrication of devices using nanomaterials.
CO5 : **Explain** the skill for phase, microstructural and elemental characterisation techniques for nanomaterials.
CO6 : **Illustrate** the properties and applications of nanomaterials in different fields.

TEXT/REFERENCE BOOKS

1. Text book of Nanoscience and Nanotechnology, T. Pradeep, Mc. Graw Hill Education (2003).
2. Textbook of Nanoscience and Nanotechnology, Murty, Shankar, B Raj, Rath, Murday, Springer (2013).
3. Chemistry of nanomaterial: Synthesis, properties & applications by CNR Rao et.al. John Wiley & Sons (2004).
4. V. Raghavan, Materials Science and Engineering, Prentice-Hall of India Private Limited (2003).
5. W.D.Callister, An Introduction to Materials Science & Engineering, John Wiley & Sons (2007).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 10 Questions each carrying 5 marks 50 Marks
Part B/Question: 5 Questions each carrying 10 marks 50 Marks

24BSC401T					Organic Chemistry-IV					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To define isomerism in naturally occurring compound.
2. To explain stereo selective, specific synthesis and its application in organic chemistry
3. To identify the symmetry elements & importance of stereo chemistry in chiral compounds.
4. To demonstrate the Importance of Nitrogen, Sulphur and Phosphorus containing compounds.
5. To analyse experimental methods of photochemistry. Photochemistry of carbonyl compound
6. To elaborate different types of photochemical reactions.

UNIT I: STEREO CHEMISTRY-I **12 Hrs.**

Introduction to the concepts of stereo chemistry, importance and history and applications. Configurations and conformations, Conformational isomerism: conformational analysis of ethane and n-butane, conformations of cyclohexane, axial and equatorial bonds, Fischer Projection, Newman projection and Sawhorse formulae and its interconversion. projection formulae (i) Fischer (ii) Sawhorse (iii) Newman (iv) Flying Wedge; threo and erythro isomers, Configurational and conformational isomerism in acyclic and cyclic compounds. Conformational analysis of cycloalkanes, cyclohexenes, cyclohexanones, halocyclohexanones, decalins, decalols, and decalones; effect of conformation on reactivity. Configuration nomenclature D L, R S and E Z nomenclature. Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules

UNIT II: STEREO CHEMISTRY-II **10 Hrs.**

Optical isomerism: concepts, optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, and Molecules with two or more chiral-centers, Distereoisomers, Relative and absolute configuration: D/L and R/S designations. Threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention, and racemization. Stereo selective and stereo specific synthesis. Enantiomeric and diastereomeric excess: definition, determination, and control. Elements of symmetry, chirality, molecules with more than one chiral center, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Optical activity in the absence of chiral carbon; Stereochemistry and configuration of allenes, spiranes, alkylidene cycloalkanes, adamantanes, catenanes, biphenyls (atropisomerism), bridged biphenyls, ansa compounds and cyclophanes. Asymmetric induction: Cram's, Prelog's and Horeau's rule.

UNIT III: INTRODUCTION TO PERICYCLIC **10 Hrs.**

Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antrafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatrophic shifts involving carbon moieties, 3, 3- and 5, 5- sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Ene reaction. Photochemistry: Introduction, Jablonskii diagram, energy pooling, photosensitization, Quantum yields, solvent effects, Stern-Volmer plot, intersystem crossing, delayed fluorescence, photosensitization, and energy transfer reactions.

UNIT IV: INTRODUCTION TO PHOTOCHEMISTRY **10 Hrs.**

Photochemical energy Franck Condon Principle, Jablonski diagram singlet and triplet states, dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield, experimental methods of photochemistry. Photochemistry of carbonyl compounds transitions, Norrish type I and Norrish type II cleavages, Paterno-Buchi reaction. Photochemical reduction, substitution reaction, cis-trans isomerism, photochemistry of butadiene, di-pi methane rearrangement and related processes, Photochemistry of aromatic compounds - Excited state of benzene its 1,2-1,3 1-4 additions, photo Fries rearrangements

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 **Define** isomerism in naturally occurring compound.
CO2 : **Explain** stereo selective, specific synthesis and its application in organic chemistry.
CO3 : **Identify** the symmetry elements & importance of stereo chemistry in chiral compounds.
CO4 : **Analyse** experimental methods of photochemistry. Photochemistry of carbonyl compound.
CO5 : **Explain** the importance of Nitrogen, Sulphur and Phosphorus containing compounds.
CO6 : **Elaborate** different types of photochemical reactions.

TEXT/REFERENCE BOOKS

1. J. Clayden, N. Greeves and S. Warren, "Organic Chemistry" (Oxford University Press) ISBN 0199270295
2. E. L. Eliel and S. H. Wilen, "**Stereochemistry in Organic Compounds"** (Wiley) ISBN 0471016705
3. D. Nasipuri **"Stereochemistry of Organic Compounds**" Wiley.
4. Jerry March, **"Advanced Organic Chemistry: Reactions Mechanisms and Structure"** Wiley.
5. Charles Dupey and O. Chapman, **"Molecular reactions and Photochemistry"** Prentice Hall.
6. S.M. Mukherji and S. P. Singh, **"Reaction Mechanism in Organic Chemistry"** Trinity press.
7. Nicholas J. Turro V. Ramamurthy J. C. Scaiano, **"Principles of Molecular Photochemistry"**

SEMESTER EXAM PATTERN

Max Marks 100 **Exam Duration: 3 Hrs.**

24BSC401P					Organic Chemistry-IV Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	

COURSE OBJECTIVES

1. Learn safety measures while working in the laboratory
2. Learn different separation techniques
3. Knowledge about different organic transformations
4. Synthesize different organic compounds
5. To familiarizes with chemicals and instruments

LIST OF EXPERIMENTS

1 To prepare a sample of p-Nitroacetanilide from acetanilide.
2 To purify a given sample of phthalic acid by sublimation.
3 Preparation of drug molecule: Preparation of Aspirin from salicylic acid
4 Polymerization– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR
5 To prepare benzanilide from aniline and benzayl chloride.
6 Multistage synthesis (benzaldehyde chalcone chalcone epoxide) and their characterization by UV, IR and Melting point
7 Synthesis of Schiff's base from aniline and p-anisaldehyde in the presence of lime juice (Green methods of synthesis)
8 Synthesis of coumarin by Knoevenagel reaction using salicylaldehyde and ethyl acetate in the presence of a base.
9 Preparation of Benzoic acid from Benzaldehyde and Benzyl alcohol by cannizaro reaction.
10 Preparation of Cinnamic acid by Perkin's reaction.

COURSE OUTCOMES

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

CO1 : **Show** how to separate various organic compounds
CO2 : **Demonstrate** different types of organic reactions
CO3 : **Construct** various organic compounds
CO4 : **Classify** different separation techniques
CO5 : **Appraise** Perkin's reaction
CO6 : **Design** different organic transformations

TEXT/REFERENCE BOOKS

1. V.K Ahluwalia, Renu Aggarwal, "**Comprehensive practical Organic Chemistry": Quantitative analysis**, Universities press; ISBN 13: 978 817371 273 9
2. A.K. Nad, B. Mahapatra & A. Ghosal, "**An Advanced Course in Practical Chemistry"**, New Central, Vogel's Text Book of PracticalOrganic Chemistry
3. Finar, I. L**. "Organic Chemistry (volume 1)",** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

SEMESTER EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

24BSC402T					Physical Chemistry-IV					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES (-04)

1. Conceptualize the fundamental principles of the properties of matter, energy quantization, its application,
2. To develop the fundamental understanding about the classical and statistical models of thermodynamics.
3. To acquire knowledge about concepts of photochemistry and photochemical processes
4. Understand the symmetry properties of molecules and application of group theory in understanding the molecular properties based on symmetry.

Unit I: QUANTUM CHEMISTRY **12 Hrs.**

The failures of classical physics, Bohr's quantum theory, Wave particle duality, Operator algebra, Linear and Hermitian operators, Quantum mechanical postulates, Schrodinger equation for a particle in one and three dimensional boxes, Rigid rotator and simple harmonic oscillator, Schrodinger equation for hydrogen atom and its solution-Derivation of Eigen function and Eigen value for hydrogen atom. Term symbols, LS and JJ coupling. The origin of electronic quantum numbers and physical significance - radial probability density-significance of magnetic quantum number with respect to angular momentum.

Unit II: STATISTICAL THERMODYNAMICS **10 Hrs.**

Statistical view of entropy. Laws of thermodynamics from statistical considerations. Molecular view of temperature and heat capacity. Derivation of Maxwell Boltzmann distribution law – partition functions and their calculation. Expressions for thermodynamic quantities in terms of partition functions-translational, rotational, vibrational, and electronic contributions to the thermodynamic properties of perfect gases, Intermolecular forces in imperfect gases. Thermodynamic quantities in terms of partition functions.

Unit III: PHOTOCHEMISTRY **8 Hrs.**

Absorption and emission of radiation, Franck Condon principle decay of electronically excited states, Jablonski diagram, radiative and non-radiative processes, fluorescence and phosphorescence, spin-forbidden radiative transitions, inter conversion and intersystem crossing. Theory of energy transfer - resonance and exchange mechanism, triplet-triplet annihilation, photosensitization, and quenching. Spontaneous and induced emissions. Einstein transition probability- inversion of population - laser and masers. Flash photolysis: Chemi and thermo luminescence.

Unit IV: GROUP THEORY **12 Hrs.**

Elements of group theory, definition, group multiplication tables, conjugate classes, conjugate and normal subgroups, symmetry elements and operations, point groups, assignment of point groups to molecules, Matrix representation of geometric transformation and point group, reducible and irreducible representations, construction of character tables, bases for irreducible representation, direct product, symmetry adapted linear combinations, projection operators. Orthogonality theorem - its consequences. Symmetry aspects of molecular orbital theory, planar π-systems, symmetry factoring of Huckel determinants, solving it for energy and MOs for ethylene and 1,4-butadiene.

TOTAL HOURS: 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : Understand the properties of matter and the wave particle duality
CO2 : Apply statistical models to understand the thermodynamic properties of macroscopic systems
CO3 : Apply the concept of quantization of energy and its modes
CO4 : Investigate the photochemical processes and apply of principles of photochemistry to real life phenomenon
CO5 : Relate symmetry of the molecules to their properties
CO6 : Apply group theory and character table to analyse the molecular properties

TEXT/REFERENCE BOOKS

1. A. K. Chandra, **Introductory Quantum Chemistry**, Tata McGraw Hill, 1994
2. C. McClelland, **Statistical Thermodynamics**, Chapman and Hall, (1973).
3. F. A. Cotton, **Chemical Applications of Group Theory**, Wiley Eastern, 1991.
4. L. K. Nash, **Elements of Classical and Statistical Thermodynamics**, Addison-Wesley, (1970).
5. K. K. Rohatgi - Mukerjee, **Fundamentals of Photochemistry**, Wiley (1992).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 h**

Part A/Question: 10 Questions from each unit, each carrying 10 marks 100 Marks

24BSC402P					Physical Chemistry-IV Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				50	50	100

COURSE OBJECTIVES

1. To understand the concepts of electrochemistry for analytical purpose.
1. To use the methods of science, in which quantitative, analytical reasoning techniques are used.
1. To learn learn depth concepts about electrochemistry.
1. To demonstrate the application of electrochemical methods

LIST OF EXPERIMENTS

1. Conductometric titration of mixture of acids and precipitation titration (KCl Vs $AgNO_3$) using conductivity bridge.
2. Determination of redox potential of Fe^{2+}/Fe^{3+} system by potentiometry.
3. Determination of strength of strong and weak acids in a given mixture conductrometrically,
4. Determination of ratio of Potasium Dicromate, chromate in a supplied mixture conductometric titrations.
5. Determination of cell constant of a cell and study the effect of dilution on equivalent conductance of strong/weak electrolytes.
6. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid like acetic acid.
7. Conducometric measurement of degree of hydrolysis of a salt.
8. Conductometric titration of a weak acid with strong base/mixture of strong and weak acid with strong base and weak acid with weak base.
9. To determine the critical micelle concentration of Sodium lauryl sulphate from the measurement of conductivities at differentconcentration
10. Determination of pKA and isoelectric point of an amino acid.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1– Apply the scientific process in the design, conduct, evaluation and reporting of experimental investigations

CO2–Derive essential mathematical relationships in kinetics and electrochemistry.

CO3- Define central parts of electrochemical cells and electrochemical equipment

CO4-Integrate qualitative and quantitative concepts of physical chemistry

CO5-Demonstrate procedures and instrumental methods applied in analytical and practical tasks of physical chemistry;

CO6-Solve problems in physical chemistry by using appropriate methodologies;

TEXT/REFERENCE BOOKS

1. C. W. Garland, J. W. Nibler, & D. P. Shoemaker, **Experiments in Physical Chemistry**, 8th Ed., McGraw – Hill, New York, 2003.
2. J. Mendham, R. C. Denney, J. B. Barnes & M. J. K. Thomas, **Vogel's Textbook of Quantitative Chemical Analysis**, 6th Ed., Pearson Education, New Delhi, 2003.
3. V.D. Athawale and P. Mathur, **Experimental Physical Chemistry**, 1st Edition, New Age International Publications, New Delhi 2001.
4. J.B.Yadav, **Advanced Practical Physical Chemistry**, Goel Publications, Meerut, 2003.

SEMESTER EXAMINATION PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

LW(Daily lab performance plus journal maintain each 25 marks) 50 Marks

LE (Viva-voce plus Lab examination each 25 marks) 50 Marks

24BSC403T					Analytical Chemistry-IV					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn about present status of water globally and the issues related to it.
2. To know about the fundamentals of waste water treatment process.
3. To learn about the advanced techniques used for waste water treatment, drinking water and saline water.
4. To know about the uniques methods of desalination, advanced cooling processes, and specialised water treatment processes.

UNIT I: DATA ANALYSIS **10 Hrs.**

Mean and standard deviations, reliability of results, confidence interval, comparison of results, comparison of two samples, correlation and regression, correlation coefficient and liner regression.

Calibration, standardizations and blank corrections: Standardizing Methods, Linear Regression and Calibration Curves, Blank Corrections

UNIT II: OBTAINING AND PREPARING SAMPLES FOR ANALYSIS **10 Hrs.**

The importance of sampling, designing a sampling plan, implementing the sampling plan, separating the analyte from interferents, general theory of separation efficiency, liquid–liquid Extractions, separation versus preconcentration

UNIT III: ACID BASE EQUILIBRIA AND BUFFER SOLUTION **11 Hrs.**

Acid-base theories, Definition of pH and pH scale (Sorenson and operational definitions), and its significance, Hammett Acidity function, pH at elevated temperatures, pH for aqueous solutions of very weak acid and base, pH for salts of weak acid and weak bases, polyprotic acids. Buffer solutions, buffer capacity, applications of buffers

UNIT IV: THEORY OF VOLUMETRIC AND GRAVIMETRIC ANALYSIS **11 Hrs.**

Introduction, Titrimetric analysis, classifications of reactions in titrimetric analysis, standard solutions, preparation of Standard solutions, primary and secondary standards, Indicators, theory of indicators, Acid–base titrations in non-aqueous media. Gravimetric Analysis, Impurities in precipitates, Gravimetric calculations, precipitation equilibria (Solubility product, common ion effect, stoichiometry), organic precipitation.

Introduction, Titration curves, Types of EDTA titrations, Methods of end point Detection Indicators, Applications of Complexometric Titrations.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Grasp** the fundamental of analysing systematic and non-systemetic errors in data analysis..

CO2 : **Explore** the strong theoretical fundamentals of acid-base equilibria, buffer solutions, and will be able to relate this knowledge to various analytical applications.

CO3 : **Gain** knowledge of volumetric and gravimetric principles and will be capable of interpreting and analyzing various chemical compounds

CO4 : **Explain** the working principles of pH metry and be able to perform calculations based on the pH of various chemicals..

CO5 : **Understand** the working principles and end point detection for EDTA titration

CO6 : **Elucidate** the technique for analyzing chemical complexes using advanced complexometric fundamentals.

TEXT/REFERENCE BOOKS

7. G. H. Geefferyetal, "**Vogel's Text Book of Quantitative Chemical Analysis**" ELBS Edn, 1989
8. D. A. Skoog, D.M. West, F.J Holler, S.R Crouch, "**Fundamentals of Analytical Chemistry**" 8th edition, Thomson Brooks Cole, 2004
9. F. Rouessac and A. Rouessac, "**Chemical Analysis: Modern Instrumentation**" Wiley
10. **"Methods and Techniques**"2nd edn, John Wiely and Sons
11. D. A. Skoog, E. J. Holler, S. R. Crouch, "**Principles of Instrumental Analysis**", 6th edition,
12. Chatwal and Anand "**Instrumental Methods of Analysis**" Himalaya Publishing House
13. A.I. Vogel "**Instrumental Methods of Inorganic Analysis"** ELBS
14. H.A. Strobel. "**Chemical Instrumentation: A Systematic approach**" Pearson

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 Questions from each unit, each carrying 1 marks	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 10 marks	80 marks

24BSC403P					Analytical Chemistry Lab-IV Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				25	25	100

COURSE OBJECTIVES

1. Learning the basic experimental techniques in the laboratory for multifarious analytical techniques
2. Analysis of the quality of waste water by analytical techniques
3. Estimation of inorganic ions by volumetric titrations
4. Estimation of hardness of water via telemetric methods

LIST OF EXPERIMENTS

1. Determination of sodium carbonate and sodium bicarbonate in washing soda.
2. Determination of available chlorine in bleaching powder.
3. Determination of Total Dissolved Solids (TDS) in a Water Sample
4. Determination of sulphate in water sample.
5. Infrared spectroscopic analysis of organic molecules for functional group identification
6. Standardization of sodiumthiosulphate solution with standard K2Cr2O7
7. Determination of iodine value of oil.
8. Determination of Calcium Content in Milk Sample Using Complexometric Titration
9. Determination of concentration of acetic acid in commercial vinegar
10. Determination of chemical oxygen demand.
11. Simultaneous estimation of chromium (III) and iron (III) by EDTA titration.
12. Complex-formation titration Water hardness

COURSE OUTCOMES

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

CO1 : **Understanding** of state of the art laboratory experimental techniques of industrial applications.
CO2 : **Perform** and **evaluate** experimental analytical technique to understand significance of primary and secondary standards
CO3 : **Perform** estimation of water pollution via estimating toxic metal content in water.
CO4 : Students will acquire experience in **determining** the inorganic content through solvent extraction techniques and EDTA titrations.
CO5 : **Comprehend** the cause and determine exactly the impurity present in the industrial samples
CO6 : **Determine** iodine value of industrial oil samples.

TEXT/REFERENCE BOOKS

1. John H. Kennedy, **"Analytical Chemistry Practice"**, Saunders College Publishing, Second Edition 1990.
2. A. I. Vogel, **"Vogels Textbook of Quantitative Chemical Analysis"**, 5th Edition, Longman Scientific & Technical Wiley 2002.
3. V. K. Ahluwalia, **"Comprehensive Experimental Chemistry"**, New Age Publications,1997.
4. R. M. Varma, **"Analytical Chemistry: Theory and Practice"**, CBS Publishers, 1994.
5. A. K. Nad, B. Mahapatra & A. Ghosal, **"An Advanced Course in Practical Chemistry"**, New Central Book Agency (P) Limited, 2014, 2014.
6. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, **"Principles of Instrumental Analysis"**, Cengage Learning, 2017.

EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Laboratory work including maintaining journal book+ mid-sem viva (LW) 50 Marks
End–sem exam and viva (LE/Viva) 50 Marks

24BSC404T					Computer Applications in Chemistry (Elective)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To provide an in-depth understand of the role of computers in chemistry.
2. Introduce the fundamentals of theories of computational chemistry.
3. Provide the overview of various computational tools and their applications.
4. Provide hands-on use of software to elucidate various structural parameters.

UNIT 1 INTRODUCTION TO COMPUTATIONAL CHEMISTRY **14 Hrs.**

Overview of computer application in chemistry, computational and statistical methods: computational chemistry, chemomatrics, chemoinformatics, Application of computational chemistry in understanding molecular structure at a fundamental level: molecular geometry, electron density, geometrical parameters, energy of the molecules, potential energy surface, Local and Global minima and maxima, chemical reactivity of a molecule, a brief idea about the types of computers, and operating systems.

UNIT 2 THEORY OF COMPUTATIONAL CHEMISTRY **14 Hrs.**

The Schrödinger equation, Hamiltonian Energy, Born-Oppenheimer approximation, Separation of variables: Nuclear and Electronic Schrodinger equation, Types of motion and energy, Chemical Concepts from Born-Oppenheimer approximation, Degrees of freedom, various theoretical approaches (density functional theory, Hartree-Fock and force field methods).

UNIT 3 COMPUTATIONAL TOOLS AND USES **14 Hrs.**

Introduction to Computational Tools, Quantum Chemistry Software: Gaussian, GAMESS, ArgusLab, Molecular Modeling Software: Schrödinger's Maestro, Accelrys Discovery Studio, and OpenEye Omega, Cheminformatics Tools: Open Babel, and ChemAxon, Molecular Dynamics Simulation Packages: GROMACS, AMBER, and NAMD, Computational Chemistry Databases: PubChem, ChemSpider, and the Cambridge Structural Database (CSD), Applications of Computational Tools, Challenges and Future Directions

UNIT 4 MODELLING AND APPLICATION **14 Hrs.**

Modelling of molecular system using ArgusLab, Geometry optimization and its importance, Optimized structural parameters, steps of geometry optimization, HOMO-LUMO identification, Comparing the geometrical parameters of known molecules with the theoretical study (Aspirin).

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- CO1 : **Recall** the significance of computational and statistical methods in chemistry.
- CO2 : **Understand** the distinctions among different types of operating systems and grasp basic computer terminology essential for computational chemistry.
- CO3 : **Apply** knowledge of computer usage in chemistry to elucidate their roles and significance in in modern research and analysis.
- CO4 : **Analyze** the fundamental theories and principles underlying computational chemistry and their application in understanding molecular behavior.
- CO5 : **Explain** and evaluate the utility of different computational software packages commonly used in chemistry research and analysis.
- CO6 : **Apply** computational software tools to analyze and interpret structural parameters of chemical systems effectively.

TEXT/REFERENCE BOOKS

1. Frank Jensen **Introduction to Computational Chemistry**, 2nd edition (Wiley)
2. Christopher Cramer, **Essentials of Computational Chemistry**, 2nd edition (Wiley)

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks

Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

24BSC405T					Organic Chemistry-V					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

5. Name of oxidizing reducing reagents in organic chemistry
6. Explain name reactions with mechanism involved in organic synthesis.
7. Make a use of the disconnection approach for total synthesis
8. Distinguish various path for retro synthesis
9. Importance of natural product chemistry.
10. Discuss importance of alkaloids and terpinoids pharmacophore

UNIT I: OXIDATION REAGENTS **10 Hrs.**

Osmium tetroxide, DDQ, selenium dioxide, Tl (NO3)3, CAN, MnO2, Ag2CO3, Hypervalent iodine (V) (Dess-Martin reagent), Oppenauer oxidation (Al (OiPr)), NaIO, Tetrapropyl ammonium peruthenate. Organic peroxides (Sharpless epoxidation,Baeyer Villiger oxidation), PCC, PDC, Dimethyl sulfoxide (Moffatt oxidation, Swern oxidation).

UNIT II: REDUCTION AND OTHER REAGENTS **12 Hrs.**

Catalytic hydrogenation (Pt, Pd, Fe, Ni, Rh, Ru catalysed), Clemmensen reduction, Wolff Kishner reduction, Reduction with diimide (NH2-NH2) and Birch reduction. NaBH4, NaBH3CN, LiAlH4, DIBAL-H, Applications of hydroboration. Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc, and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Lithium Organocuprates, ylides of sulfur, phosphorous and nitrogen. Organosilanes, Organostannes reagents.

UNIT III: ADVANCED NAME REACTIONS **10 Hrs.**

Detailed study of Neber, Prins, Bouveault Blanc Reaction, Appel reaction, Vilsmeier-Haack Reaction, Tishchenko Reaction, Fukuyama reaction, McMurry reaction, Jones Oxidation, Wilkinson reaction, Woodward and Prevost Reaction, Oxymercuration-Demercuration reaction. Cross coupling reactions: Stille, Suzuki, Sonogashira, Heck, Negishi, Hiyama, Kumada couplings. Mitsunobu reaction, Buchwald Hartwing reaction, Swern oxidation reaction, Michael addition, Darzen's glycidic ester synthesis, Mannich reaction Dickmann reaction, Witting reaction, Knoevanagel reaction. Multicomponent reactions: Olefin metathesis, Passerine reaction, Ugi reaction, Phase transfer catalysis.

UNIT IV: RETEROSYNTHESIS AND DISCONNECTION APPROACH **10 Hrs.**

An introduction to Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1,2, 1,3, 1,4 & 1,5- difunctional compounds. Retro- synthesis of Alkene, acetylenes and aliphatic nitro alcohols and carbonyl compounds, amines, the importance of the order of events in organic synthesis, chemoselectivity, regioselectivity. Diels Alder reaction, Michael addition and Robinson annulation.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Name** oxidizing reducing reagents in organic chemistry.
CO2 : **Explain** name reactions with mechanism involved in organic synthesis.
CO3 : **Identify** use of the disconnection approach for total synthesis.
CO4 : **Analyse** various path for retro synthesis.
CO5 : **Explain** importance of natural product chemistry.
CO6 : **Discuss** the importance of alkaloids and terpinoids pharmacophore.

TEXT/REFERENCE BOOKS

5. Peter Sykes, **"A guide Book to Mechanism in Organic Chemistry"**
6. Benjamin R. Breslow. **Organic Reaction Mechanism"**
7. Stuart Warren, **"Organic Synthesis, The Disconnection Approach"**
8. Simonson, **"Terpenes"**
9. Manskey and Holmes: **"Alkaloids."**

SEMESTER EXAM PATTERN

Max. Marks: 100 Exam **Exam Duration: 3 Hrs**

24BSC405P					Organic Chemistry-V Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	

COURSE OBJECTIVES

1. Learn safety measures while working in the laboratory.
2. Knowledge about different laboratory reagents and multistage synthesis.
3. Learn how to handle hazardous chemicals with all the safety measures.
4. Application of organic chemistry for industrial and domestic use.

LIST OF EXPERIMENTS

1 Chromatography: Thin layer chromatography, Column chromatography
2 Fischer Indole synthesis: Synthesis of 2-phenyl indole.
3 Fischer Indole synthesis: Synthesis of Tetra Hydro carbazole.
4 Synthesis of Aspirin (Drugs)
5 Synthesis of Paracetamol (Drugs)
6 Synthesis of Sulphanilamide (Drugs)
7 Synthesis of Azo dyes,.(Dyes)
8 Synthesis of Triphenylamine (Dyes)
9 Synthesis ofFluorescein(Dyes)
10 Synthesis of Eosin(Dyes)
11 Chromatography: Thin layer chromatography, Column chromatography

COURSE OUTCOMES

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

CO1 : **Find** natural products from organic compounds
CO2 : **Demonstrate** multistage synthesis
CO3 : **Identify** how to separate organic compounds mixtures
CO4 : **Analyse** different separation techniques
CO5 : **Appraise** different functional groups
CO6 : **Predict** the structure of the organic compound by spectroscopy

TEXT/REFERENCE BOOKS

1. Vogel A. I., Furniss B.S., Hannaford A.J., Smith P.W.G., Tatchell A. R., **"Vogel's Textbook of Practical Organic Chemistry"** John Wiley & sons Inc.
2. Jerry R. Mohrig et al; "**Modern projects and experiments in organic chemistry: Mini scale and willianmson micro scale"**, W.H Freenan and company press; ISBN: 0-7167-3921-6
3. B.S. Fumiss, A.J. Hannaford, V. Rogers, P.W.G. Smith and A.R. Tatchell, **"Text book of Practical Organic Chemistry",** LBS, Singapore.

SEMESTER EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

24BSC406T					Inorganic Chemistry-IV					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts of inorganic reaction mechanism.
2. To gain the knowledge of organometallic chemistry.
3. To learn the importance of organometallic chemistry for industrial applications.
4. To attain an understanding of inorganic photochemistry.
5. To develop the theoretical knowledge on nuclear chemistry.

UNIT I: INORGANIC REACTION MECHANISM **10 Hrs.**

Introduction to Inorganic Reaction Mechanism; Substitution in Octahedral and Square Planar Complexes; Lability; Trans- effect; Conjugate Base Mechanism; Racemisation; Electron Transfer Reactions: Inner Sphere and Outer SphereMechanism; Marcus theory.

UNIT II: INORGANIC PHOTOCHEMISTRY **10 Hrs.**

Introduction to Inorganic Photochemistry; Photochemical Laws and Photochemical Kinetics; Photochemical, Reactions: Substitution, Decomposition and Fragmentation, Rearrangement, and Redox Reactions; Electronic absorption spectra of Metal Complexes; Characteristics of the Electronically Excited States of Inorganic Compounds; Photophysical Processes; Photosensitization; Photo-electrochemistry of Excited State Redox Reactions.

UNIT III: INDUSTRIALLY RELEVANT INORGANIC MATERIALS & APPLICATIONS **12 Hrs.**

Non-metallic materials: Silicates, silicones, chalcogenide materials, thermoelectric and photovoltaic inorganic materials, boron compounds, nitrides; metallic materials: alkali and alkaline earth metal compounds such as oxides, hydroxides, carbonates, transition metal based materials like polyoxometalates, precipitation reactions leading to inorganic materials (ex: chemical gardens) and their significance for cheap and efficient technological applications including battery and other energy technologies

UNIT IV: NUCLEAR CHEMISTRY **10 Hrs.**

Radioactive Decay Processes: Multipole Radiation and Selection Rules; Isomeric Transition; Internal Conversion and Auger Effect; Nuclear Structure; Nuclear Energy Levels; Nuclear Models; Nuclear Reactions; Labelling; Nuclear Reactors; Radioanalytical Techniques. Nuclear Processes in Geology, Geochemistry & Astrophysics: Ages of Rocks and Minerals; Age of earth-Radioactive Dating; Nuclear Fusion and its importance in current energy scenario w.r.t to fusion energy, Nuclear Fusion and Stellar Energy (Cosmo chemistry).

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** different types of inorganic reactions and their mechanism
CO2 : **Demonstrate** the theoretical knowledge of organometallic chemistry
CO3 : **Illustrate** the importance of organometallic chemistry towards current industrial applications
CO4 : **Explain** different photophysical and photochemical processes of inorganic compounds
CO5 : **Apply** the concept of inorganic photochemistry in predicting their potential applications
CO6 : **Learn** the advanced concepts of nuclear chemistry and applications thereof

TEXT/REFERENCE BOOKS

1. R.H. Crabtree; "**The organometallic Chemistry of transition metals**", John Wiley Publishers.
2. R C Melhotra; "**Organometallic chemistry: A unified concept**", New Age International publishers
3. G. L.Geoffrey and M. S. Wrighton; "**Organometallic Photochemistry**", Academic Press.
4. K. K. Rohatagi-Mukherjee; "**Fundamentals of Photochemistry**", Wiley Eastern Publishers.
5. M. S. Wrighton; "**Inorganic and Organometallic Photochemistry**", ACS Publications.
6. H. J. Arnikar; "**Essentials of Nuclear chemistry**", , Wiley-Eastern Ltd. New Delhi.

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

~~Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks~~
~~Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks~~

24BSC406P					Inorganic Chemistry IV Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand synthetic inorganic complexes and acquire the practical knowledge of qualitative verification of the spectrochemical series
2. To gain the practical knowledge of studying optical isomerism of coordination complexes
3. To gain an experience in equilibrium studies of inorganic reactions by different methods
4. To develop the skills for handling air and moisture sensitive compounds

1. Synthesis and Characterization of inorganic compounds (Melting point, IR, UV-vis, Magnetic Moment, Conductivity, Cyclicvoltammetry etc.) [At least three]

Reinkey's salt, $[Co(NH_3)_6]Cl_3$, $[Co(NH_3)_5Cl]Cl_2$, $[Ni(en)_2]Cl_2$, $K_3[Fe(ox)_3]$, $K_3[Cr(ox)_3]$, $[Co(NH_3)_6]Cl_3$, $[Cu(NH_3)_4(SO_4)(H_2O)]$, $[K_2SO_4,Cr_2(SO_4)_3, 24H_2O]$

Comparison of the electronic spectra of $Cu(H_2O)_4]^{2+}$ $[Ni(NH_3)_6]^{2+}$ and $[Co(en)_3)]^{2+}$ and qualitative verification of the spectrochemical series.

2. Synthesis and characterization of $[Co(en)_3]Cl_3$. Separation of its optical isomers and determination of their optical rotation by using polarimeter.

3. Equilibrium studies on inorganic reactions [At least two]

a. Determination of composition of Fe(III)-sulfosalicylate complex in solution by Mole-Ratio, and Slope-Ratio method and Job's method of continuous variation.

b. Determination of composition of Fe(II)-1,10-phenanthroline complex in solution by Mole-Ratio and Slope-Ratio method and Job's method of continuous variation.

c. Determination of composition of Ni(II)-dimethyl glyoxime complex in solution by Mole-Ratio and Slope-Ratio method and Job's method of continuous variation.

d. Determination of composition of $[Co(NH_3)_6]Cl_3$ in solution by Mole-Ratio and Slope-Ratio method and Job's method of continuous variation.

4. Handling of air and moisture sensitive compounds.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 : **Develop** the skills for synthesis, purification and characterization of inorganic complexes.

CO2 : **Learn** the skills for characterization of inorganic complexes by different physicochemical techniques.

CO3 : **Demonstrate** the practical skills for qualitative verification of the spectrochemical series.

CO4 : **Gain** an experience in studying optical isomerism of coordination complexes.

CO5 : **Demonstrate** the practical knowledge for equilibrium studies of inorganic reactions by different methods.

CO6 : **Understand** the handling of air and moisture sensitive compounds.

TEXT/REFERENCE BOOKS

1. **A Text book of quantitative Inorganic Analysis** – A. I. Vogel
2. **Experimental Inorganic Chemistry** – W. G. Palmer.
3. **Practical Inorganic Chemistry, Preparations, reactions and instrumental methods**, Geoffrey Pass , Haydn Sutcliffe, Springer
4. **Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual**, Gregory S. Girolami, Thomas B. Rauchfuss and Robert J.Angelici. University Science Books.
5. **Practical Inorganic Chemistry**, L Rakesh Sharma, Evincepub Publishing

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

~~Laboratory work including maintaining journal book+ mid-sem viva (LW)~~ ~~50 Marks~~

~~End–sem exam and viva (LE/Viva)~~ ~~50 Marks~~

24BSC407T					Analytical Chemistry V					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Acquisition of the fundamental knowledge of advanced analytical methods
2. Learning the basic principles of spectroscopic techniques.
3. Understanding and acquiring the necessary basic knowledge of chromatographic separation working of various chromatographic techniques
4. Learning the basic electrochemical techniques and attaining the fundamental knowledge of potentiometry.

UNIT I: SEPARATION TECHNIQUES **11 Hrs.**

Types of separation techniques, solid (SLE), liquid-liquid extraction (LLE), Technique for solvent extraction: batch extraction and continuous extraction, Extraction of lighter type or heavier type liquid, Working Methodology and Applications of extraction LLE, SPE, SPME, solid-liquid extraction factors influencing.

UNIT II: CHROMATOGRAPHY **11 Hrs.**

Fundamentals of chromatography, Definition of the resolution, capacity factor, selectivity factor, dead time and dead volume. Types of chromatography depend upon mobile phase, instrumentation, and separation. TLC, HPTLC, Ion exchange, types of resin, working methodology and application of TLC, HPTLC and Ion exchange, instrumentation and working methodology and applications of HPLC & GC (Gas Chromatography), types of columns, packed columns, capillary columns, bonded phase columns.

UNIT III: ADVANCED SPECTROSCOPIC TECHNIQUES: ELECTRON-SPIN RESONANCE SPECTROSCOPY **10 Hrs.**

Introduction, Theory, ESR Absorption Positions: The g Factor, Instrumentation, Working of an ESR Spectrometer, Sample Handling, Sensitivity of an ESR Spectrometer, Multiplet Structures in ESR Spectroscopy, Interpretation of ESR Spectra, Applications of ESR Spectroscopy

UNIT IV: ADVANCED SPECTROSCOPIC TECHNIQUES: MOSSBAUER SPECTROSCOPY **10 Hrs.**

Mossbauer Spectroscopy: Basic principle, Isomer Shift, Quadrupolar Splitting, Examples of Mossbauer Spectra analysis, Applications of Mossbauer Spectroscopy

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Comprehend the basic principles of different separation techniques based on partition and adsorption chromatography

CO2 : Gain working principle and application of various chromatographic techniques for the separation and identification of various organic and inorganic analytes.

CO3 : Attain fundamental knowledge of spectroscopy and comprehend the principles behind spectroscopic instruments.

CO4 : Learn calibration methods for instruments used in analytical chemistry and understand the basic optical systems of these instruments.

CO5 : Explain the working principles of potentiometric analysis and describe the principles of electrodes in potentiometric techniques.

CO6 : Identify the appropriate technique, that is, chromatographic, spectroscopic, and potentiometric methods for qualitative and quantitative analysis for organic and inorganic analyte

TEXT/REFERENCE BOOKS

1. D.L. Pavia, G. M. Lampman, G. S. Kriz "**Introduction to Spectroscopy**" Harcourt College Publisher, NY, 2001
2. William Kemp "**Organic Spectroscopy**" ELBS 3rd Ed. 1994.
3. David Harvey "**Modern Analytical Chemistry**" McGraw Hill, 2000.
4. M. Kolthoff "**Treatise on Analytical Chemistry**" Vol Ito VII – I. Wiley
5. M. Silverstein and G. C. Bassler "**Spectroscopic identification of organic compounds**" Wiley
6. D.H. Williams and I. Fleming "**Spectroscopic methods in organic chemistry**" McGraw-Hill Education
7. P. S. Kalsi "**Applications of spectroscopic techniques in Organic chemistry**" New Age International Private Limited

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 Questions from each unit, each carrying 1 marks	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 10 marks	80 marks

24BSC407P					Analytical Chemistry-V Practical					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To learn experimental techniques using state-of-the-art equipment's
2. To acquire the skill of analytical techniques like spectroscopy, solvent extraction, titrimetric methods
3. To demonstrate the importance of calibration and standardization in analytical measurements.
4. To develop the skill of qualitative analysis techniques to identify unknown substances

LIST OF EXPERIMENTS

1 Separation and identification of mixtures using Two-Dimensional Thin Layer Chromatography
2 Cyclic voltammetric study of Potassium Ferricyanide
3 Extraction of Nicotine from tobacco sample using solvent extraction method
4 Estimation of Nicotine content in commercial sample using Spectrophotometric method
5 Estimation of the purity of oxalic acid employing standard KMnO4 solution.
6 Determination of total alkalinity of soda ash
7 Redox titrations of determination of ascorbic acid.
8 Determine the concentration of $KMnO_4$ using UV spectroscopy.
9 To determine the stoichiometry and stability constant of ferric salicylic acid complex by Job`s method and mole ratio method.
10 Determination of Dissolved Oxygen (DO) in water sample.
11 Determination of iron in iron tablets.
12 Simultaneous determination of metal ions by spectrophotometry

COURSE OUTCOMES

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

CO1 : **Gain** an insight into laboratory techniques like ion-exchange, solvent extraction and titrimetric methods
CO2 : **Demonstrate** the skills to determine inorganic and organic content by ion-exchange chromatography
CO3 : **Acquire** practical knowledge and skills for determination of organic content by spectrophotometric methods.
CO4 : **Determine** the organic content titrimetric methods
CO5 : **Demonstrate** the expertise for various analytical techniques
CO6 : **Gain** an experience in determining the inorganic content in water sample

TEXT/REFERENCE BOOKS

1. Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 1990.
2. Vogels Textbook of Quantitative Chemical Analysis, 6th Edition, 2002.
3. Comprehensive Experimental Chemistry; V. K. Ahluwalia, New Age Publications, 1997
4. Analytical Chemistry: Theory and Practice; R. M. Varma, CBS Publishers, 1994
5. A. K. Nad, B. Mahapatra & A. Ghosal, An Advanced Course in Practical Chemistry, New Central, 2007. Vogel's Text Book of Practical Organic Chemistry (5th Edn).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **3 Hrs.**

Laboratory work including maintaining journal book + mid-sem viva (LW) 50 Marks

End–sem exam and viva (LE/Viva) 50 Marks

24BSC408T					Theoretical & Computational Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. The objective of unit I is to ensure that students understand the importance of Computer-Aided Drug Design (CADD) in the drug design process.
2. The objective of unit II is to ensure that students learn about structure-based and ligand-based drug design methods.
3. The objective of unit III is to ensure that students learn the basics of UNIX and LINUX programming, and understand molecular mechanics and its implementation in chemistry.
4. The objective of unit IV is to ensure that students learn how electronic structure calculations can be used as an adjunct to their experimental research.

Unit I COMPUTER-AIDED DRUG DISCOVERY-I (CADD) **14 hours**

Traditional drug design approaches: Serendipity, Chemical modification, High throughput screening, Combinatorial Synthesis, rational drug design methods, Importance of CADD in drug design and medicinal chemistry, Phases of CADD, Protein/enzyme form and function in disease, Enzyme inhibition, Characteristics of a druggable target and drug, Advantage of CADD

Unit 2 COMPUTER-AIDED DRUG DISCOVERY-II (CADD) **14 hours**

Classification of CADD, Ligand-based drug design, Structure-based drug design, virtual screening, Druglikeness studies, ADME/T parameters. Ligand based drug design: Basic concept, Pharmacophore modelling, validation studies, Ligand-based virtual screening, and common softwares for implementing ligand-based drug design. Structure-based drug design: Basic concept, Pharmacophore modelling and Molecular docking (brief overview), Structure-based virtual screening, common softwares for implementing structure-based drug design.

Unit 3 ELECTRONIC STRUCTURE THEORY-I **14 hours**

Introduction to the LINUX and UNIX operating system, LINUX/UNIX commands.
Introduction to classical and quantum mechanics, Molecular mechanics: Introduction, Basic theory, Concept of potential energy surface. Force field and its components (stretch- Morse Potential, bend, out-of-plane bending, torsional, van der Waals and electrostatic energy), Types of Force fields, General features of force field, Existing force field.

Unit 4 ELECTRONIC STRUCTURE THEORY-II **14 hours**

Electronic structure methods: Basics of electronic structure calculations, Semi-empirical methods and Ab-initio methods, Advantages of Semi-empirical methods.
Density functional methods: Basic theory, building geometry, Basis set, functional's, Level of theory, Optimization and computable properties like absorption, energy, optimized bond lengths, bond angles, dihedral angles, charge calculations.

TOTAL HOURS: 56 Hrs.

COURSE OUTCOMES

Upon completion of the course, student will be able to

CO1 : **Define** the role of CADD in drug discovery process.
CO2 : **Illustrate** the use of different computational softwares.
CO3 : **Solve** the potential energy from the concept of molecular mechanics and its implementation.
CO4 : **Describe** the role of electronic structure calculations in defining the experimental research.
CO5 : **Explain** the types of operating systems.
CO6 : **Elaborate** the softwares utilization to evaluate the structural parameters related to small organic compounds.

REFERENCE BOOKS:

1. Computational Drug Design: A Guide for Computational and Medicinal Chemists, By D. C. Young.
2. Linux Fundamentals by Paul Cobbault, Publication date 2015-05-24 CEST.
3. Computational Chemistry: A Practical Guide for Applying Techniques to Real-World Problems. David C. Young Copyright (2001 John Wiley & Sons, Inc.)

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

STREAM ELECTIVES FOR INDUSTRIAL CHEMISTRY SPECIALIZATION

24MSC601T					Paints, Pigments & Cosmetics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the basic concepts of paints, pigments, dyes and cosmetics.
2. To understand the formulation and structure-activity relationship of different paints, pigments and cosmetics.
3. To demonstrate the knowledge of natural pigment extraction and dye synthesis.
4. To evaluate the safety, efficacy and physiological effect of synthetic and herbal cosmetics.
5. To apply the theoretical concepts in design and formulation of paints and cosmetics.

UNIT I: PIGMENTS & DYES **11 Hrs.**

Introduction to dyes and natural pigments: history, nomenclature and classification. Colour and chemical constitution: chromophores, auxochromes, hypsochromic and bathochromic shift. Concepts of fluorescence and phosphorescence. Extraction of natural pigments. Classification of dyes. Synthesis, properties and application of representative azo dyes. Synthesis, properties and application of representative fluorescent and laser dyes.

UNIT II: PAINTS **11 Hrs.**

Introduction to paints, surface coating compounds. Paints and pigments-formulation, composition and related properties. Oil paint. Thinners. Enamels. Emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint).

UNIT III: CHEMISTRY OF COSMETICS **10 Hrs.**

Introduction to cosmetics and cosmetology: definition, history and application. Anatomy of skin and hair with respect to cosmetology. Classification of cosmetics. Physiological effects of cosmetics. Introduction to cosmeceuticals: definition, classification, chemicals, mechanism of action. Introduction to oral care, skin, nail and hair care products: classification, properties, working mechanism, and formulation. Chemistry and function of materials used in cosmetics and cosmeceuticals.

UNIT IV: MODERN TRENDS IN COSMETICS **10 Hrs.**

Study of representative cosmetic products. Introduction to herbal cosmetics. Safety and testing of cosmetics. Regulatory and quality control of cosmetics. Modern developments in cosmetic chemistry. Cosmetic surgery and related studies.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Understand historical prospectives, and basic concepts behind the pigment and dye applications.
CO2 : Application of the new knowledge of extracting natural pigments, synthesizing specific dyes, paint composition, and formulation.
CO3 : Comprehend the latest developments in oil paint, thinners, enamels, emulsifying agents, and special paints.
CO4 : Gain a theoretical understanding of formulating cosmetics and cosmeceuticals, including their mechanisms
CO5 : Assess the safety, effectiveness, and physiological impacts of cosmetics
CO6 : Analyze contemporary trends in herbal cosmetics, cosmetic surgery, and related studies

TEXT/REFERENCE BOOKS

1. Venkataraman "**The Chemistry of Synthetic Dyes**" Vol. I to VII by, Academic Press, New York.
2. E. N. Abrahart "**Dyes and their intermediates**"
3. K. M. Shah "**Handbook of Synthetic Dyes and Pigments**" Vol. I & II
4. Klans Hunger "**Industrial Dyes**" Germany by Wiley-VCH.
5. D.F. Williams "**Chemistry and Technology of the Cosmetics and Toiletries Industries**" Springer International Edition.
6. Anthony J. O'Lenick Jr.; Thomas G. O'Lenick, Carol Stream, IL "Organic chemistry for cosmetic chemists" Allured Publishing, © 2008.
7. Schueller and Romanowsk "**Beginning Cosmetic Chemistry**" Allured Pub Corp; 3rd edition, 2008.
8. Barel AO, Paye M, Maibach HI "**Handbook of cosmetic science and technology**" CRC Press; 2014.

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 4 Questions from each unit, each carrying 7 marks	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 9 marks	80 Marks

24MSC602T					Polymer Chemistry & Composite Materials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Students should understand and differentiate the main categories of composite materials and cite the distinguishing features of each.
2. Students should understand the principles of the matrix and disperse phases and their behavior on the characteristics, geometry/distribution, and properties of the constituent phases.
3. Students should be able to gain the in-depth knowledge of types of polymers, different methods of synthesis, their properties and applications.
4. Students should be able to understand the concept of characterization of polymeric materials.

UNIT I: INTRODUCTION TO POLYMERS **10 Hrs.**

Introduction; Classification of Polymers; Degree of Polymerization. General Characteristics of Chain Growth Polymerization; Alkene Polymerization by Free Radical, Cationic and Anionic Initiators; General Characteristics of Step Growth Polymerization; Synthesis of Polymers by Step Growth Polymerization: Polyesters, Polyamides, Polycarbonates, Polysulphones, Polyphenyl Oxides and Polysiloxanes, Ring-opening Polymerization of Ethers and Lactones.

UNIT II: FUNCTIONAL POLYMERS, POLYMERIC MATERIALS AND THEIR APPLICATIONS **10 Hrs.**

Conducting polymers, History of Conducting Polymers, Electronic Classification of conductors, Band Theory of conducting polymers, Doping of Conducting Polymers, Intrinsic and Extrinsic Conducting Polymers, Band Structure of Conducting Polymers: Solitons, Polarons and Bipolarons, Synthesis of Conducting Polymers, Electrochemical Synthesis of Polypyrrole, Chemical Polymerization of Aniline, Mechanism of Polymerization of Aniline. polymer catalysts, photoresponsive polymers, pH and temperature responsive polymers, ionomers (PTFE, etc.) and packaging applications of ionomers, biopolymers.

UNIT III: INTRODUCTION TO COMPOSITE MATERIALS **11 Hrs.**

Definition of composites, history of composites, classification of composites, composite manufacturing techniques, properties of fiber-reinforced and particulate composites: advantages of composites, disadvantages of composites, applications of composites.

UNIT IV: TYPES OF COMPOSITES, THEIR PROCESSING PROPERTIES AND APPLICATIONS **11 Hrs.**

Polymer Matrix Composites (PMC): Glass Fiber–Reinforced Polymer (GFRP) Composites, Carbon Fiber–Reinforced Polymer (CFRP) Composites. Processing, properties and applications of PMC

Metal Marix Composites (MMC): Types of Metal Matrix Composites, Important Metallic Matrices, Aluminium alloys, Titanium Alloys, Magnesium Alloys, Copper Alloys, Intermetallic Compounds. Processing, properties and applications of PMC.

Ceramic Matrix Composites (CMC): Processing of CMC, properties and applications of CMC.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Learn basic concepts of polymerization and classification of polymers, their unique properties and applications.
CO2 : Understand the synthesis methods and mechanisms of various polymerization techniques.
CO3 : Develop knowledge regarding composite materials, their classification, manufacturing techniques, properties, etc.
CO4 : Analyze the learnings and try to apply for practical laboratory application.
CO5 : Perceive knowledge regarding the concepts of reinforcements in matrix materials and the fundamental properties underlying the formation of composites.
CO6 : Discuss the relation between the disperse phase and matrix materials in order to visualize enhancement in the properties of the new composites.

TEXT/REFERENCE BOOKS

1. Chawla, Krishan K., **"Composite materials: science and engineering**", Springer Science & Business Media, 2012.
2. Odian, George., **"Principles of polymerization"**. John Wiley & Sons, 2004.
3. Balasubramanian, M. **"Composite materials and processing"**. CRC press, 2013.
4. F. W. Billmeyer, **"Text Book of Polymer Science"**, Wiley 2005.
5. R. J. Young and P. A. Lovell, **"Introduction to Polymers"**, CRC Press, 2011.
6. G. Challa, **"Polymer Chemistry"**, New York : Ellis Horwood
7. George Odian, **"Principles of Polymerization",** Wiley Interscience.
8. Mathews and Rawlings, **"Composite materials: Engineering and Science"**, Chapman and Hall.
9. Clyne, T. W., and Derek Hull, **"An introduction to composite materials"**, Cambridge university press, 2019.
10. Hollaway, L. C., ed. **"Handbook of polymer composites for engineers"**. Woodhead publishing, 1994.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs**
10 Questions, each carrying 10 marks	100 Marks

24MSC603T					Materials & Nano Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To familiarize with the concepts of materials and nanochemistry and their size and shaped dependent properties
2. To provide the knowledge about the various strategies for the synthesis of nanomaterials
3. To understand the different techniques for characterization of nanomaterials
4. To evaluate the role of nanomaterials in various applications associated to real world problems

UNIT I: NANOMATERIALS AND NANOCHEMISTRY **10 Hrs.**

Nanomaterials-introduction and classifications, Surface area to volume ratio, Size and shape Dependent Chemical and Physical Properties, Bulk and porous materials, Nanocomposite and Hybrid materials. Incorporation of heteroelements

UNIT II: SYNTHETIC METHODS FOR NANOMATERIALS **10 Hrs.**

Bottom-up and top-down approach, wet chemical synthesis, Chemical and Physical methods, film formation, Chemical Vapour Deposition (CVD), Spin and dip coating, template, self-assembly and green synthesis approaches

UNIT III: CHARACTERIZATION OF NANOSTRUCTURED MATERIALS **11 Hrs.**

X-ray diffraction, X-ray photoelectron spectroscopy (XPS), Raman Spectroscopy; Thermal analysis (TGA/DTA/DSC), BET surface area, Scanning Electron Microscope (SEM)) Transmission electron microscopy (TEM), Atomic Force Microscopy (AFM), Elemental analysis: CHNS, AAS, ICP-OES.

UNIT IV: APPLICATIONS OF NANOMATERIALS **11 Hrs.**

Nanomaterials as catalyst, energy storage and conversion, batteries, supercapacitors, fuel cells, water splitting, solar cell, sensors; Environmental remediation, water treatment.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the concepts of materials and nanochemistry
CO2 : **Demonstrate** the size and shape dependent chemical and physical properties of nanoscale materials
CO3 : **Knowledge** on understanding synthesis of nanomaterials
CO4 : **Apply** the knowledge about characterization of nanomaterials.
CO5 : **Explain** the fundamental concept and applications of nanoscale materials
CO6 : **Illustrate** the importance and principles of nanochemistry in real world problems.

TEXT/REFERENCE BOOKS

1. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Ghuzang G.Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004
4. Introduction to Nanoscience by Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, Anil K. Rao. CRC Press, 2008.
5. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 10 Questions each carrying 5 marks 50 Marks
Part B/Question: 5 Questions each carrying 10 marks 50 Marks

24MSC604T					Fine chemicals (Soaps, oils, detergents, pesticides, pharmaceuticals)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To acquire the fundamental knowledge of fine chemicals of industrial importance.
2. Learning the chemical composition manufacturing and applications of fats, oils and soaps in industries.
3. To understand and acquire the necessary basic knowledge, chemical composition and manufacturing of pesticides.
4. Attaining basic knowledge and applications of fine chemicals, pharmaceuticals and biochemical reagents.
5. Learning the basics of the manufacturing and applications of heavy organic chemicals in industries.

UNIT I: FATS, OILS AND SOAPS **10 Hrs.**

Chemical composition of fats and oils; Essential oils, surfactants and emulsifying agents, Hydrogenation, oxidation and auto-oxidation, polymerization, hydrolysis, esterification, interesterification, sulfonation, amidation, methathesis and co-metathesis, pyrolysis etc.; Present status of soap and detergent industries; Raw materials for soap industry and their selection; Kinetics and Phase reactions in soap boiling, various types of soaps and applications; Chemistry and technology of synthetic detergents (anionic, cationic, non-ionic, and amphoteric), detergent additives.

UNIT II: PESTICIDES **11 Hrs.**

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).

UNIT III: FINE CHEMICALS **10 Hrs.**

Manufacture of following with reference to: (i) raw material, (ii) production process, (iii) quality control, (iv) hazards and safety, (v) effluent management. Sodium borohydrate, lithium aluminium hydride, sodium ethoxide, tetracyclin, naproxen, ~~paracetamol,~~ chloramphenicol; norfloxacin, erythromycin, sulphonamides; trimethoprim; acyclovir, Enrofloxacin, Metoprolol, Cetirizine phenobarbital, AZT-Zidovudine; Biochemical reagents – ninhydrin, tetrazolium blue, 1, 2-naphthaquinone-4-sulphonate.

UNIT IV: HEAVY ORGANIC CHEMICALS **11 Hrs.**

Manufacture of following with reference to: (i) raw material, (ii) flow chart, (iii) effluent management. (iv) uses;propargyl alcohol, 1, 4-butanediol, vinyl chloride, pyridines, picolines, phthalic anhydrides, glycerol, sorbitol, chloroform, Ethanolamine; Industrial solvents – DMF, DMSO, sulfolane, alkyl pyrrolidone, THF, dioxane

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

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

CO1 : Comprehend the fundamental techniques concerning the chemical composition and production of fats and oils, alongside their practical applications.

CO2 : Gain a comprehensive understanding of the fundamental techniques employed in the synthesis of soaps and detergents, including their practical applications.

CO3 : Attain foundational knowledge regarding the industrial synthesis of pesticides and their practical applications.

CO4 : Familiarize oneself with various techniques utilized in the synthesis, quality control, hazards, and safety protocols involved in the production of fine chemicals.

CO5 : Acquire new knowledge pertaining to the synthesis, quality control, hazards, and safety measures involved in the production of significant pharmaceuticals and biochemical reagents.

CO6 : Understand the synthesis, quality control, hazards, and safety measures associated with the production of valuable heavy organic chemicals and industrial solvents.

TEXT/REFERENCE BOOKS

1. Vermani, O. P.;Narula, A. K. (2004) "**Industrial Chemistry**" Galgotia Publications Pvt. Ltd., New Delhi.
2. Bhatia, S. C. (2004) "**Chemical Process Industries**" Vol. I & II, CBS Publishers, New Delhi.
3. Gupta, P.K.; Gupta, S.K.(2011) "**Pharmaceutics and Cosmetics**" Pragati Prakashan
4. B K Sharma "**Industrial Chemistry part 1&2**" Krishna Prakashan
5. E. Stocchi "**Industrial Chemistry, Vol-I**" Ellis Horwood Ltd. UK
6. C.C. Furnas "**Roger's Manual of Industrial Chemistry**" (Edition), 6th edition, Vol.I, D. Van Nostrand Company, Inc.
7. V.P. Mehta "**Engineering Chemistry**" 4th Edition, Jain Brothers, New Delhi.
8. P.C. Jain and M. Jain "**Engineering Chemistry**" Dhanpatrai Publishing Company

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 Questions from each unit, each carrying 1 marks	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 10 marks	80 marks

24MSC605T					Petroleum Chemistry & Catalysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts of crude oil and
2. To learn the fundamentals of heterogeneous catalysis
3. To understand crude oil and catalyst characterization techniques
4. Attaining basic knowledge of catalytic reactors used in industry.

UNIT I: INTRODUCTION TO PETROLEUM CHEMISTRY **10 Hrs.**

Properties and General Characteristics of Hydrocarbon, Composition, Molecular types in Petroleum.

Origin of Crude Oil; Characterization and Analytical Techniques for Crude Oil: Physical properties, Thermal properties, Electrical properties, Optical properties, Chromatographic techniques, Spectroscopic methods (Principles and Applications of UV Visible, IR, and NMR Spectroscopy), Characterization of formation water. SARA Separation methods, Metals and Heteroatoms in Heavy crude oil.

UNIT II: CATALYSIS: FUNDAMENTALS. PREPARATION & CHARACTERIZATION **10 Hrs.**

Introduction to Catalysis, Definition, Classification, Properties of catalysts, Preparation of catalysis - Laboratory Techniques, Industrial methods, Transition models, Dual functional catalysts, Zeolites, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active ingredients. Formation of catalysts, Surface area measurements, BET Theory, Pore size distribution, Porosimetry Chemisorption, Crystallography and surface analysis techniques, XRD, Surface acidity and toxicity, Activity, Life time, Bulk density, Thermal stability

UNIT III: APPLICATION OF PETROLEUM CHEMISTRY **11 Hrs.**

Processing and Refining of crude oil: Processing and Refining of crude oil: Distillation, Sweetening and Cracking (basic concepts), Reforming, Isomerization, Alkylation processes, Polymerization processes, Solvent process, Knocking, Octane number and Cetane number, Additives to improve the quality of Diesel and Petrol, Catalysis and Applications of Catalysts (like Zeolite and other catalysts) in separation processes and also in petroleum industries. Shape selective catalysis

UNIT IV: CATALYTIC REACTORS **11 Hrs.**

Industrial reactor types, theoretical background, design and operation of reactors, strategy and considerations in reactor design, evaluation of reactor performance, Catalyst deactivation, types of deactivation and regeneration. Industrial applications of catalyst, Catalysis and green chemistry, phase transfer catalysis and bifunctional catalysis. Chemical engineering aspects of reactors.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic concepts of petroleum chemistry and heterogeneous catalysis
CO2 : **Understand** different methods of catalyst preparation and formation.
CO3 : **Analyse** and correlate the physicochemical properties of catalysts.
CO4 : **Correlate** the properties of crude oil with their physicochemical properties
CO5 : **Understand** the design and application of catalytic reactors in lab and industry
CO6 : **Have** depth knowledge of industrial applications of catalysis in petroleum industry.

TEXT/REFERENCE BOOKS

1. Charles N Shatterfield, **Heterogeneous Catalysis in Industrial Practice**, Krieger Publishing, 2nd Edn. 1996
2. H. Scott Fogler, **Elements of Chemical Reaction Engineering**, Fourth Edition,.
3. G. F. Froment, K. B. Bischoff, **Chemical Reactor Analysis and Design**,
4. Roger Arthur Sheldon, Isabel Arends ,**Green Chemistry and Catalysis**.
5. Jerzy Haber1, Jochen H. Block, Bernard Delmon James Speight, Baki Ozum. **Petroleum Refining Processes, Methods and Procedures for Catalyst Characterization**,
6. Speight, J. G - **The Chemistry and Technology of Petroleum**
7. George A. Olah & Arpad Molnar – **Hydrocarbon Chemistry**
8. Speight, J. G. - **Handbook of Petroleum Analysis**
9. William D. McCain - **The Properties of Petroleum Fluids**

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 3 Questions from each unit, each carrying 3 marks	36 Marks
Part B/Question: 2 Questions from each unit, each carrying 8 marks	64 Marks

24MSC616P					Industrial Chemistry Stream Elective Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				50	50	100

COURSE OBJECTIVES

1. To learn synthesis and characterization of pigments.
2. To learn analysis of commercial cosmetic products.
3. To learn synthesis and characterization of nanomaterials.
4. To acquire hands on experience on polymer synthesis.
5. To learn use of gas chromatography for sample analysis.
6. To test various properties of oils.

LIST OF EXPERIMENTS

1. Preparation and characterization of red/yellow/white/green pigment. (Any one amongst Fe3O4/Chrome yellow/ZnO, PbCl2/Malachite).
2. Testing photo stability of commercial sunscreens by absorption spectroscopy.
3. Synthesis and characterization of polyacrylamide based superadsorbent polymer.
4. Analysis of water absorption capacity of superadsorbent polymer.
5. Estimation of hardness of water by titration with soap solution.
6. Synthesis and characterization of nanomaterials using wet chemical methods (any one): Metal Oxides/Metal Hydroxides/Metal Sulphides/Hybrid Composites.
7. Synthesis of zeolite via hydrothermal method.
8. Characterization of zeolite by FT-IR analysis and XRD analysis.
9. Emulsion polymerization of styrene.
10. Analysis of mixture of hydrocarbons by gas chromatography.
11. To find the flash and fire point of the given oil sample.
12. To determine the viscosity of a given oil sample and also the effect of temperature on viscosity.

COURSE OUTCOMES

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

CO1 : Learn to prepare and characterize pigments.
CO2 : Derive the % purity and stability of commercial cosmetic products by spectroscopic/chromatographic techniques
CO3 : Develop and characterize different types of nanomaterials.
CO4 : Discover the synthesis of polymers and proficiency in water absorption capacity analysis.
CO5 : Evaluate the mixture of hydrocarbons by gas chromatography
CO6 : Test the important quality parameters of oils.

TEXT/REFERENCE BOOKS

1. Martín, Mariano Martín, **"Industrial chemical process analysis and design"**, Elsevier, 2016.
2. Benvenuto, Mark Anthony, **"Industrial chemistry: for advanced students"**, Walter de Gruyter GmbH & Co KG, 2015.
3. Mohammad, Farhat Ali, and M. E. A. Bassam, **"Handbook of industrial chemistry: organic chemicals"** (2005).

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
LW(Daily lab performance plus journal maintain each 25 marks)	50 Marks
LE (Viva-voce plus Lab examination each 25 marks)	50 Marks

STREAM ELECTIVES FOR ANALYTICAL CHEMISTRY SPECIALIZATION

24MSC606T					Atomic & Molecular Spectroscopy					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To comprehend advanced spectroscopy as a tool for molecular structure determination
2. Attaining basic principles applied for mass spectrometry measurements.
3. To estimate how chemical reactions like fragmentation in mass assist in spectral analysis
4. Acquiring the knowledge of basic theory of nuclear magnetic resonance spectroscopy and able to interpret basic NMR spectra
5. Learning the fundamental principal of photoelectron spectroscopy.

UNIT I: FUNDAMENTALS OF MASS SPECTROMETRY **11 Hrs.**

Introduction of mass spectrometry- Basic terminology, Principle of a mass spectrometer Formation and acceleration of ions, Behavior of ions in electric and magnetic fields, Ion focusing, The Mass Spectrometer, High-Resolution Mass Spectrometry

Instrumentation: Ionization Methods, Chemical Ionization; Electron Ionisation (EI), Electrospray Ionisation (ESI), Desorption Ionization, Modes of ionization (positive, negative), mass analyser and detectors Detectors, data acquisition, vacuum systems:

Interpretation of mass spectra: Molecular and Fragment Ions, The Base Peak, The Molecular or Parent Ion (M+), The (M + 1)+ Ion Formation of Adducts, Isotopic Fragments; Depicting Mass Spectral Data; The Molecular or Parent Ion; Predicting the Formation of M+; The Nitrogen Rule; Metastable Ions; Doubly Charged Ions; The General Fragmentation Process; The Fragmentation of a Hypothetical Molecule

UNIT II: MASS SPECTROMETRY: DATA ANALYSIS & STRUCTURE ELUCIDATION **11 Hrs.**

The Analysis of Mass Spectra: Identifying the Molecular Ion; The Fragmentation of M+; Determining the Molecular Ion from the Fragments; General Rearrangement; Skeletal Rearrangement; The McLafferty Rearrangement; The Loss of Neutral Fragments; Atomic Weight Determinations; The Isotopes of Carbon; Calculating Relative Intensities; The Experimental Determination of the Carbon Number; Compounds Containing Bromine and/or Chlorine; Compounds Containing Sulfur,

Structural Elucidation: The Fragmentation Patterns of- Straight-Chain Alkanes, Branched Alkanes, Cycloalkanes, Unsaturated Hydrocarbons, Alkyl Halides, Phenyl Halides, Benzyl Halides, Alcohols and Phenols, Problems in Mass Spectrometry: Introduction: Some General Suggestions for Interpreting Mass Spectra

UNIT III: PROTON NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY **10 Hrs.**

Introduction to NMR: Theory: Nuclear spin quantum number, properties of the nuclei, Magnetic moment of a nucleus, Fundamental NMR equation, Larmor precession, spin-spin and spin lattice relaxations,

Instrumentation & Chemical Shift: Sample Handling, Shielding, Deshielding and Chemical Shift, Standard for proton NMR, Tetramethylsilane (TMS) as reference compound, Advantages of TMS as a reference compound, Measurement of Chemical Shift: NMR Scale, δ(or ppm) and τ scale, Factors Affecting chemical Shift: Electronegativity-inductive effect, Anisotropic effects, Hydrogen bonding, van der Waals deshielding

Interpretation & Applications of NMR: Number of PMR Signals: Equivalent and Non-equivalent Protons, Peak Area and Proton counting, Spin-Spin Splitting: Spin-Spin coupling, Multiplicity-Number of Component Peaks (Lines) in Multiplet, Relative Intensities of Component Peaks (Lines) of a Multiplet, Analysis (Interpretation) of NMR Spectra, Applications of PMR Spectroscopy

UNIT IV: PHOTOELECTRON SPECTROSCOPY **10 Hrs.**

Introduction to Photoelectron spectroscopy: The photoelectric effect, Origin of X-ray spectra, Energy levels in atom, electron binding (ionization) energy, UV photoelectron spectroscopy,

Principle & Instrumentation X-ray photoelectron spectroscopy: Chemical shifts in XPS, Chemical shifts and oxidation states,

Analytical applications of XPS, Auger electron spectroscopy: Auger process, mechanism of emission of an Auger electron, Auger Transitions: ionization, relaxation and emission, nomenclature for Auger transitions: ABB transitions, AAB transitions, Coster-Kronig transitions, Examples of Auger Processes, Kinetic Energies of Auger Electrons.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Estimate** molecular weight by using mass spectra
CO2 : **Able** to understand various mass spectrometric parameters
CO3 : **Elucidate** chemistry of fragmentation reactions in mass spectroscopy
CO4 : **Understand** and differentiate between XPS, UPS and Auger spectroscopy and can demonstrate their practical application
CO5 : **Interpret** the basic H^1NMR spectra, differentiate equivalent and non-equivalent protons and identify the splitting of NMR peak by analysing the chemical formulae
CO6 : **Conceptualize** the role of electron, proton and atomic mass, in magnetic resonance spectroscopy, photoelectron spectroscopy and mass spectrometry

TEXT/REFERENCE BOOKS

1. Donald L. Pavia, Gary M. Lampman, George S. Kriz, Introduction to Spectroscopy
2. Yadav, L. D. S. (2013). *Organic spectroscopy*. Springer Science & Business Media.
3. C. N. Banwell, E. M. McCash, Fundamentals of molecular spectroscopy
4. Peter Atkins, Julio de Paula, Physical Chemistry
5. William Kemp, Organic Spectroscopy
6. D. A. Skoog, D. M. West, Principles of Instrumental Analysis

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration

24MSC607T					Advanced Instrumental Techniques-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

7. Gaining the practical kowlwdge of microscopic techniques.
8. Acquiring basic principles applied for spectroscopic measurements.
9. Attaining necessary basic knowledge of chromatographic separation and difference in various kind of chromatographic techniques
10. Gaining the factual knowledge of surface analysis techniques
11. Learning of various instrumental techniques to determine characteristic properties.

UNIT I: MICROSCOPIC TECHNIQUES **11 Hrs.**

Electron Microscopy-Principles of electron microscopy, Electrons in microscopy, Resolution of EM, instrumentation, Scanning Electron Microscopy: Electron sources and lens, Scattering of electrons, secondary electrons, back scattered electrons, components of SEM, Advantages and disadvantages of SEM, Transmission Electron Microscopy: Pricipal of TEM, components of TEM, Advantages and disadvantages of TEM,
Atomic Force Microscopy: working principal of AFM, types of AFM: contact mode AFM, Non-contcat mode AFM, intermittent or tapping mode AFM, resolution of AFM.
Confocal Microscopy: Principle, instrumentation, advantages and disadvantages, and applications.
Fluorescence Microscopy: Principles: Excitation and emission, fluorophores, Jablonski diagrams, excitation and emission spectra, Intersystem crossing, Quantum yield and fluorescence intensity, and applications.

UNIT II: OPTICAL TECHNIQUES **11 Hrs.**

Infra-red Spectroscopy:
Introduction to IR Spectroscopy, Electromagnetic Spectrum, Electromagnetic Radiation and Spectroscopy, Infrared Regions, Molecular Vibrations, Calculation of Molecular Vibrations, Infrared Active Modes, Absorption Considerations,
Basic principles of instrumentation: FTIR Instruments: IR source, Interferometer, Beam Splitter, Moving Mirror, Fixed Mirror, Laser, Detector FTIR Operation, FTIR Advantages: Speed, Sensitivity, Simplicity, Internal calibration, Sample Preparation: As a Liquid, As a Solution, As a Nujol Mull, As a KBr Disc, Attenuated Total Reflectance (ATR): Typical ATR Crystal Materials, ATR Instrument**,** Applications of IR Spectroscopy.
Ultra-violet and Visible Spectroscopy- Introduction to UV/VIS Spectroscopy: What is UV/VIS spectroscopy**,** Measurement principle**,** Lambert-Beer law**,** UV/VIS Spectroscopy in Analytical Chemistry**,** Why do we measure UV/VIS spectra? Qualitative analysis: Identification**,** Quantitative analysis: Concentration determination
Spectrophotometer Design: Design comparison, scanning spectrophotometer, Array spectrophotometer Optical pathways: Single beam configuration, Double-beam optical pathway: Simultaneous in time, and Alternating in time with an optical chopper (OC) Cuvette-based UV/VIS spectroscopy, Applications, Fixed wavelength, Concentration determination by quantification, Scanning, Kinetics
Accurate and Precise UV/VIS Measurements: Solvent selection, Sample concentration, Wavelength selection, Analysis of mixtures, Micro-volume based UV/VIS spectroscopy

UNIT III: CHROMATOGRAPHIC TECHNIQUES **10 Hrs.**

Introduction to Chromatographic techniques: Classification, principle and efficiency of the technique.
Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.Qualitative and quantitative aspects of chromatographic methods of analysis: Liquid chromatography, Gel permeation chromatography, Thin layer chromatography, Gas chromatography, High performance liquid chromatography IC, GLC, GPC, TLC and HPLC.
Instrumentation and applications of GC, GPC, HPLC.

UNIT IV: SURFACE ANALYSIS INSTRUMENTS **10 Hrs.**

BET surface area technique- Brunauer-Emmett-Teller (BET) theory, the physical adsorption of gas molecules on a solid surface, BET equations, measurement of the total Surface area, specific surface area of materials, Porosity - pore volume, pore radius, sample preparation and experimental setup, Applications and shortcomings of BET.
X-ray photoelectron Spectroscopy: Principle of the technique, instrumentation, peak identification, and application.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Learn various type of chromatographic techniques and will acquire the basic knowledge of the instrumentation involved in these techniques.
CO2 : Describe the technique to analyse surface area and can differentiate between topographic techniques and surface area analysis
CO3 : Utilize the knowledge of advance instrumentation techniques and will be able to understand their working principal and applications .
CO4 : Examine the working mechanism of electron microscopy.
CO5 : Perceive the knowledge on the topographic techniques available for surface analysis
CO6 : Develop comprehensive understanding of optical techniques and apply this knowledge effectively in laboratory settings.

TEXT/REFERENCE BOOKS

1. Vogel, Arthur I, **"A Test book of Quantitative Inorganic Analysis"** (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman.
2. Willard, Hobert H. et al., **"Instrumental Methods of Analysis"**, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D, **"Analytical Chemistry"**, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C, **"Exploring Chemical Analysis"**, Ed. New York, W.H. Freeman, 2001.
5. Robinson, James W., Eileen Skelly Frame, and George M. Frame II, **"Undergraduate instrumental analysis"** CRC press, 2014.
6. Srivastava. A.K. and. Jain, P.C, **"Instrumental Approach to Chemical Analysis"**, 4th Edition, S Chand and Company Ltd, New Delhi, 2012. 2.
7. Chatwal. G. R., Anand, Sham K., **"Instrumental Methods of Chemical Analysis"** 5th Edition, Himalaya Publishing House, 2005.
8. Harvey, David, **"Modern analytical chemistry"** McGraw Hill, 2000.
9. Rouessac, Francis, and Annick Rouessac, **"Chemical analysis: modern instrumentation methods and techniques"** John Wiley & Sons, 2022.
10. Vickerman, John C., and Ian S. Gilmore, eds. **"Surface analysis: the principal techniques"** John Wiley & Sons, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	Exam Duration: 3 Hrs
Part A/Question: 10 multiple choice questions 1 mark each	10 Marks
Part B/Question: 10 Questions of 2 marks each with internal choice	20 Marks
Part C/Question: 4 Questions of 15 marks each with internal choice	60 Marks
Part D/Question: 1 Questions of 10 marks comprising a figure of an instrument for labelling and identifying its various parts	10 Marks

24MSC608T					Advanced Instrumental Techniques-II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To gain the factual knowledge of X-Ray analysis techniques and basic instrumentation techniques based on X-ray
2. To learn the fundamental principles of various thermal techniques
3. To acquire basic principles applied for magnetic resonance measurements
4. To attain necessary basic knowledge of Raman analysis
5. To learn the basic instrumentations of various analytical techniques comprising instruments used in surface analysis, spectroscopic analysis, and thermal analysis

UNIT I: X-RAY DIFFRACTION TECHNIQUE **11 Hrs.**

Principles of Diffraction- Origin of X-Ray Spectra, Energy Levels in Atoms, Moseley's Law, X-Ray Methods, X- Ray Absorption Process, X-Ray Fluorescence Process, X-Ray Diffraction Process.

X-Ray Diffraction- Single-Crystal X-Ray Diffractometry, Crystal Structure Determination, Powder X-Ray Diffractometry, Applications of XRD, Analytical Limitations of XRD

X-Ray Photoelectron Spectroscopy- Basics principles of XPS, application of XPS

UNIT II: THERMAL TECHNIQUE **11 Hrs.**

Thermogravimetry- TGA Instrumentation, Analytical Applications of Thermogravimetry, Derivative Thermogravimetry, Sources of Error in Thermogravimetry

Differential Thermal Analysis- DTA Instrumentation, Analytical Applications of DTA

Differential Scanning Calorimetry- Basics principles of DSC, Difference between DSC and DTA, DSC Instrumentation, Applications of DSC.

UNIT III: ELECTRON SPIN RESONANCE TECHNIQUE **10 Hrs.**

Introduction, Theory, ESR Absorption Positions: The g Factor, Instrumentation, Working of an ESR Spectrometer, Sample Handling, Sensitivity of an ESR Spectrometer, Multiplet Structures in ESR Spectroscopy, Interpretation of ESR Spectra, Applications of ESR Spectroscopy

UNIT IV: RAMAN TECHNIQUE **10 Hrs.**

Principles of Raman Scattering, Raman Instrumentation, Applications of Raman Spectroscopy Introduction, Raman Effect and Origin of Raman Spectroscopy, Theories of Raman Effect and Raman Spectroscopy, Zero-Point Energy, Vibrational Raman Spectra, Pure Rotational Raman Spectra, Types of Molecules and Rotational Raman Spectra, Vibrational-Rotational Raman Spectra, Polarization of Raman Lines, Rule of Mutual Exclusion, Instrumentation, Sample Handling, Applications of Raman Spectroscopy

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : Gain an understanding of the fundamental principles of surface analysis and be able to describe how interaction of X-ray on the matter

CO2 : Obtain new knowledge about the instrumentation involved for various X-ray techniques

CO3 : Application of thermal techniques in characterization of the material.

CO4 : Basic principle, instrumentation and applications the electron spin resonance (ESR) spectroscopy for organic and inorganic analysis

CO5 : Basic principles, instruments and theory behind Raman spectroscopy.

CO6 : Study various types of surface and molecular analysis techniques and acquire basic knowledge of the instrumentation used in these techniques.

TEXT/REFERENCE BOOKS

1. Vogel, Arthur I "**A Test book of Quantitative Inorganic Analysis** "5th Ed. TheEnglish Language Book Society of Longman.
2. Willard, Hobert H. "**Instrumental Methods of Analysis**" 7th Ed. Wardsworth Publishing Company,Belmont, California, USA, 1988.
3. Christian, Gary D "**Analytical Chemistry**" 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C "**Exploring Chemical Analysis**" New York, W.H. Freeman, 2001.
5. Robinson, James W., Eileen Skelly Frame, and George M. Frame II. "**Undergraduate instrumental analysis**" CRCpress, 2014.
6. Srivastava. A.K. and. Jain, P.C, "**Instrumental Approach to Chemical Analysis**", 4th Edition, S Chand andCompany Ltd, New Delhi, 2012.
2.
7. Chatwal. G. R., Anand, Sham K., "**Instrumental Methods of Chemical Analysis**" 5th Edition, HimalayaPublishing House, 2005.

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 Questions from each unit, each carrying 1 mark	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 10 marks	80 marks

24MSC609T					Electroanalytical and Radio Analytical Methods of Analysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the role of electrochemistry in use of electroanalytical techniques.
2. To understand the importance of radioanalysis.
3. To gain knowledge about the principles of potentiometry, amperometry and coulometry.
4. To attain basic knowledge of voltammetry, polarography and electrochemical impedance spectroscopy.
5. To learn the basic principles and techniques for radioactive/radiolabelled chemical's analysis.

UNIT I: INTRODUCTION TO ELECTROANALYTICAL TECHNIQUES **10 Hrs.**

Introduction to electroanalytical techniques, electrochemical cells, electrodes and electrode potentials, Faradaic and Non-Faradaic Processes, Electric double layer, Point of zero charge, Rates of Electrode Reactions: overpotentials and cell resistances, mass transport control (Nernst-Planck Equation), Applications of eletroanalytical techniques

UNIT II: ELECTROANALYTICAL TECHNIQUES I **12 Hrs.**

Potentiometry: Principle, Electrodes- Reference, Indicator, membrane, ion selective, Cell EMF, potential measurement and determining processes; immiscible phases; potentials at electrolyte-electrolyte boundaries-conductance and transference, liquid junction potentials, Applications

Amperometry: Principle, applications, amperometric titrations, chronoamperometry and chrono-potentiometry.

Coulometry: Principle, fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faraday's laws of electrolysis, coulometric titrations, controlled potential coulometry, (Amperostatic coulometry)

UNIT III: ELECTROANALYTICAL TECHNIQUES II **10 Hrs.**

Polarography, differential pulse, normal pulse, staircase, and square-wave polarography Ilkovic Equation, Voltammetry- square wave, stripping, linear sweep and cyclic voltammetry, hydrodynamic (rotating disk) voltammetry, Applications of polarography and voltammetry, electrochemical impedance spectroscopy

UNIT IV: RADIOANALYTICAL METHODS OF ANALYSIS **10 Hrs.**

Activation analysis: Neutron activation analysis, principle and steps involved and applications. Radiochemical and instrumental methods of analysis, Isotope dilution analysis: Principle, types of isotope dilution analysis, typical applications of isotope dilution analysis; Radiometric titration: Principle, techniques based on complex formation and precipitation, radiometric titration curves for estimation of ions from their mixture.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the foundational principles applied to electroanalyticalysis and radioanalysis.
CO2 : **Demonstrate** the fundamentals of Potentiometry, amperometry and Potentiometry.
CO3 : **Knowledge** of electrochemistry and electroanalytical technique to select the appropriate characterization method.
CO4 : **Apply** the voltammetry, polarography and EIS for different redox systems.
CO5 : **Explain** the use of various types of radioanalytical techniques.
CO6 : **Illustrate** the schemes for chemical sample analysis using radioanalytical and electrochemical techniques.

TEXT/REFERENCE BOOKS

1. **Introduction to instrumental analysis** by R. D. Broun, Mc Graw Hill (1987).
2. **Instrumental methods of chemical analysis** by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986).
3. **Fundamentals of analytical chemistry** by D. A. Skoog, D. M. West and H. J. Holler sixth edition (1992) and Principles of Instrumental Analysis Skoog, West, Niemann.
4. **Cyclic Voltammetry and frontiers of electrochemistry** by N.Noel and K.I. Vasu IBH, New Delhi (1990).
5. **Principle of Activation Analysis**- P. Kruger, John Wiley and sons.
6. **Nuclear Analytical Chemistry** – J. Tolgyessy and S. Verga vol. 2, University Park press.
7. **Radiochemistry and Nuclear Chemistry**- Gregory Choppin, Jan-Olov Liljenzin, Jan Rydberg, Christian Ekberg, Fourth Edition • 2013, Elsevier Inc.
8. **Radiochemistry and Nuclear methods** – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
9. **Nuclear and Radiochemistry: Fundamentals and Applications**, Third, Revised Edition, Editor(s):Jens-Volker Kratz, Karl Heinrich Lieser, First published:30 August 2013

EXAM PATTERN

Max. Marks: 100 Exam **Duration: 3 Hrs**

Part A/Question: 3 Questions from each unit, each carrying 3 marks 36 Marks

Part B/Question: 2 Questions from each unit, each carrying 8 marks 64 Marks

24MSC610T					Method Development and Validation					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To gain the fundamental knowledge of advance data analysis, correlation, and regression analysis
2. To learn the basic principles for regulatory requirements for analytical method validation
3. To understand and acquire the necessary basic knowledge of qualification of instruments; installation, operation, and performance qualification of analytical equipment.
4. To attain detailed insight into accuracy and precision role in method validation
5. To learn the basic calibration of instrument including the Limit of Detection (LOD) and Limit of Quantification (LOQ).

UNIT I: DATA ANALYSIS **11 Hrs.**

Sampling (Statistics of Sampling), Standardization and Calibration: Analytical samples and methods;
Sampling; Automated Sample Handling; Standardization and Calibration; Correlation and Regression Analysis, Linear Regression; Detection Limits; How to efficiently use MS Excel and Origin in data analysis (Slope, Intercept, and Coefficient of Determination)
Calibration of analytical balance and pH meter; role of quantification limit and specificity; Limit of Detection (LOD) and Limit of Quantification (LOQ); Robustness and method validation; Ruggedness of chromatographic method; Ruggedness of sample preparation procedure; Calibration verses Qualification verses Validation

UNIT II: METHOD DEVELOPMENT AND VALIDATION-I: SPCTRTOSCOPIC AND THERMAL TECHNIQUES **11 Hrs.**

Qualification: Overview of qualification of instruments; installation, operation, and performance
qualification of analytical equipment; method validation for UV-Visible Spectrophotometer, IR Spectrophotometer, Spectrofluorometer, TGA, DSC, DTA, qualitative and quantitative method validation; parameters of validation; statistics in validation; detailed discussion on accuracy and precision role in method validation; protocols and interpretation.

UNIT III: METHOD DEVELOPMENT AND VALIDATION-II: CHROMATOGRAPHIC **10 Hrs.**

Qualification: Overview of qualification of instruments; installation, operation, and performance
qualification of analytical equipment; method validation for HPTLC, GC, HPLC; qualitative and quantitative method validation; parameters of validation; statistics in validation; detailed discussion on accuracy and precision role in method validation; protocols and interpretation.

UNIT IV: METHOD DEVELOPMENT AND VALIDATION-III: ELECTROANALYTICAL TECHNIQUES **10 Hrs.**

Qualification: Overview of qualification of instruments; installation, operation and performance qualification of analytical equipment; method validation for electroanalytical techniques like voltametric techniques (cyclic voltammetry, liner sweep voltammetry), pulse techniques (SWV and DPV), frequency response analysis (FRA); qualitative and quantitative method validation; parameters of validation; statistics in validation; detailed discussion on accuracy and precision role in method validation; protocols and interpretation.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Understand** the basic principles of error analysis and comparison of two or more than two data sets
CO2 : **Acquire** the fundamental knowledge of calibration and ruggedness.
CO3 : **Learn** various types of method developments and validation of spectroscopic methods.
CO4 : **Explore** methods necessary to interpret the chromatographic technique.
CO5 : **Explain** the accuracy and precision role of electroanalytical methods.
CO6 : **Explain** the basic calibration of the instrument including the Limit of Detection (LOD) and Limit of Quantification (LOQ) for spectroscopic, chromatographic and electroanalytical methods.

TEXT/REFERENCE BOOKS

1. Chris Burgess & J J Wilson "**Valid Analytical Methods and Procedures**" 2001
2. Chung Chow Chan, Herman Lam, Y.C. Lee, Xue-Ming Zhang "**Analytical Method Validation and Instrument Performance Verification**" 2004
3. David Harvey "**Modern Analytical Chemistry**" McGraw Hill, 2000.
4. Charles H. Lochmüller "**Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach**" Duke University, 2009
5. G. H. Geefferyetal "**Vogel's Text Book of Quantitative Chemical Analysis**" ELBS Edn, 1989
6. D. A. Skoog, D.M. West, F.J Holler, S.R Crouch "**Fundamentals of Analytical Chemistry**" 8th edition, Thomson Brooks Cole, 2004
7. F. Rouessac and A. Rouessac "**Chemical Analysis: Modern Instrumentation**" Kindle Edition
8. D. A. Skoog, E. J. Holler, S. R. Crouch "**Principles of Instrumental Analysis**" 6th edition, Cengage Learning, 2017

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration
Part A/Question: 20 Questions from each unit, each carrying 1 marks	20 Marks
Part B/Question: 8 Questions from each unit, each carrying 10 marks	80 marks

24MSC617P					Stream Elective- Analytical Chemistry Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	3	1.5	3				50	50	100

COURSE OBJECTIVES

1. To learn the basic experimental techniques like chromatography, titrimetric, spectrophotometric methods
2. To gain experimental knowledge to separate ions or compounds by paper chromatographic method and TLC.
3. To estimate organic content in food products
4. Proficiency in extraction methods and purification techniques.
5. Structural determination of compounds by various analytical methods

LIST OF EXPERIMENTS

1. Determining the Concentration of Citric Acid in Commercially Available Cold Drink Using Titration.
2. Analysis of COD in Waste Water Sample
3. Paper Chromatographic technique for separation of metal ions
4. Extraction of caffeine from coffee.
5. Spectrophotometric Analysis of a Mixture: Caffeine and Benzoic Acid in a Soft Drink.
6. Determination of %age of Asprin in the given tablet.
7. Determination of saponification value of oil.
8. Structural elucidation of compounds by FTIR and XRD analysis; band gap analysis by solid state UV analysis.
9. Determination of Vitamin C from given tablet using titration.
10. Simultaneous estimation of chromium (III) and iron (III) by EDTA titration.
11. Separation of complex organic mixture (eg. BTX) using GC.
12. Separation of aminoacids/ dyes/ drugs by TLC.

COURSE OUTCOMES

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

CO1 : **Relate** the theoretical knowledge with the laboratory technique for the various analytical techniques
CO2 : **Illustrate** the experimental analytical technique to determine % purity of desired compound present in the given material.
CO3 : **Acquire** the knowledge of determination of chemical oxygen demand in the given sample of waste water.
CO4 : **Take** part in hands on experiment and deep knowledge regarding different analytical techniques.
CO5 : **Examine** the given organic mixture by different analytical techniques.
CO6 : **Construct** a critical thinking to effectively solve complex problem using various analytical techniques.

TEXT/REFERENCE BOOKS

1. John H. Kennedy, **"Analytical Chemistry Practice"**, Saunders College Publishing, Second Edition 1990.
2. A. I. Vogel, **"Vogels Textbook of Quantitative Chemical Analysis"**, 5th Edition, Longman Scientific & Technical Wiley 2002.
3. V. K. Ahluwalia, **"Comprehensive Experimental Chemistry"**, New Age Publications,1997.
4. R. M. Varma, **"Analytical Chemistry: Theory and Practice"**, CBS Publishers, 1994
5. A. K. Nad, B. Mahapatra & A. Ghosal, **" An Advanced Course in Practical Chemistry"**, New Central Book Agency (P) Limited, 2014, 2014.
6. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, **"Principles of Instrumental Analysis"**, Cengage Learning, 2017.

EXAM PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Laboratory work including maintaining journal book+ mid-sem viva (LW) 50 Marks
End–sem exam and viva (LE/Viva) 50 Marks

STREAM ELECTIVES FOR ORGANIC CHEMISTRY SPECIALIZATION

24MSC611T					Reagents and Organic Synthesis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To define various lanthanides-based reagents
2. To outline numerous name reactions involved in various organic transformation
3. To construct basic knowledge of modern spectroscopic techniques.
4. To analyse interpreting individual spectra and sets of spectra obtained by different spectroscopic
5. To explain Importance of spectroscopic techniques in application to elucidate organic compound structure
6. To predict theory and application of various spectroscopy in organic synthesis

UNIT I: LANTHANIDES BASED REAGENTS **12Hrs.**

General properties and use of Lanthanides, Lanthanide metal compounds at different oxidation states in synthesis. Study of reagents from (i) Cerium
(ii) Samarium (iii) Ytterbium

UNIT II: MODERN ORGANIC SYNTHETIC REACTIONS **10 Hrs.**

Aza-Cope and Aza-Wittig reactions, Baylis-Hillman reaction, BINAL and BINAP assisted reactions, click reaction, Julia- Lythgoe olefination, Mukayama aldol reaction, Peterson's stereoselective olefination, selected total synthesis.

UNIT III: PRINCIPLES AND APPLICATION OF UV-VISIBLE AND IR SPRCTROSCOPY FOR ORGANIC COMPUNDS **10 Hrs.**

UV-VISIBLE SPECTROSCOPY: Various electronic transitions - Effect of solvent on electronic transitions - Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes aromatic and heterocyclic compounds. Fieser Woodward rules for conjugated dienes and carbonyl compounds. IR: Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. Interpretation of spectroscopic (UV and IR) data, as applied to organic system.

UNIT IV: PRINCIPLES AND APPLICATION OF NMR AND MASS SPRCTROMETRY FOR ORGANIC COMPUNDS **10 Hrs.**

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY: 1H-, 13C-, 19F-, 15N-, and 31P-NMR, Introduction to 2D- NMR techniques: COSY, HMQC and
HECTOR Spectra. MASS: Theory, instrumentation and modifications; Unit Mass and molecular ions; recognition of M+ ions, General fragmentation rules; McLafferty rearrangements. Interpretation of spectroscopic (NMR and mass) data, as applied to organic system.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Define** various lanthanides-based reagents
CO2 : **Explain** numerous name reactions involved in various organic transformation
CO3 : **Identify** the basic knowledge of modern spectroscopic techniques.
CO4 : **Analyse** individual spectra and sets of spectra obtained by different spectroscopic
CO5 : **Explain** importance of spectroscopic techniques in application to elucidate organic compound structure
CO6 : **Predict** theory and application of various spectroscopy in organic synthesis

TEXT/REFERENCE BOOKS

1. T. Imamoto, Lanthenides in **"Organic synthesis"**, Academic Press.
2. Carruthers, W. "**Modern Methods of Organic Synthesis**" Cambridge University Press.
3. Kemp, W. **"Organic Spectroscopy"** H. Freeman & Co.
4. P.Y. Bruice, **"Organic Chemistry"** Prentice Hall.
5. Silverstein, R.M., Bassler, **"Spectroscopic Identification of Organic Compounds John Wiley & Sons."**
6. Pavia Lampman, **"Organic Spectroscopy"**

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration 3 Hrs

24MSC612T					Stereochemistry and Photochemistry					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To define isomerism in naturally occurring compound.
2. To explain stereo selective, specific synthesis and its application in organic chemistry
3. To identify the symmetry elements & importance of stereo chemistry in chiral compounds.
4. To demonstrate the Importance of Nitrogen, Sulphur and Phosphorus containing compounds.
5. To analyse experimental methods of photochemistry. Photochemistry of carbonyl compound
6. To elaborate different types of photochemical reactions.

UNIT I: STEREOCHEMISTRY-I **12Hrs.**

Molecular Symmetry & Chirality: Symmetry operations and symmetry elements (Cn & Sn). Criteria for Chirality. Desymmetrization, Stereochemistry of the compounds containing Nitrogen, Sulphur and Phosphorus. Asymmetric synthesis. Stereochemistry of fused, bridged, and caged ring systems, resolution of enantiomers, etc.

UNIT II: STEREOCHEMISTRY-II **10 Hrs.**

Prochirality, enantiotopic and diasterotopic groups and faces, The Hammett relationship, stereochemistry and mechanism. Stereoelectronic and steric principles in reactions: Substitution, elimination and addition; selectivity and specificity. Importance of stereochemistry in real life: some examples

UNIT III: PHOTOCHEMISTRY-I **10 Hrs.**

Photochemical energy Franck Condon Principle, Jablonski diagram singlet and triplet states, dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield, experimental methods of photochemistry. Photochemistry of carbonyl compounds transitions, Norrish type I and Norrish type II cleavages, Paterno-Buchi reaction.

UNIT IV: PHOTOCHEMISTRY-II **10 Hrs.**

Photochemical reduction, substitution reaction, cis-trans isomerism, photochemistry of butadiene, di-pi methane rearrangement and related processes, Photochemistry of aromatic compounds – Excited state of benzene its 1,2-1,3 1-4 additions, photo Fries rearrangements

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Define** isomerism in naturally occurring compound.
CO2 : **Explain** stereo selective, specific synthesis and its application in organic chemistry.
CO3 : **Identify** the symmetry elements & importance of stereo chemistry in chiral compounds.
CO4 : **Analyse** experimental methods of photochemistry. Photochemistry of carbonyl compound**.**
CO5 : **Explain** the importance of Nitrogen, Sulphur and Phosphorus containing compounds.
CO6 : **Elaborate** different types of photochemical reactions.

TEXT/REFERENCE BOOKS

1. J. Clayden, N. Greeves and S. Warren, **"Organic Chemistry"** (Oxford University Press) ISBN 0199270295
2. E. L. Eliel and S. H. Wilen, "**Stereochemistry in Organic Compounds"** (Wiley) ISBN 0471016705
3. D. Nasipuri **"Stereochemistry of Organic Compounds**" Wiley.
4. Jerry March, **"Advanced Organic Chemistry: Reactions Mechanisms and Structure"** Wiley.
5. Charles Dupey and O. Chapman, **"Molecular reactions and Photochemistry"** Prentice Hall.
6. S.M. Mukherji and S. P. Singh, **"Reaction Mechanism in Organic Chemistry"** Trinity press.
7. Nicholas J. Turro V. Ramamurthy J. C. Scaiano, **"Principles of Molecular Photochemistry"**

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration 3 Hrs

24MSC613T					Heterocycles and Vitamins					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To define the basic concepts, importance of five and six membered heterocyclic.
2. To explain skills for various heterocycle synthesis and its application in organic chemistry
3. To develop the synthesis of heterocyclic compounds.
4. To acquire the basic knowledge of Chemistry, absorption & transport, sources, function of vitamins.
5. To discuss the biosynthesis of vitamins.

UNIT I: HETEROCYCLES – I **12Hrs.**

Five and six membered heterocyclics with two hetero atoms. Synthesis, reactivity, aromatic character and importance of the following heterocycles: Pyrazole, Imidazole, Oxazole, Thiazole, Isoxazole, Isothiazole, Pyridazine, Pyrimidine. Pyrazine, Oxazine, thiazine, benzimidazole, benzoxazole and benzthiazole. Heterocyclics with more than two hetero atoms. Synthesis, reactivity, aromatic character and importance of the following and their applications in organic synthesis. Heterocycles: 1,2,3-triazoies,1,2,4-triazoles, Tetrazoles, 1,2,4-oxadiazole, 1 ,3,4-oxadiazole, 1,2,5- oxadiazole, 1,2,3- thiadiazoles, 1,3,4-thiadiazoles, 1,2,5- thiadiazoles, 1,2,3-triazine, 1,2,4- triazine, 1,3,5- triazine,tetrazines. Synthesis and importance of purines and
pteridines. Syntheis of Caffeine, theobromine and theophylline.

UNIT II: HETEROCYCLES – II **10 Hrs.**

Nomenclature of bicyclic and tricyclic fused systems; Introduction to the chemistry of azepins, diazepenes oxepins, thiepins and their aza-analogues; Phosphorus and selenium containing heterocycles. Cyclazines. Larger ring and other Heterocycles: structure, stability and reactivity of Azepines, Oxepines and Thiepines. Synthesis of Diazepines rearrangements of 1, 2 – diazepines. Synthesis of Benzoazepines, Benzodiazepines,Benzooxepines,
Benzothiepines, Azocines and Azonines. Synthesis of selenophenes, Tellerophenes, Phospholes and Boroles.

UNIT III: VITAMINS – I **10 Hrs.**

Introduction, structure, and classification of common vitamins. Biological importance of vitamins. Chemistry, absorption & transport, sources, function and deficiency of both fat soluble and water-soluble vitamins.

UNIT IV: VITAMINS – II **10 Hrs.**

Biosynthesis of Vitamin A, E, B1 (Thiamine), AND B2 (Riboflavin)

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Define** importance of various heterocycle synthesis and its application in organic chemistry
CO2 : **Demonstrate** the basic concepts, importance of Heterocycles
CO3 : **Identify** properties and application of various industrial heterocyclic compound
CO4 : **Functions** of Vitamins in daily routine.
CO5 : **Explain** the importance of the function and deficiency of vitamins.
CO6 : **Construct** hetero cyclic scaffolds on the basis of synthesis knowledge for pharmacology.

TEXT/REFERENCE BOOKS

1. Morrison, R. N. & Boyd, R. N. **"Organic Chemistry",** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bahl, A. **"A text book of organic chemistry".** S. Chand.
3. Graham Solomons and Craig B. Frhyle , **"Organic Chemistry,"** John Wiley and Sons.
4. Lubert Stryer, **"Biochemistry,"** W. H. Freeman and Company.
5. David A. Bender, **"Nutritional Biochemistry of Vitamins"** Cambridge university press

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration 3 Hrs

24MSC614T					Chemistry of Natural Products					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. List biosynthesis of natural products
2. Classification of natural products.
3. Make a use of natural product chemistry in real life/pharmaceutical and industrial sector.
4. Analyse the structure and stereochemistry of natural products.
5. Importance of natural product as pharmacophore.
6. To demonstrate the basic knowledge of natural product synthesis.

UNIT I: TERPENOIDS AND CAROTENOIDS **12Hrs.**

Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Menthol, and β- Carotene.

UNIT II: ALKALOIDS AND PLANT PIGMENTS **10 Hrs.**

Alkaloids: Structure, stereochemistry, synthesis and biosynthesis of Ephedrine and Morphine.

Plant Pigments: Occurrence, nomenclature and general methods of structure determination; Isolation and synthesis of anthocyanins.

UNIT III: STEROIDS **10 Hrs.**

Basic skeleton and stereochemistry, Structure and synthesis of cholesterol, Steroid hormones, Chemical tests for steroids.

UNIT IV: PEPTIDES, PROTEINS AND NUCLEIC ACIDS **10 Hrs.**

Structure, synthesis, biogenesis of peptides, proteins, nucleosides, nucleotides; DNA and RNA.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Relate** List biosynthesis of natural products
CO2 : **Explain** Classification of natural products..
CO3 : **Identify** natural product chemistry in real life/pharmaceutical and industrial sector.
CO4 : **Analyse** the structure and stereochemistry of natural products.
CO5 : **Explain** importance of natural product chemistry.
CO6 : **Discuss** the importance of the basic knowledge of natural product synthesis.

TEXT/REFERENCE BOOKS

1. Finar, I. L. **"Organic Chemistry"**
2. Agarwal, O. P., **"Organic Chemistry Natural Products"**
3. Cseke, L.J**. "Natural Products from Plants".** CRC Press, Taylor and Francis.
4. Dewick, P.M., **"Medicinal Natural Products: A Biosynthetic Approach."** Willey & Sons, UK.
5. V.K. Ahluwalia, **"Chemistry of Natural Products."**
6. Thomson, R.H., **"The Chemistry of Natural Products"** Springer.

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration 3 Hrs

24MSC615T					Asymmetric Synthesis/Catalysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To define strategies to control stereo chemical relationships.
2. To explain the importance of enantiomerically pure organic compounds.
3. To make use of asymmetric catalysis in asymmetric synthesis.
4. To demonstrate syntheses of target core structures in a stereo controlled manner
5. To analyse the Importance of asymmetric synthesis.
6. To elaborate the knowledge of metal catalysis and organocatalysis.

UNIT I: PRINCIPLES OF ASYMMETRIC SYNTHESIS **12Hrs.**

Introduction and terminology. Topocity in molecules. Homotopic, Stereoheterotopics (enantiotropic and diastereotopic) groups and faces – Symmetry, substitution and addition criteria. Prochirality nomenclature: Pro – R, Pro – S, Re and Si.

UNIT II: SELECTIVITY IN SYNTHESIS **10 Hrs.**

Stereospecific reactions, Stereoselective reactions, Conditions of Stereoselectivity: Symmetry and transition state criteria, kinetic and thermodynamic control. Methods for inducing enantio and diastereoselectivity. Analytical methods: Techniques for determination of Enantioselectivity. Specific rotation, Chiral HPLC.

UNIT III: METHODOLOGY OF ASYMMETRIC SYNTHESIS **10 Hrs.**

Classification of Asymmetric Reactions into (1) Substrate controlled (2) Chiral Auxiliary controlled (3) Chiral reagent controlled and (4) Chiral catalyst controlled.

UNIT IV: ASYMMETRIC CATALYSIS **10 Hrs.**

Metal mediated catalysis – asymmetric hydrogenation; Noyori's BINAP – Sharpless epoxidation, Dihydroxylation, aminohydroxylation of alkenes, Organocatalysis – Proline mediated aldol reaction and further expansion in the field of Organocatalysis.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

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

CO1 : **Define** strategies to control stereo chemical relationships.
CO2 : **Explain** the importance of enantiomerically pure organic compounds
CO3 : **Identify the** use of asymmetric catalysis in asymmetric synthesis.
CO4 : **Analyse** syntheses of target core structures in a stereo controlled manner
CO5 : **Explain** the importance of asymmetric synthesis..
CO6 : **Elaborate** the knowledge of metal catalysis and organocatalysis

TEXT/REFERENCE BOOKS

1. D. Nasipuri **"Stereochemistry of Organic Compounds"** Wiley.
2. Vittorio Caprio, Jonathan M. J. Williams, **"Catalysis in Asymmetric Synthesis**" Wiley.
3. Iwao Ojima, **"Catalytic Asymmetric Synthesis"** Wiley.
4. Marisa C. Kozlowski, Patrick J. Walsh, **"Fundamentals of Asymmetric Catalysis"**
5. Mrs Y. Vatsala **"Asymmetric Synthesis-Principles And Methodology"** New Age International (P) Ltd Publishers
6. G. R. Stephenson, " Advance Asymmetric Synthesis
7. T. Takahikko akiyama, "Catalytic Asymmetric Synthesis"

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration 3 Hrs

24MSC618P					Stream elective-Organic Chemistry Lab-III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Knowledge about different multistage organic transformations
2. Learn regio-selective and chemo-selective Principles
3. Synthesis and mechanism

LIST OF EXPERIMENTS

Preparation of Industrially important compound by following name reactions (Mechanism, purification and Characterization of the synthesized compounds.

1 Sandmeyer reaction
2 Pechmann reaction
3 Skraup synthesis
4 Riemer-Tiemann reaction
5 Kolbe-smith reaction
6 Claisen-smith synthesis
7 Hoffman reaction
8 Diels-alder reaction t
9 Pechmann Condensation
10 Diazo Reaction

COURSE OUTCOMES

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

CO1 : **Define** region selective and chemo selective reactions
CO2 : **Interpretation** of structure for the synthesized compounds
CO3 : **Apply** different purification techniques
CO4 : **Analyse** different characterization techniques
CO5 : **Explain** the importance of multistep synthesis in commercial products.
CO6 : **Develop** new methods for organic synthesis and purification

TEXT/REFERENCE BOOKS

1. V.K Ahluwalia, Renu Aggarwal, "Comprehensive practical **Organic Chemistry: Quantitative analysis",** Universitiespress; ISBN 13: 978 81 7371 273 9
2. A. K. Nad, B. Mahapatra & A. Ghosal, "**An Advanced Course in Practical Chemistry"**, New Central,
3. Vogel's **"TextBook of Practical Organic Chemistry"**
4. Finar, I. L**.: "Organic Chemistry (volume 1)",** Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

SEMESTER EXAM PATTERN

Max Marks 100	Exam Duration