॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरणानुसार पदव्युत्तर स्तरावरील प्रथम वर्षाचे अभ्यासक्रम शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्याबाबत.

प रि प त्र क

संदर्भ:– १. जा.क्र.शै–१/एनईपी२०२०/S&T/अक्र/२०२३–२४/१३० दिनांक ३०/०६/२०२३

२. जा.क्र.शै–१/एनईपी२०२०/S&T/अक्र/२०२३–२४/१३३ दिनांक ०७/०७/२०२३

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, संदर्भीय परिपत्रकान्वये दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या मा. विद्यापरिषदेच्या बैठकीतील ऐनवेळचा विषय क्र. ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरणानुसार अभ्यासक्रम शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्यात आलेले आहेत. तथापी वरील संदर्भीय परिपत्रक १ व २ अन्वये प्रकाशित केलेल्या अभ्यासक्रमामध्ये अभ्यासमंडळानी किरकोळ दुरूस्ती करून अभ्यासक्रम सादर केले आहेत. त्यानुसार दुरूस्तीसह खालील अभ्यासक्रम लागू करण्यात येत आहेत.

1. M. Sc. Chemistry I year (University Campus)
2. M. Sc. Zoology I year (University Campus)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शैक्षणिक–१/परिपत्रक/एनईपीपीजी/S&T/
२०२३–२४/302

आपली विश्वासू

डॉ. सरिता यन्नावार
सहाय्यक.कुलसचिव

दिनांक : १८.०९.२०२३.

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यानां देवून कळविण्यात येते की, सदरील परिपत्रक विद्यापीठाच्या संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

School of Chemical Sciences

(Structure and Syllabus of Two Years Degree Program with Multiple Entry and Exit Option)

TWO YEAR MASTERS PROGRAMME IN SCIENCE

Subject: Chemistry (SCS)

With effect from academic year 2023-24

Under the Faculty of

Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program

Subject: Chemical Sciences

Year & Level 1	Sem. 2	Major Subject (DSC) (4 Cr) 3	Major Subject (DSE) 4	RM 5 (3 Cr)	OJT / FP 6 (3 Cr)	Research Project 7	Practicals 8	Credits 9	Tot Cred 10
1	1	SSCSC401 Inorganic Chemistry SSCSC402 Organic Chemistry SSCSC403 Physical Chemistry	SSCSE401 Principles of Analytical Chemistry **(3 Cr)** SSCSE402 Unit Operations **(3 Cr)** SSCSE403 Introduction to medicinal chemistry **(3 Cr)** SSCSE404 Chemistry of heterocyclic molecules **(3 Cr)** SSCSE405 Photochemistry **(3 Cr)** SSCSE406 Fundamentals of Polymer Chemistry **(3 Cr)**	SVECR 401 *Research Methodology*	--		Lab. Course 1 Inorganic Chemistry (2Cr) Lab. Course 2 Physical Chemistry (2Cr)	**22**	**44**
	2	SSCSC451 Inorganic Chemistry SSCSC452 Organic Chemistry SSCSC453 Physical Chemistry	SSCSE451 Spectrochemical Methods of analysis **(3 Cr)** SSCSE452 Transportation Processes in Unit Operations **(3 Cr)** SSCSE453 Drug Design **(3 Cr)** SSCSE454 Chemistry of Natural Products **(3 Cr)** SSCSE455 Statistical Thermodynamics **(3 Cr)** SSCSE456 Polymer Characterization and Testing **(3 Cr)**	---	OJT/FP SDSCOJ 451	--	Lab. Course 3 Organic Chemistry (2Cr) Lab. Course 4 Analytical Chemistry (2Cr)	**22**	
Exit option: Exit Option with PG Diploma *(after 2024-25)*									

2	**3**	SSCSC501 (4 Cr) SSCSC502 (4 Cr) SSCSC503 (4 Cr) Basic Principles of Spectroscopy and Group Theory (4Cr) Organic Reaction Mechanism (4 Cr) Organic Spectroscopy (4 Cr)	SSCSE501 (4 Cr) Chromatograhphic Methods of Analysis (4 Cr) Unit processes in Organic Synthesis (4 Cr) Advanced Medicinal Chemistry (4Cr) Organic Synthesis (4Cr) Electrochemistry (4Cr) Polymer Processing Technology (4Cr) (*From same Department / School)*	--		Research Project SDSCR551 (4Cr)	SDSCP501 (1 Cr) SDSCE502 (1 Cr) SDSCP551 (1Cr) SDSCE552 (1Cr) **(Practicals for third and four sem of 1 Cr are converted into 4Cr each and for third sem only.)** Lab Course 1 (4Cr) for Analytical Chemistry Industrial Chemistry Polymer Chemistry Lab Course 2 (4 Cr) for Medicinal Chemistry Organic Chemistry Physical Chemistry	**24**	**44**
	4	Synthetic Methods in Organic Chemistry (4Cr) Quality Assurance and Quality Control, Method of Analytical Development and Validation (4 Cr)	Applied Analytical Chemistry (4 Cr) Process Industry and Industrial Pollution Management (4Cr) Chemotherapy (4Cr) Advanced Organic Chemistry (4Cr) SDSCC552 (4 Cr) Advanced Quantum Chemistry (4Cr) Polymers from Renewable Resources (4Cr) (*From same Department / School)*	SVECP 551 Publication Ethics (2 Cr)		Research Project SDSCR552 (6 Cr)	-----	**20**	
Total Credits		**44**	**16**	**05**	**03**	**10**	**10**	**88**	

M. Sc. First Year Semester I *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSCSC 401	Inorganic Chemistry	**04**	**--**	**04**	**04**	**--**
	SSCSC 402	Organic Chemistry	**04**	**--**	**04**	**04**	**--**
	SSCSC 403	Physical Chemistry	**04**	**--**	**04**	**04**	**--**
Elective (DSE)	SSCSE401 SSCSE402 SSCSE403 SSCSE404 SSCSE405 SSCSE406	Principles of Analytical Chemistry Unit Operations Introduction to medicinal chemistry Chemistry of heterocyclic molecules Photochemistry Fundamentals of Polymer Chemistry	**03**	**--**	**03**	**03**	**--**
Research Methodology	SVECR 401	Research Methodology	**03**	**--**	**03**	**03**	
DSC Practical	SSCSP 401	Lab. Course I Inorganic Chemistry	**--**	**02**	**02**	**--**	**04**
	SSCSP 402	Lab. Course II Physical Chemistry	**--**	**02**	**02**	**--**	**04**
Total Credits			**18**	**04**	**22**	**18**	**08**

M. Sc. First Year Semester I *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits of individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SSCSC 401	Inorganic Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 402	Organic Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 403	Physical Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Elective (DSE)	SSCSE401 SSCSE402 SSCSE403 SSCSE404 SSCSE405 SSCSE406	Principles of Analytical Chemistry Unit Operations Introduction to medicinal chemistry Chemistry of heterocyclic molecules Photochemistry Fundamentals of Polymer Chemistry	**15**	**15**	**15**	**60**	**--**	**--**	**75**
Research Methodology	**SVECR401**	RESEARCH Methodology	**15**	**15**	**15**	**60**	**--**	**--**	**75**
DSE Practical	SSCSP 401	Lab. Course I Inorganic Chemistry	**--**	**--**	**--**	**--**	**10**	**40**	**50**
	SSCSP 402	Lab. Course II Physical Chemistry	**--**	**--**	**--**	**--**	**10**	**40**	**50**

M. Sc. First Year Semester II *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSCSC 451	Inorganic Chemistry	**04**	**--**	**04**	**04**	**--**
	SSCSC 452	Organic Chemistry	**04**	**--**	**04**	**04**	**--**
	SSCSC 453	Physical Chemistry	**04**	**--**	**04**	**04**	**--**
Elective (DSE)	SSCSE451 SSCSE452 SSCSE453 SSCSE454 SSCSE455 SSCSE456	Spectrochemical Methods of analysis Transportation Processes in Unit Operations Drug Design Chemistry of Natural Products Statistical Thermodynamics Polymer Characterization and Testing	**03**	**--**	**03**	**03**	**--**
On Job Training	SSCSO451	ON Job Training	**03**	**--**	**03**	**03**	
DSC Practical	SSCSP 451 (2Cr)	Lab. Course III Organic Chemistry	**--**	**02**	**02**	**--**	**04**
	SSCSP 452 (2Cr)	Lab. Course IV Analytical Chemistry	**--**	**02**	**02**	**--**	**04**
Total Credits			**18**	**04**	**22**	**14**	**08**

M. Sc. First Year Semester II *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits of individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SSCSC 451	Inorganic Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 452	Organic Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 453	Physical Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Elective (DSE)	SSCSE451 SSCSE452 SSCSE453 SSCSE454 SSCSE455 SSCSE456	Spectrochemical Methods of analysis Transportation Processes in Unit Operations Drug Design Chemistry of Natural Products Statistical Thermodynamics Polymer Characterization and Testing	**15**	**15**	**15**	**60**	**--**	**--**	**75**
On Job Training	SSCSO451	ON Job Training	**15**	**15**	**15**	**60**	**--**	**--**	**75**
DSE Practical	SSCSP 451 (2Cr)	Lab. Course III Organic Chemistry	**--**	**--**	**--**	**--**	**10**	**40**	**50**
	SSCSP 452 (2Cr)	Lab. Course IV Analytical Chemistry	**--**	**--**	**--**	**--**	**10**	**40**	**50**

SSCSC 401: *Inorganic Chemistry*

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic concepts in inorganic chemistry such as atomic number, electronic configuration, ligands, metal complexes, oxidation states of metal, metal chelates etc.
- Knowledge of metal-ligand bonding theories such as VBT and CFT, their applications.

Course objectives:

- To learn various approaches proposed to explain structures of simple molecules thoroughly and the difference them.
- To understand the mechanisms operating behind substitution and redox reactions taking place in coordination complexes, the variety of factors affecting to substitution reactions.
- To understand molecular orbital approach for explaining bond formation in simple molecules as well as in coordination complexes, the difference between sigma and pi bond formation in coordination complexes, the orbitals used in sigma and pi bond formation.
- To understand role of essential elements in biological systems, chemistry of various biomolecules and their applications in biological systems.

Course outcomes:

- Student will be able to discuss various approaches proposed to explain structures of simple molecules thoroughly to differentiate between these approaches.
- Student will be able to write mechanisms operating behind substitution and redox reactions taking place in coordination complexes, to discuss variety of factors affecting to such reactions.
- Student will be able to draw molecular orbital diagrams for explaining bond formation in simple molecules as well as in coordination complexes and to discuss them in detail.
- Student will be able to explain roles of various elements in biological elements, to discuss chemistry of various biomolecules and their applications in biological systems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Reaction Mechanism (Part I)**	**15**
	1.1	**Introduction:** Rates of reactions, Factors affecting rates of reactions, labile and inert complexes, Henry Taube's explanation of lability and inertness.	
	1.2	**Kinetic aspects & Stability:** Kinetic aspects of VBT and CFT, Stability, thermodynamic & kinetic stability of complexes, factors affecting stability of complexes (related to properties of metal ion and ligand), stepwise and overall stability constant and relationship between them.	
	1.3	**Ligand substitution reactions in octahedral complexes:** Introduction, SN^1 and SN^2 mechanisms, comparison.	
	1.4	**Hydrolysis reactions:** Acid hydrolysis and factors affecting acid hydrolysis, base hydrolysis, mechanism for base hydrolysis, base hydrolysis by conjugate base (SN^1CB) mechanism, indirect evidences in favor of SN^1CB mechanism.	
2.0		**Reaction Mechanism (Part II)**	**10**
	2.1	**Ligand substitution reactions in square planar complexes:** Introduction, Trans effect, Theories of Trans effect (Grinberg's polarisation Theory & Pi-bonding Theory), Applications of Trans effect.	
	2.2	**Mechanism and factors affecting rate:** Mechanism of substitution reactions in square planar complexes, factors affecting rate of substitution reactions in square planar complexes.	
	2.3	**Reduction-oxidations reactions in complexes:** Introduction, classification of reduction-oxidation reactions	
	2.4	**Mechanisms of redox reactions:** Inner sphere mechanism, Outer sphere mechanism, examples, main characteristics of inner & outer sphere mechanism.	
3.0		**Molecular Orbital Theory (MOT)**	**20**
	3.1	**Molecular orbital Theory (MOT) for simple molecules:** Introduction, linear combination of atomic orbitals (LCAO), conditions for effective combination of atomic	

		orbitals, mixing of orbitals, rules for adding electrons in molecular orbitals	
	3.2	**Molecular orbital diagrams:** Molecular orbital diagrams for homonuclear diatomic molecules (He_2 to Ne_2), molecular orbital diagrams for heteronuclear diatomic molecules (CO, NO, HF, HCl), comparison of bond order and stability in various diatomic molecules.	
	3.3	**Molecular orbital theory of coordination complexes:** Recap of crystal field theory (CFT), limitations of crystal field theory (CFT), Nephelauxatic effect, Nephelauxatic series.	
	3.4	**Molecular orbital diagrams for coordination complexes:** Assumptions of MOT for octahedral complexes, formation of ligand group orbitals with respect to octahedral complexes (with diagrams), formation of ligand group orbitals with respect to tetrahedral complexes (without diagrams), molecular orbital diagrams for sigma and pi-bonding in complexes (octahedral, tetrahedral and square planar), Evidences in favor of pi-bond formation in complexes (crystallographic and IR spectroscopic evidence)	
4.0		**Bio-inorganic Chemistry**	**15**
	4.1	Biological importance of essential and non-essential elements, sodium-potassium pump	
	4.2	Metalloporphyrins including hemoglobin and myoglobin, difference between them	
	4.3	Electron carrier proteins in biological systems including iron-sulfur proteins, iron-storage proteins, cytochrome, iron transporting biomolecules	
	4.4	Biological enzymes	
		Total	

Reference Books:

1. James Huheey, Eller A. Keiter, and Richard L. Keiter, "Inorganic Chemistry (Principles of Structure and Reactivity", 4th Edition, Harper Collins Publishers.
2. W. U. Malik, G. D. Tuli, and R. D. Madan, "Selected Topics in Inorganic Chemistry", S. Chand Publications.
3. Gurdeep Raj, "Advanced Inorganic Chemistry", Vol. I, Goel Publishing House.

4. B. R. Puri, L. R. Sharma, and K. C. Kalia, “Principles of Inorganic Chemistry”, Milestone Publishers & Distributors.
5. Satish Kumar Agarwal and Keemti Lal, “Advanced Inorganic Chemistry”, Pragati Prakashan.
6. F. A. Cotton and G. Wilkinson, “Advanced Inorganic Chemistry (A Comprehensive Text)”, Interscience Publishers, John Wiley & Sons.
7. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Michael Hagerman, “ Shriver & Atkins’ Inorganic Chemistry”, 5th Edition, Oxford University Press, W. H. Freeman and Company, New York.
8. G. Wilkinson, R. D. Gillars and J. A. McCleverty, “Comprehensive Coordination Chemistry. Eds.”, Pergamon.

SSCSC-402: *Organic Chemistry*

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic concepts in organic chemistry such as structure, chemical bonding conjugation, resonance, stability, intermediates, aromaticity, and reactivity.
- Knowledge of reaction mechanisms such as S_N1, S_N2, SET, S_NI and NGP.
- Knowledge of stereochemistry and name reactions.

Course objectives:

- To understand the nature of chemical bonding in organic molecules, structure, and reactivity.
- To grasp various concepts of stereochemistry, asymmetric synthesis, absolute configuration, and conformation analysis
- To learn the aromaticity of benzenoid and non-benzenoid compounds

Course outcomes:

- Students will be able to understand the various types of reaction mechanisms.
- Students will gain the concept of bonding in organic molecules.
- Learn the concept of stereochemistry and identify the stereochemical reactions.
- Student will be able to solve the various examples of aromaticity, homoaromaticty, and antiaromaticity.
- Gain knowledge of various types of substitution, free radical reactions, and their mechanism.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Nature of Bonding in Organic Molecules**	**10**
	1.1	**Chemical bonding and reactivity:** Chemical bond, delocalization, conjugation, resonance, hyperconjugation, tautomerism, inductive effects, steric effect	
	1.2	**Bonding other than covalent bonding:** Ionic bond, hydrogen bond, inclusion compounds, rotaxanes, catenanes, cyclodextrins, cryptands, fullerenes, crown ethers	
	1.3	**The relation between structure and acidity and basicity**.	
	1.4	**Aromaticity:** Benzenoid and non-benzenoid compounds, Huckel's rule, antiaromaticity, homo-aromaticity. Application to carboxylic and heterocyclic systems, annulenes, azulenes	
2.0		**Reaction Mechanism: Structure and Activity**	**10**
	2.1	Elementary and simple reaction, Hammond postulate, Molecularity, Energy profile diagram	
	2.2	Thermodynamics of the reaction, kinetic of the reaction, thermodynamic versus kinetic control of reactions, Hammett and Taft effect.	
	2.3	Kinetic isotopic effects, method of determining reaction mechanism	
	2.4	Structure and stability of reactive intermediates, carbenes, nitrenes, carbocations, carbanions, benzynes, ylides, enamines, and free radicals	
	2.5	Bredt's rule, Baldwin's rule.	
3.0		**Stereochemistry**	**15**
	3.1	Concept of chirality and molecular dissymmetry	
	3.2	Symmetry elements and chiral centers, Prochiral relationship, homotopic, enantiotopic, and disteriotopic groups and faces.	
	3.3	Geometrical isomerism, E and Z nomenclature, R and S	

		nomenclature with suitable examples.	
	3.4	Conformational analysis: Cyclohexane (mono and disubstituted i.e. halo, hydroxyl and methyl) and decalins, stability and reactivity. Types of confirmation and their stability (Chair, Half Chair, Boat, Twist Boat)	
	3.5	Optical activity in absence of chiral carbon, biphenyl, allenes and spirenes, chirality due to helical shape	
4.0		**Substitution and Free Radical Reactions**	
	4.1	Aliphatic nucleophilic substitution Reactions: S_N1, S_N2, SET mechanism, Aliphatic electrophilic substitution reaction: SE1, SE2, SEi. Electrophilic substitution accompanied by double bond shift. Effect of substrate, leaving group and solvent polarity on the reactivity.	
	4.2	Effect of structure, nucleophile, leaving group and solvent on the rate of S_N1 and S_N2 reactions.	
	4.3	NGP by pi bonds, sigma bonds, halogens and hetero atoms, classical and non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangement in NGP, SNi mechanism,	**25**
	4.4	Generation, characterization and stability of free radicals	
	4.5	Free radical mechanism, NGP in free radical reactions	
	4.6	Reactivity for aliphatic and aromatic substrate at bridge head	
	4.7	Hundsdiecker reaction	
		Total	**60**

Reference Books:

1. Advanced organic chemistry-Reaction mechanism and structure, Jerry March, Jhon Wiley.
2. Structure and mechanism in organic chemistry, C. K. Ingold, Cornell University Press.
3. Advanced organic chemistry, F. A. Carey and R. J. Sundberg, Plenum.
4. A guide book to mechanism in organic chemistry, Peter Sykes, Longman.
5. Stereochemistry of organic compounds, D. Nasipuri, New Age International.
6. Reaction mechanism in organic chemistry, S. M. Mukherji and S. P. Singh, Macmilan.

7. Modern organic reactions, R. O. C. Norman and J. M. Coxon, Blackie Academic and Professional.
8. Organic chemistry, R. T. Morison Boyd, Prentice-Hall.
9. Stereochemistry of organic compounds, P. S. Kalsi, New Age International.
10. Modern organic reactions, H. O. House, Benjamin-Cumming Publishing.
11. Advanced Organic Chemistry- Jagdamba singh and L. D. S Yadav, Pragati Prakashan.
12. Organic Chemistry- J. Clayden, N. Greeves and S. Warren, Oxford University Press.

SSCSC 403: *Physical Chemistry (4 Credits)*

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Basic information like classical laws and quantum mechanical laws, particle nature, orbital, rules governing filling of electrons in shell, coupling of magnetic field of electron orbital and spin motion.
- Knowledge of laws of thermodynamics, key equations in thermodynamics, Activity, activity coefficient, probability, basic concept of partition function, non-equilibrium states, basics of entropy production, concept adsorption and its applications.

Course objectives:

- To understand the basic concepts, laws and postulates of quantum mechanics, concept of wave functions and operators to solve Schrodinger wave, to develop skill for problems solving
- To learn the rigid rotor, harmonic oscillator and angular momentum and electronic structure of atoms
- To understand laws of thermodynamics, concept of partial molar properties and non-ideal systems
- To understand the distribution and thermodynamic probability and to discuss the partition functions and its significance, entropy production in different system and Onsager's relations
- To understand the different types of adsorption and describe different adsorption models

Course outcomes:

- Student will be able to understand the basic concepts, laws and postulates of quantum mechanics, concept of wave functions and operators to solve Schrodinger wave, to develop skill for problems solving
- Student will be able to learn the rigid rotor, harmonic oscillator and angular momentum and electronic structure of atoms
- Student will be able to understand laws of thermodynamics, concept of partial molar properties and non-ideal systems
- Student will be able to understand the distribution and thermodynamic probability and to discuss the partition functions and its significance, entropy production in different system and Onsager's relations
- Student will be able to understand the different types of adsorption and describe different adsorption models

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required
1. 0		**Quantum Chemistry (Part I)**	**15**
	1.1	**Introduction:** Introduction to quantum mechanics, blackbody radiation, Planck's hypothesis, Einstein's photoelectric effect, the spectrum of hydrogen atom, dual nature of matter, the Heisenberg uncertainty principle, Numerical.	
	1.2	**Postulates and wave: Wave functions and Operators:** Postulates of quantum mechanics, wave function, normalized and orthogonal wave functions, acceptability of wave functions, operators	
	1.3	**Applications of Schrodinger wave equation:** Discussion of solutions of Schrodinger wave equation to the systems such as particle in One dimensional box, Harmonic oscillator, vibrational energy levels, the Rigid rotor, rotational energy levels	
	1.4	**Numericals:** Numericals based on the Einstein's photoelectric effect, Heisenberg uncertainty principle, Schrodinger wave equation and its applications (1D box)	
2.0		**Quantum Chemistry (Part II)**	**15**
	2.1	**Angular momentum and its applications:** Angular momentum, magnitude of angular momentum, Eigen functions for angular momentum, Eigen values of angular momentum, spin antisymmetry and Pauli exclusion principle.	
	2.2	**Electronic structure of atoms:** Electronic structure of atoms, Russel-Sanders coupling schemes, term symbols, spin-orbit coupling and Zeeman splitting. Evaluation of terms for different configurations of atoms and metallic ions in complex	
	2.3	Schrödinger equation for hydrogen atom, spherical harmonics, precise values of angular momentum, hydrogen atomic orbital's, three p orbital's for n>= 2.	
	2.4	Solution of the Schrodinger wave equation to particle in three dimensional box, degeneracy, time independent perturbation theory, variation method, quantum mechanical tunneling	
3.0		Thermodynamics	**20**
	3.1	**Classical Thermodynamics:** Recapitulation of Laws of thermodynamics, state and path functions and their applications, thermodynamic description of various types of processes, Maxwell's relations, spontaneity and equilibria, temperature and of pressure dependence of thermodynamic quantities.	

	3.2	**Partial molar quantities and non-ideal systems:** Partial molar properties, partial molar free energy, chemical potential, partial molar volume, partial molar heat content, determinations of partial molar volume, concept of fugacity and determination of fugacity by graphical method. Non-ideal systems: Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions, ionic strength, numerical on ionic strength.	
	3.3	**Statistical Thermodynamics:** Distribution, thermodynamic probability and most probable distribution. Ensemble: different types of ensembles, canonical, grand canonical and Microcanonical ensembles, Partition functions: molecular partition function, derivations of translational, rotational, vibrational and electronic partition functions and thermodynamic properties in terms of partition function	
	3.4	**Non-equilibrium Thermodynamics:** Thermodynamic criteria for non-equilibrium states, entropy production in chemical reactions and entropy production due to heat flow, transformation properties of fluxes and forces, principle of microscopic reversibility and Onsager's reciprocity relations.	
4.0		Surface Chemistry-I	**10**
	4.1	Introduction, physical and chemical adsorption, difference between physical and chemical adsorption, factors affecting adsorption	
	4.2	Basics of adsorption of gas on surface of solid, Langmuir adsorption isotherm and Freundlich adsorption Isotherm	
	4.3	Adsorption from solution-Gibbs adsorption isotherm, surface films on liquids (Electro-kinetic phenomenon) and catalytic activity at surfaces	
	4.4	Applications of adsorption in different fields	
		Total	**60**

Reference Books:

1. Donald A.McQuarrie, Davis John D. Simon, "Physical Chemistry-A Molecular Approach", 2nd Edition, University Science Books .
2. A. K. Chandra, "Introduction to Quantum Chemistry", 4th edition, Tata McGraw Hill.
3. Ira N. Levine, "Quantum Chemistry",7th edition Pearson Education India.
4. P.W. Atkins, "Physical Chemistry", ELBS.
5. Puri, Sharma, Pathania, "Principles of Physical Chemistry",48th Edition, Vishal Publishing Co.
6. P. W. Atkins, "Molecular Quantum Mechanics", Vol. I & II,Oxford University Press.
7. Alberty and Silby, "Physical Chemistry", 4th edition, Wiley India Pvt. Limited.
8. T. L. Hill, Addison Wesley, "Statistical thermodynamics", Dover Publications.

9. Normand M. Laurendeau, “Statistical Thermodynamics” Cambridge University Press, 2005.
10. F. T. Wall, “Chemical thermodynamics” W. H. Freeman & Co, New York.
11. Robert J. Silbey, Robert A. Alberty, Moungi Gabriel Bawendi, “Physical Chemistry” 4th edition, Wiley, 2005.

SSCSE401: Principles of Analytical Chemistry

Credits 3 (45 Contact hrs)

Course pre-requisite:

- Knowledge of basic concepts in chemistry such as acids, bases, solutions, indicator etc.

Course objectives:

- To gain knowledge regarding statistical analysis part in analytical chemistry.
- To understand various concept involved in sampling.
- To study acid-base chemistry through various acid-base theories, buffer solutions, preparation and applications.
- To gain knowledge about theoretical principles and procedures involved in volumetric and gravimetric methods, comparison of both these methods.

Course outcomes:

- Student will understand importance of statistical analysis and various tests used for analysis and data presentation in analytical chemistry.
- Student will learn basic principles regarding sampling, importance of sampling in analysis, various operational procedures used in sampling etc.
- Student will learn various acid-base theories and will understand the improvement occurred in the subject, various concepts related to acid-base chemistry, use of buffer solutions in various fields, determination of pH of weak acid and weak base etc.
- Student will understand minute details necessary for performing analysis of unknown samples using classical methods of analysis such as volumetry and gravimetry. He/she will learn to apply various theoretical principles involved in these classical methods when needed.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Errors, Statistics and Sampling**	**15**
	1.1	Introduction, accuracy, error, types of errors, systematic and random errors, minimization of errors, precision,	
	1.2	mean and standard deviations, reliability of results, confidence limit and confidence interval, comparison of results [student T test, F test, comparison of two samples (Paired T test)].	
	1.3	Introduction to sampling, the basis of sampling, sampling procedure, problems associated with obtaining gross samples (for solids, liquids and gases), operations of drying and preparing solution of analyte, dissolving inorganic solids, dry ashing, wet digestion.	
	1.4	**Numerical problems.**	
2.0		**Acid Base Equilibria and Buffer Solutions**	**10**
	2.1	Introduction, acid-base theories (Arrhenius, Lowry-Bronsted, Lewis, solvent-system concept and Usanovich concept) including definitions, utility and limitations.	
	2.2	Definition of pH & pH scale (Sorenson and operational definitions) and its significance, pH at elevated temperatures, pH for aqueous solutions of very weak acid and base, pH for salts of weak acid and weak bases (derivations).	
	2.3	Introduction to buffer solutions, buffer capacity, applications of buffers.	
	2.4	**Numerical problems.**	
3.0		**Volumetric analysis**	**10**
	3.1	Introduction to volumetric analysis, titration, fundamental requirements of a titrimetric method, types of titration reactions,	
	3.2	Standard solutions, preparation of standard solutions, primary standards, secondary standards, Detection of	

		end point, indicators, theories of indicators (Ostwald's theory and Modern Quinoid theory)	
	3.3	Introduction to complexometric titrations, key points in general complexometric procedure, titration curves, EDTA as versatile reagent, types of EDTA titrations (Direct titration, Back titration, Displacement or substitution titration, alkalimetric titration and indirect titration), acid base titrations in non-aqueous media.	
	3.4	**Numerical problems.**	
4.0		**Gravimetric analysis**	
	4.1	Introduction to gravimetric analysis, steps in gravimetric analysis.	**10**
	4.2	Impurities in precipitates, coprecipitation and post precipitation, precipitants and types of precipitants (organic and inorganic), sequestering or masking agents.	
	4.3	Solubility product, common ion effect, gravimetric calculation (gravimetric factor), limitations of gravimetry,	
	4.4	**Numerical problems**	
		Total	**45**

Reference Books:

1. General Analytical Techniques. Gurdeep R. Chatwal (Edited by M. Arora), Himalaya publishing house.
2. Analytical Chemistry. Theory and Practice (Third edition). R. M. Verma, CBS Publishers & Distributors PVT Limited.
3. Analytical chemistry (Sixth Edition). G. D. Christian, Wiley publications
4. Fundamental of Analytical Chemistry, 7th Edition (1996). D. A. Skoog and D. M. West, Saunders College Publishing, Philadelphia, Holt, London.
5. Modern Analytical Chemistry. David Harvey, McGraw Hill Higher education.
6. Vogel's Textbook of quantitative Analysis, (Fourth Edition). G. H. Jaffery, J. Bassett, J. Mendham, R. C. Denney, Longman Scientific & Technical Publications.

SSCSE402: Unit Operations

Credits 3 (45 Contact hrs)

Course objectives:

- To learn the concept of unit operations
- To study the basic laws governing the different unit operations in the industry
- To understand the material balance of different unit operations in the industry
- To evaluate the unit operations like evaporation, distillation, extraction, filtration, drying etc.
- To design the equipments for heat and mass transfer operations

Course outcomes:

- Students will acknowledge the basic laws governing the different unit operations.
- Able to apply their knowledge of material balance of unit operations.
- They can apply their knowledge of different industrial unit operations like evaporation, distillation, extraction, filtration, drying etc. To the actual performance of these operations.
- They aid in the design of equipments for heat and mass transfer operations.
- Students can handle equipments and instruments skill fully in industries and laboratories.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Evaporation and Distillation**	**15**
	1.1	Definition, principle and theory of evaporation, boiling point elevation, Duhrings rule, single effect evaporator, multiple feed effect evaporator, (forward feed, backward feed and parallel feed) horizontal tube and vertical tube evaporator, forced circulation evaporator, material balance	
	1.2	Definition, boiling point, Raoult's law, Dalton's law, method of distillation of binary systems, flash or equilibrium distillation, continuous rectification, fractionating column, batch distillation, azeotropes, steam distillation, material balance.	
2.0		**Liquid-liquid extraction and Crystallization**	**15**
	2.1	Liquid-liquid extraction in three step process, ternary system, triangular diagrams, selection of solvent for extraction, mixer- setters, perforated plate, tray-tower, spray towers, packed towers, rotating disk contactor.	
	2.2	Crystallization: Introduction, solubility and solubility curves, theory of crystallization, Mier's supersaturation theory, caking of crystals, methods of supersaturation, crystallizers-agitate crystallizer, Swenson-Walker Crystalliser, vacuum crystallizer, Oslo crystallizer, Material balance.	
3.0		**Filtration, Sedimentation and Drying**	**15**
	3.1	Principle of filtration, types of filtration, constant pressure filtration and constant rate filtration, filter medium, filter aids, filtration equipment, pressure filters, plate and frame press, vacuum filters, rotary drum filter, leaf filters and Moore filter.	
	3.2	Mechanism of settling, laboratory batch sedimentation test, thickener, door thickener, settling zones in continuous thickeners.	
	3.3	Principle and theory of drying, drying equipments, tray dryers, tunnel dryers, spray dryer, rotary dryer, vacuum dryers.	
		Total	**45**

Reference Books:

1. Unit operation of chemical engineering by Juliam C. Smith
2. Introduction to chemical Engg. By Badger and Banchero (Mc Graw Hill
3. Mass transfer by Robert E. Treybal. (Mc Graw hill, 1981).
4. Chemical Engg. By Coulson and Richardon, (Vol. I, III, IV, VI) Pergamon Press, 1985.
5. Unit Operations I and II by K. A. Gavhane (Nirali Prakashan).
6. Transport Processes and Unit operation (third edition) by Christie J. geankoplis.
7. Het Marks and Momentum transfer by Benett.
8. Principles of Unit operations by Foust, Wenzel and other (Wiley Interscience).
9. Engineering heat transfer by Gupta and Prakash, Nem Chand and brothers 1989.

SSCSE403: Introduction to medicinal chemistry

Credits 3 (45 Contact hrs)

Course pre-requisite:

1. BSc in chemistry

Course objectives:

- To Learn basic principles of **medicinal chemistry**
- To know the role of medicinal chemist in development of medicinal agents
- Learn how to analyze macromolecular Targets

Course outcomes:

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

- Understand key component of drug discovery process in designing
- Understanding the role of medicinal chemist in development of medicinal agents
- Appreciate the concept of receptor and its interaction for the utility in drug design.
- Appreciate the research articles related pertaining to medicinal chemistry.

Curriculum Details

Module No.	Unit No.	Topic	Hrs.Required
1.0		Drug targets	
	1.1	Drugs and drug targets: an overview,	
	1.2	Protein structure and function	
	1.3	Enzymes: structure and function	**15**
	1.4	Receptors: structure and function	
	1.5	Receptors and signal transduction	
	1.6	Nucleic acids: structure and function	
2.0		B Pharmacodynamics and B Pharmacokinetics:	
	2.1	Enzymes as drug targets	
	2.2	Receptors as drug targets	
	2.3	Nucleic acids as drug targets and Miscellaneous drug targets	**15**
	2.4	Pharmacokinetics and related topics	
	2.5	Case study 1: Statins	
3.0		Drug discovery, design, and development:	
	3.1	Drug discovery: finding a lead	
	3.2	Drug design: optimizing target interactions	
	3.3	Drug design: optimizing access to the target	**15**
	3.4	Getting the drug to market	
	3.5	The design of angiotensin converting enzyme (ACE) inhibitors	
		Total	**45**

Reference Books:

1. An Introduction to medicinal chemistry, Graham L. Patrick. Oxford university press.
2. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.

SSCSE404: Chemistry of Heterocyclic molecules

Credits 3 (45 Contact hrs)

Course objectives: The students should learn about

Types of heterocycles.

1. Nomenclature.
2. Synthetic routes.
3. Applications of heterocycles in different areas.
4. Heterocycles in natural products.

Course outcomes: The learner should know

1. Characteristic features of different heterocycles
2. The importance of heterocycles in different fields
3. Synthetic methods for different heterocyclic moieties
4. Therapeutic application of heterocycles

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		**Five-membered rings**	**15**
	1.1	Nomenclature and classification of heterocycles	
	1.2	Synthesis and reactions of Furan, Pyrrole, and thiophene	
	1.3	Synthesis and reactions of Benzofuran, indole, benzothiophene	
2.0		Six membered and Seven membered rings	**15**
	2.1	Synthesis and reactions of Pyridine, Quinoline, Isoquinoline.	
	2.2	Synthesis and reactions of azepines, oxepines, thiepines	
3.0		rings with more than one hetero atom and Non aromatic heterocycles	**15**
	3.1	Synthesis and reactions of imidazoles, oxazoles, thiazoles, pyrimidines, purines, oxadiazoles, thiadiazoles	
	3.2	structure, synthesis and preparation of azeridine, oxirane, thiairane, oxaziridine, azetidine, azetidinone, oxetane, oxetanone, thietane	
		Total	**45**

Reference Books:

1. Heterocyclic chemistry by Joule and Mills.
2. Modern Heterocyclic chemistry by L. A. Paquette, Benjamin.
3. Advanced organic chemistry by – Carry and Sundberg
4. Mechanism and structure in organic chemistry by – E. S. Gould, Holt, Rinehart and Winston.
5. The Chemistry of Heterocycles by Theophil Eicher, Siegfried hauptmann.
6. Heterocyclic chemistry by R. K. Bansal.
7. Heterocyclic Chemistry by T. L. Gilchrist.
8. Contemporary Heterocyclic Chemistry by G. R. Newkome and W. W. Poudler, Wiley.

SSCSE405: Photochemistry

Credits 3 (45 Contact hrs)

Course objectives:

- The theoretical foundation for photochemistry is outlined and discussed on the basis of the properties of light and the nature of relevant photophysical and photochemical processes involved within.
- The response to the application of radiation at uni and bimolecular levels will be reviewed and discussed with particular emphasis on mechanistic aspects.
- Special attention will be paid to the importance of photochemical and photophysical processes with respect to organic and inorganic aspects.

Course outcomes:

- At the end of this course, the fundamental concepts behind interaction of matter with radiation and its fine tuning in order to control the photophysical as well as photochemical processes will be thoroughly understood.
- The significance of reactive energy states generated while interaction of matter with radiation and their kinetics and lifetime will be established.
- The knowledge of quenching mechanism by added substances or self-quenching will be generated.
- Application of these concepts to some organic and inorganic systems will be done

Curriculum Details

Iodule No.	Unit No.	Topic	Hrs. Required
1.0		**Photochemical Reactions**	**2**
	1.1	Interaction of electromagnetic radiation with matter, types of excitation, rate of excited molecule, quantum yield, transfer of excitation energy, actionomety	
2.0		**Determination of Reaction Mechanism**	**8**
	2.1	Classification, rate constant and life times of reactive energy states determination of rate constants of reactions, effects of light intensity on the rate of photochemical reactions.	
	2.2	Types of photochemical reactions, photodissociation, gas phase photolysis.	
3.0		**Photophysical process in electronically excited molecules**	**15**
	3.1	Types of photochemistry, pathways with jabalonski diagram radiation theory, internal conversion and intersystem crossing, fluorescence emission, fluorescence and structure, triplet states and photophosperescnce emission.	
	3.2	Emission property and the electronic configuration, photophysical kinetics of unimolecular process, state diagrams delayed fluorescence, the effect of temperature on emission process	
4.0		**Photophysical kinetics of Bimolecular Process**	**10**
	4.1	Kinetic collisions and optical collision, bimolecular collisions in gases and vapors and the mechanism of fluorescence quenching, collisions in solution.	
	4.2	kinetics of collisions quenching, stern-volmer equation, concentration dependence of quenching and excimer Kormation, quenching by foreign substances	
5.0		**Some aspects of organic and Inorganic photochemsitry**	**10**
	5.1	Photoreduction and reactions, photoxidation and photo oxygenation.	
	5.2	Cycloaddition reactions, woodward-Hoffman rule of electrocyclic reactions, chemiluminiscence, transition metal complexes	
		Total	**45**

Text Books:

1. Fundamentals of Photochemistry, K. K. Rohtagi- Mukherji, Wiley eastern
2. Essentials of Molecular Photochemistry, A. Giolber and J. baggot, Blackwell Scientific Publication

Reference Books:

1. Molecular Photochemistry, NJ Turro, W. A. Benjamin
2. Introductory Photochemistry, A.Cox, T. Camp, McGraw-Hill
3. Photochemsitry, R. P. Kundall and A. Golbert, Thomson Nelson
4. Organic Photochemistry, J. Coxon, B. Halton, Cambridge University Press

SSCSE406: Fundamentals of Polymer Chemistry

Credits 3 (45 Contact hrs)

Course per-requisite

Students (Undergraduate/postgraduate) from chemistry background

Course objectives:

- to get exposure about history, importance of polymers
- to introduce fundamental aspects of polymer chemistry
- to understand types of polymers
- to know how different polymers are prepared

Course outcomes:

- student will gain knowledge of polymeric material
- student will know how different polymers synthesis
- student will understand use of polymeric material in daily life

Curriculum Details

Module no	Unit no.	Topic	Hrs Required
1.0		**Introduction**	**13**
	1.1	History & development in polymeric Science, monomer & functionality, oligomer polymer, degree of polymerization, IUPAC nomenclature of polymers	
	2.1	Classification of polymers, Glass transition, melt transition, molar mass, crystallinity in polymers, homopolymer and copolymer. Uses of polymers.	
2.0		**Types of Polymers**	**12**
	2.1	Thermoset-Thermoplast, Organic-inorganic, hybrid material, Natural polymers - synthetic polymers	
	2.2	linear, branched, crosslinked, hyperbranched, graft and dendritic polymers, polymers from renewable resources with suitable examples.	
3.0		**Types of Polymerisation Reactions**	**10**
	3.1	Polymerization reactions with example like radical, anionic, cationic, free radical polymerization, addition polymerization, elimination polymerization,	
	3.2	Step growth polymerization, polycondensation, phase-transfer catalyzed and interfacial polycondensations.	
	3.3	Copolymers, importance/advantages of copolymers with example.	
4.0		**Types of Polymerization Methods**	**10**
	4.1	Bulk, solution, suspension, precipitation, emulsion, dispersion, in green solvents	
	4.2	interfacial (phase transfer catalyzed interfacial polymerization) and solid state polymerization. (examples-PET, PC), under microwave irradiation. Examples of polymers manufacturing companies/industry their names and polymers prepared by them.	
		Total	**45**

Reference Books:

1) Principles of Polymer Chemistry, Second Edition **A. Ravve, Kluwer** Academic Publishers (2000) ISBN 0-306-46368-7.
2) Chemistry and Physics of Macromolecules Ed. **E. W. Fischer, R. C. Schulz and H. Sillescu**, VCH,(1991)
3) Organometallic Catalysis and Olefin Polymerization: Catalysis for New Millennium. Ed. **R. Blom, A. Follestad, E. Rytter, M. Tilset, M. Yestenes**.
4) Organic Chemistry of Synthetic High Polymers, **R. W. Lenz**, Interscience Publishers, New York(1967)
5) Polymer Science and Technology, **J. R. Fried**, Practice-Hall (1995)
6) Polymer Science, **V. R. Gowariker, N. V. Vishwanathan and J. Sreedhar**, Wiley Eastern Limited, Seventh Reprint(1995).
7) Introduction to Polymer Science and Technology, An SPE Textbook, **H. S. Kanfman and J. J. Falcetta**, John Wiley and Sons, New York.
8) Introduction to Synthetic Polymers, **I.M. Campbell**, 1st Edition, Oxford Press(1994)
9) Polymer Chemistry: An Introduction, **G. Challa**, 1st Edition, Ellis Horwood (1993).
10) Polymers: Chemistry and Physics of Modern Materials, **J. M. G. Cowie**, 1st Edition, CRC Pres, (1998).
11) An Introduction to Plastics, **H. G. Elias**, 1st Edition, Jhon Wiley, 1989.
12) Elements of Polymer Science and Engineering: An Introductory Text and Reference for Engineers and Chemists, **A. Rudin**, 2nd Edition, Academic Press, 1998.
13) Principles of Polymer Chemistry, **P. J. Flory**
14) Principles of Polymerization, **G. Odian**, Wiley-Interscience Publication(1997)
15) Synthesis of Polymers: A Comprehensive Treatment, Ed: **A. D. Schulter** (1991) Wiley-VCH
16) Advanced Polymer Chemistry: A Problem Solving Guide, **Chanda**. Marcel Dekker, 2000
17) The Chemistry of Polymers, Second Edition. **J. W. Nicholson**, The Royal Society of Chemistry (1997).
18) Comprehensive Polymer Science Vo. 4,5 and 6 and first supplement.
19) Handbook of Polymer Synthesis, Ed. **H. R. Kricheldorf**. Marcel Dekker, INC. New York (1992).
20) Anionic Polymerization: Principles and Practical Applications, **H. L. Hsieh & R. P. Quirk**. Marcel Dekker, Inc. New York(1996)
21) Cationic Polymerizations, Mechanisms, Synthesis and Applications, Ed. **K. Matyjasezewski**. Marcel Dekker, Inc; New York(1996)
22) Macromolecular Design: Concept and Practice. Ed. **M. K. Mishra.** Polymer Frontier New York 1994, International INC.
23) Designed Polymers by Carbocationic Macromolecurlar Engineering, Theory and Practice. **J. P. Kennedy and B. Ivan. Hanser** (1991)
24) Metalorganic Catalysts for Synthesis and Polymerization, Ed. **W. Kaminsky**, Springier (1991).
25) **Jonathan S. Rhoad** Written Assignments in Organic Chemistry: Critical Reading and Creative Writing *J. Chem. Educ.,* 94(3), pp 267 - 270 **2016.**

SSCSP 401: *Laboratory Course I Inorganic Chemistry (Practicals)*
2 Credits (30 contact hrs)

Course pre-requisite:

- Knowledge of glasswares and apparatus used in chemistry laboratory such as standard flasks, beakers, conical flasks, funnels, filter papers, weighing balance etc.
- Knowledge of basic operations required in chemistry laboratory such as preparation of solution, heating of solutions, filtration, precipitation, use of reagents etc.

Course objectives:

- To understand role of various factors in structure determination of coordination complexes, principles and operating procedures and applications of analytical techniques in structure determination.
- To learn various basic principles involved in the analysis of inorganic mixtures, nature of inorganic mixtures and radicals by conducting various tests, various reactions involved.
- To prepare and use various reagents and solutions required for the analysis of inorganic mixtures.

Course outcomes:

- Student will be able to discuss role of various factors in structure determination of coordination complexes, various principles involved, operating procedures and applications of analytical techniques in structure determination.
- Student will be able to discuss various principles involved in the analysis of inorganic mixtures, nature of inorganic mixtures and radicals, the importance of conducting various tests and various reactions involved.
- Student will be able to prepare and use various reagents and solutions required for the analysis of inorganic mixtures.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Preparation of metal complexes and characterization (Any five)**	**10**
	1.1	Vanadium acetylacetonate $VO(acac)_3$	
	1.2	Manganese acetylacetonate $Mn(acac)_3$	
	1.3	Potassium trioxalato ferrate(III) $K_3[Fe(C_2O_4)_3]$	
	1.4	Hexammine Cobalt(III) Chloride $[Co(NH_3)_6Cl_3]$	
	1.5	Cis-Potassium dioxalatodiaquochromate Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$	
	1.6	Chloropentammine cobalt(III) chloride $[Co((NH_3)_5Cl)Cl_2]$	
	1.7	Mercury(II) tetrathiocyanatocobaltate(II) $[HgCo(SCN)_4]$	
	1.8	Bis (dimethylglyoxime) Nickel (II) complex	
2.0		**Detection of three acidic and three basic radicals from given inorganic mixtures (Any five)**	**20**
		Total	**30**

Reference Books:

1. G. Svehla, "Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis", 5th Edition, Longman Group Limited, London (1979).
2. Gurdeep Raj, "Advanced Practical Inorganic Chemistry", Goel Publishing House, India (2013).
3. Shikha Gulati, J. L. Sharma and Shagun Manocha, "Practical Inorganic Chemistry", CBS Publishers & Distributors Private Limited, India (2017).
4. Amita Dua and Dr. Navneet Manav, "Practical Inorganic Chemistry", Manakin Press Private Limited, New Delhi, India (2016).
5. G. Pass, "Practical Inorganic Chemistry: Preparations, reactions and instrumental methods (Science paperbacks)", 2nd Edition, Springer Publicaitons, July 1979.
6. Michael J. Prushan, "Lab Manual Advanced Inorganic Chemistry Laboratory", Department of Chemistry and Biochemistry, La Salle University (2002-2003).
7. M. Pranjoto Utomo, "Laboratory Manual of Practical Inorganic II Chemistry", Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University (2011).

SSCSP 402: *Laboratory Course II Physical Chemistry (Practicals)*

2 Credits (30 contact hrs)

Course pre-requisite:

- Knowledge of preparation of solutions, practice of accurately prepared molar and normal solutions, expertise in handling the glassware and apparatus etc.
- Information of use of equipments and standardization of equipments

Course objectives:

- To understand basic principles and theory of different instruments and to understand qualitative and quantitative analysis
- To perform different experiments using equipments like conductivity meter, pH meter, potentiometer, calorimeter, refractometer etc. and set various experiments based on the different instrumentations which will have industrial applications
- To understand basic principles and theory of measurements of density, viscosity, refractive index, surface tension, adsorption and perform the calculations

Course outcomes:

- Understand the basic principles and theory of different instruments used during the conduction of the experiments learn to understand qualitative and quantitative analysis
- Students will be able to perform different experiments using equipments like conductivity meter, pH meter, potentiometer, calorimeter, refractometer etc. and set various experiments based on the different instrumentations
- Students will be able to understand basic principles and theory of measurements of density, viscosity, refractive index, surface tension, adsorption and perform the calculations

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Performance of following Instrumentation experiments (Any eight)**	
	1.1	1. To determine velocity constant and energy of activation for saponification of ethyl acetate by NaOH conductometrically. 2. To determine the relative strength of chloroacetic acid and acetic acid conductometrically 3. To determine equivalent conductivity of strong electrolyte at several concentrations and to verify Onsager's equation. 4. To determine the solubility and solubility product of sparingly soluble salt, [$BaSO_4$/$PbSO_4$] at different temperatures conductometry. 5. To determine potentiometrically the pK_1 and pK_2 values of H_3PO_4 6. To determine Hammett constant of given substituted benzoic acid using pH-mete 7. To determine pH values of various mixtures of sodium acetate and acetic acid in aqueous solution and hence find out dissociation constant of acid. 8. To determine concentration of Cu (II) ion in given solution titrating with EDTA solution by calorimetry. 9. To determine the relative strength of two acids by polarometry. 10. To study the variation of refractive index with composition of mixtures of CCl_4 and ethyl acetate.(Any other related experiments may be added)	**30**
		Performance of following Non-instrumentation experiments (Any seven)	
2.0	**2.1**	1. To determine molecular weight of high polymer by viscosity measurements. 2. To study the effect of surfactant on surface tension of water by using Stalagmometer. 3. To determine the viscosity of mixtures by Ostwald's viscometer. 4. To determine the solubility of benzoic acid at different temperature and hence to determine its heat of solution. 5. To construct the phase diagram of three component system. [$CHCl_3$, CH_3COOH and H_2O] 6. Investigate the autocatalytic reaction between $KMnO_4$ and oxalic acid. 7. To determine the rate constant of hydrolysis of ester	**30**

		[catalyzed by NaOH/HCl] 8. To investigate the adsorption of (oxalic acid/acetic acid) by activated charcoal and to test the validity of Freundlich and Langmuir isotherm. 11. To study the surface tension concentration relationship for the solution.(Any other related experiments may be added)	
		Total	**60**

Reference Books:

1. B. Viswanathan and P.S. Raghavan , **"**Practical Physical Chemistry**"**.
2. B.P. Levitt Longman, **"**Findley's Practical Physical Chemistry**"**.
3. A.M. James and F.F. Prichanrd, **"**Longman Practical Physical Chemistry**"**.
4. R.C. Das and B.Behra, "Experimental Physical Chemistry**"**,Tata McGraw Hill.
5. V.D. Athanale and Parul Mathur, **"**Experimental Physical Chemistry**"**, New age International.
6. Dr. T.K. Chandhekar & S.W. Rajbhoj, **"**Systematic experimental Physical Chemistry**"**.
7. J.B. Yadao, **"**Advance Practical Physical Chemistry**"** Goel Pubs. House.
8. Dr. D.V.Jahagirdhar, **"**Experimentals in Physical Chemistry**"**.
9. D.P.ShoemakerExperiments in Physical Chemistry**"**.

SSCSC 451: *Inorganic Chemistry*

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic concepts in inorganic chemistry such as types of orbitals, spin momentum, orbital momentum, paramagnetic, diamagnetic complexes and geometry of complexes etc.
- Knowledge of basic concepts of catalysis.

Course objectives:

- To understand electronic spectra of coordination complexes and various factors affecting, interpretation of electronic spectra, magnetic properties of coordination complexes.
- To understand the difference between diamagnetic and paramagnetic complexes, calculating number of unpaired electrons and predicting magnetic nature of complexes.
- To understand the chemistry of carbonyl and nitrosyl ligands and their complexes, boranes/carboranes and metal clusters.
- To understand catalysts, their types and various catalytic reactions in inorganic chemistry.

Course outcomes:

- Student will be able to discuss electronic spectra of coordination complexes and various factors affecting, to interpret electronic spectra of coordination complexes.
- Student will be able to the differentiate between diamagnetic and paramagnetic complexes, calculating number of unpaired electrons and predicting magnetic nature of complexes and to discuss each of these aspects to a sufficient detail.
- Student will be able to discuss the chemistry of carbonyl and nitrosyl ligands and their complexes, boranes/carboranes and metal clusters.
- Student will be able to discuss catalysts, their types and various catalytic reactions in inorganic chemistry.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Electronic Spectra and Magnetic Properties of Transition Metal Complexes**	**20**
	1.1	**Electronic spectra:** Introduction, coupling of orbital angular momentum and spin angular momentum, spin-orbit coupling, Russell Saunders coupling and j-j coupling, Term symbol, Hund's rules for determination of ground state term symbol, prediction of ground state term symbol for various configurations, microstates, calculation of number of microstates and problems, Hole formulation, Racah parameters.	
	1.2	**Effect of crystal field on terms:** Effect of weak octahedral and tetrahedral crystal field potential on terms, Orgel diagrams (plotting of Orgel diagrams for d^1-d^9 configurations), Tanabe-Sugano (T-S) diagrams (for d^2 & d^6 configurations only), Selection rules (Lapporte selection rule & Spin selection rule), relaxation in selection rules, charge transfer spectra (LMCT and MLCT), interpretation of electronic spectra of transition metal aqua complexes.	
	1.3	**Magnetic properties:** Introduction, prediction of magnetic moment values of transition metal complexes (d1-d9 configurations) using spin only formula, anomalous magnetic moments and spin crossover	
	1.4	**Problems:** Problems based on electronic spectra, determination of number of unpaired electrons and prediction of magnetic properties of complexes.	
2.0		**Metal Carbonyls and Nitrosyls**	**10**
	2.1	**Metal carbonyls:** Introduction, Classification of carbonyl complexes, Formation of CO molecule, Coulson's modification and explanation of strong field effect of Co ligand, Bonding in metal carbonyl complexes (mono, di & trinuclear carbonyl complexes, synergic relationship between metal and CO ligands)	
	2.2	**Metal carbonyls examples:** Preparation, properties & structures of mono, di & trinuclear carbonyl complexes [$V(CO)_6$, $Cr(CO)_6$, $Ni(CO)_4$, $Fe(CO)_5$, $Mn_2(CO)_{10}$, $Co_2(CO)_8$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$], Effective Atomic Number (EAN) rule and 18 electron rule for metal carbonyls	

	2.3	**Metal nitrosyls:** Introduction, classification of metal nitrosyls, linear v/s bent nitrosyls, preparation, properties, structure & applications of sodium nitroprusside (SNP), brown ring compound, Effective Atomic Number (EAN) rule and 18 electron rule metal nitrosyls	
	2.4	Problems based on EAN rule and 18 electron rule for metal carbonyls and nitrosyls	
3.0		**Boranes, Carboranes and Metal Clusters**	
	3.1	**Boranes:** Introduction, classification & nomenclature of boranes, preparation, properties & structure of B_2H_6, Wades rules for predicting structure type in boranes, styx code (determination of styx code for B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} & B_6H_{10} molecules by drawing their structures),	
	3.2	**Carboranes:** Introduction, Chemistry of $C_2B_{10}H_{12}$ (Di-carbacloso-dodecacarborane), Wades rules for predicting structure type in carboranes	**10**
	3.3	**Metal clusters:** Introduction, classification of metal clusters, structural aspects of low nuclearity carbonyl clusters (LNCC) and halide type clusters (Di, tri, tetra & hexanuclear clusters), Cheverel phases and Zintl ions, Wades rules for total electron count in HNCC	
	3.4	**Numerical Problems:** Numerical based on Wades rules	
4.0		**Inorganic Catalysis**	
	4.1	**Introduction to catalysis:** Introduction, general principle & mechanism of catalytic reactions, types of catalysts (6 types-positive, negative, auto, induced, enzyme, acid-base catalyst).	
	4.2	**Homogenous catalysis:** Hydrogenation of alkenes, hydroformylation reaction, methanol carbonylation reaction, Wacker oxidation of alkene, Pd catalyzed C-C bond formation reaction.	**15**
	4.3	**Heterogenous catalysis**: The nature of heterogenous catalysis, ammonia synthesis, SO_2 oxidation, Fischer-tropsch synthesis, alkene polymerization, new direction in heterogeneous catalysis such as Tethered catalysis.	
		Total	

Reference Books:

8. James Huheey, Eller A. Keiter, and Richard L. Keiter, "Inorganic Chemistry (Principles of Structure and Reactivity", 4th Edition, Harper Collins Publishers.
9. W. U. Malik, G. D. Tuli, and R. D. Madan, "Selected Topics in Inorganic Chemistry", S. Chand Publications.
10. Gurdeep Raj, "Advanced Inorganic Chemistry", Vol. II, Goel Publishing House.
11. B. R. Puri, L. R. Sharma, and K. C. Kalia, "Principles of Inorganic Chemistry", Milestone Publishers & Distributors.
12. Satish Kumar Agarwal and Keemti Lal, "Advanced Inorganic Chemistry", Pragati Prakashan.
13. F. A. Cotton and G. Wilkinson, "Advanced Inorganic Chemistry (A Comprehensive Text)", Interscience Publishers, John Wiley & Sons.
14. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong, Michael Hagerman, " Shriver & Atkins' Inorganic Chemistry", 5th Edition, Oxford University Press, W. H. Freeman and Company, New York.
15. G. Wilkinson, R. D. Gillars and J. A. McCleverty, "Comprehensive Coordination Chemistry. Eds.", Pergamon.
16. R. L. Carlin, "Magnetochemistry", Springer Verlag.
17. N. N. Greenwood and A. Earnshaw, "Chemistry of the Elements", 2nd Edition, Pergamon.
18. A. B. P. Lever, "Inorganic Electronic Spectroscopy", Elsevier publications.

SSCSC-452: *Organic Chemistry*

Credits 4 (60 Contact hrs)

Course objectives:

- Students should learn about Nature of Chemical bonding in Organic molecules, Structure and Reactivity.
- To understand the various concept of Stereochemistry, Asymmetric synthesis, absolute configuration and Conformation analysis.
- To explain the mechanism of aliphatic electrophilic and nucleophilic substitution reactions.
- To interpret the problems of Benzenoid and Non Benzenoid compounds.
- Students develop the knowledge of Thermodynamic of the reaction and Kinetic of the reactions
- Student should explain the Free radical mechanism.
- To develops skill of writing mechanism.

Course outcomes:

- Understand the various types of Reaction Mechanism.
- Adopt the concept of Bonding in Organic Molecules.
- Learn the concept of Stereochemistry and to identify the Stereo chemical reactions.
- Explain the various problems of aromaticity, homoaromaticty and antiaromaticity.
- Familiarize the various types of Substitution reactions and their mechanism
- Gain the knowledge of free radical reactions.
- Justifies the various effect of substrate.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required
1. 0		**Aromatic Substitution Reactions**	**10**
	1.1	**Aromatic Electrophilic Substitution Reactions:** Introduction, the arenium ion mechanism, orientation and reactivity. Energy profile diagram, steric effect, ortho/para ratio, ipso attack, introduction of a third group into benzene ring, Electrophilic substitution in polycyclic and heterocyclic ring system.	
	1.2	**Some Important Name Reactions:** Diazonium coupling Vilsmeier-Haack reaction (With suitable examples).	
	1.3	**Aromatic Nucleophilic Substitution Reactions**: S_N^1, S_N^2, S_N^{Ar} and S_{RN}^1 mechanisms. Aromatic nucleophilic substitution via benzyne intermediate. Factor affecting reactivity in aromatic nucleophilic substitution reaction.	
	1.4	**Some Important Name Reactions:** Chichibabin reaction, Somlet-Houser and Smiles rearrangement (With suitable examples).	
2.0		**Addition to Carbon-Carbon and Carbon-Hetero Multiple Bonds.**	**20**
	2.1	Electrophilic addition to Carbon-Carbon double bond.	
	2.2	Mechanism and stereochemical aspects of addition reaction involving electrophile, nucleophile and free radicals.	
	2.3	Regio and chemo selectivity, orientation and reactivity, conjugate addition.	
	2.4	Addition to cyclopropane, hydroboration, Michael reaction, Sharpless asymmetric epoxidation, hydroxylation of alkene-diol formation.	
	2.5	Some general and stereochemical aspects of addition to carbonyl compounds.	
	2.6	Mechanism and stereochemistry of metal hydride reduction.	
	2.7	Addition of organo-metallic compounds to carbon hetero-multiple bond (organo-zinc, organo-copper, organo- lithium, reagents to carbonyl and unsaturated carbonyl compounds).	
	2.8	**Some Important Name Reactions:** Wittig reaction, Knoevenagel, Claisen, Mannich, Perkin and Stobbe condensation (With suitable examples).	

3.0		**Elimination Reactions**	**10**
	3.1	The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions.	
	3.2	Hoffman versus Saytzeff elimination, Pyrolytic syn-elimination.	
	3.3	Competition between substitution and elimination reactions.	
	3.4	**Reactivity**: Effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions. Pyrolytic elimination reactions.	
4.0		**Pericyclic Reactions**	**20**
	4.1	Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.	
	4.2	Classification of pericyclic reactions.	
	4.3	Woodward-Hoffmann correlation diagram, FMO and PMO approaches.	
	4.4	**Electrocyclic Reaction:** con-rotatory and dis-rotatory motion, 4n, 4n+2 and allyl system.	
	4.5	**Cycloadditions:** Superafacial and antrafacial addition, 4n and 4n+2 system, 2+2 addition of ketenes, 1,3 dipolar cycloaddition and chelotropic reaction.	
	4.6	**Sigmatropic Rearrangements:** Suprafacial and antrafacial shifts of H, sigma tropic shifts involving carbon moieties, 3,3 and 5,5 sigmatroic rearrangements.	
	4.7	**Some Important Pericyclic Reactions:** Claisen, Cope and Aza-cope rearrangements.	
		Total	**60**

Reference Books:

1. Advanced organic chemistry-Reaction mechanism and structure, Jerry March, John Wiley.
2. Structure and mechanism in organic chemistry, C. K. Ingold, Cornell University Press.
3. Advanced organic chemistry, F. A. Carey and R. J. Sandburg, Plenum.
4. A guide book to mechanism in organic chemistry, Peter Sykes, Longman.
5. Stereochemistry of organic compounds, D. Nasipuri, New Age International.
6. Modern organic reactions, R. O. C. Norman and J. M. Coxon, Blackie Academic and Professional.
7. Organic chemistry, R. T. Morison Boyd, Prentice-Hall.
8. Organic reactions and their mechanism, P. S. Kalsi, New Age International.

9. Modern organic reactions, H. O. House, Benjamin.
10. Pericyclic reactions, S. M. Mukherji, Macmilan, India.
11. Advanced Organic Chemistry- Jagdamba singh and L. D. S Yadav, Pragati Prakashan.
12. Organic Chemistry- J. Clayden, N. Greeves and S. Warren, Oxford University Press.

SSCSC 453: *Physical Chemistry*

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Basic information about polymers, surfactants and their applications
- Knowledge of basic concepts of electrochemistry such as cell, half cell, anode, cathode, working electrode, reference electrode, corrosion etc.
- Basics concepts like rate, order, molecularity of reaction, reaction mechanism, temperature dependence of rate, complex reactions, catalysis, basic of fast reactions

Course objectives:

- To understand concepts and properties of surfactants and macromolecules
- To state and understand laws, principles, theories related to the electrochemistry of the solutions, corrosion, its monitoring and presentation
- To learn different theories of reaction rates and understand the kinetics of complex reactions, catalysis etc.
- To develop skill in problems solving, solve the numerical of electrochemistry and chemical kinetics, critical thinking and analytical reasoning.

Course outcomes:

- Students will be able to understand concepts and properties of surfactants and macromolecules
- Students will be able to state and understand laws, principles, theories related to the electrochemistry of the solutions, corrosion, its monitoring and presentation
- Students will be able to learn different theories of reaction rates and understand the kinetics of complex reactions, catalysis etc.
- Students will be able to develop skill in problems solving, solve the numerical of electrochemistry and chemical kinetics, critical thinking and analytical reasoning.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required
1. 0		**Electrochemistry**	**20**
	1.1	**Electrochemistry of solutions:** Debye-Huckel-Onsager treatment, ion solvent interactions, thermodynamics of electrified interface, Lippmann equation, over potential, exchange current density, derivation of Butler-Volmer equation, Tafel plot, quantum aspects of charge transfer at electrodes-solution interfaces, tunneling	
	1.2	**Semiconductor/electrolyte interface:** Theory of double layer at semiconductor/electrolyte interface, structure of double layer interface, flat-band potential, effect of light at semiconductor solution interface	
	1.3	**Polarography:** Principle, theory and applications of polarography, Ilkovic equation, polarogram, significance of diffusion current and half wave potential, Applications of polarography for qualitative and quantitative analysis of electro-active species, numerical on Ilkovic equation	
	1.4	**Corrosion:** Introduction, forms of metallic corrosion - uniform, pitting, crevice, intergranular, stress corrosion, corrosion fatigue, dealloying, high-temperature, biological, liquid metal attach, and exfoliation corrosion, monitoring and corrosion prevention techniques	
2.0		**Chemical Kinetics (I)**	**15**
	2.1	**Introduction:** Rate and mechanism of reactions, determination of rates of reactions, determination of rate law of the reaction, temperature dependence of reaction rates in general	
	2.2	**Theories of reaction bimolecular rates:** Collision theory of reaction rates in gas phase for bimolecular reactions, energy requirement, steric factor, Activated complex theory (Transition state theory), assumptions, Thermodynamic formalism and derivation of Eyring Equation, Arrhenius equation.	
	2.3	**Theories of reaction unimolecular rates:** Concept of steady state approximation, Lindemann theory of unimolecular reactions	
	2.4	**Numericals:** Numericals based on the order of reaction, Arrhenius	

		equation, Eyring equation, unit of rate constant etc.	
3.0		**Chemical Kinetics (II)**	**10**
	3.1	**Reactions in solution:** Introduction, reactions in solutions, solvent effects on reaction rates, reaction showing solvent effect, and diffusion controlled reactions, ionic reactions and salt effect.	
	3.2	**Kinetics of complex reactions:** Dynamics of chain reactions between hydrogen-bromine, pyrolysis of acetaldehyde with two mechanism having different order, photochemical reactions between hydrogen-bromine and hydrogen-chlorine	
	3.3	**Catalysis:** Introduction, acid-base catalysis and enzyme kinetics, Michaelis- Menten mechanism for dependence of the initial rate of enzyme-catalyzed reactions on concentration for enzyme kinetics, active sites, Michaelis-Menten equation, Graphical presentation of change in the order of enzyme kinetics substrate concentration	
	3.4	**Study of fast reactions:** General features of fast reactions, study of fast reaction by flow methods, continuous flow method, stopped flow method, quenched flow method, relaxation method and flash photolysis.	
4.0		**Surface Chemistry (II)**	**15**
	4.1	**Micelles:** Recapitulation of surface tension, Surface active agents, classification of surface active agents, hydrophobic interactions, micellization, thermodynamics of micellization, critical micelle concentration (CMC), factors affecting CMC of surfactants.	
	4.2	**Macromolecules:** Definition of macromolecule (Polymers), classification of polymers, mathematical definition of number average and mass average molecular mass of polymers, Polydispersity Index of polymer	
		Determination of molecular mass of polymers: Methods for determination of molecular mass of polymers i) Viscometry method and ii) Light scattering method	
	4.3	**Numerical:** Numerical based on number average and mass average molecular mass of polymers	
		Total	**60**

Reference Books:

1. V. Moroi, Micelles,"Theoretical and Applied Aspects",Plenum.
2. S. F. Sun, John ,"Physical chemistry of macromolecules",Wiley and Sons, INC.
3. V. R. Gowarikar, N, V. Vishwanathan & J. Sridhar ,"Introduction to Polymer Science", Wiley Eastern.
4. J. O. M. Bockris & A.K.N. Reddy ,"Modern Electrochemistry" Vol. I &II, 2nd Edition,Plenum.
5. Puri, Sharma, Pathania , "Principles of Physical Chemistry", 48th Edition,Vishal Publishing Co.
6. P. W. Atkins , "Physical Chemistry", ELBS.
7. A. K. Chandra , "Introduction to Quantum Chemistry", 4th edition, Tata McGraw Hill.
8. Ira N. Levine, "Quantum Chemistry", 7th edition Pearson Education India.
9. R. Mc Weeny , "Coulson's Valence",3rd edition, ELBS.
10. K. J. Laidler,"Chemical Kinetics", 3rd edition ,McGraw Hill.
11. J. Rajaraman and J. Kuriacose, "Kinetics and Mechanism of Chemical Transformations", Macmillan

SSCSE451: Spectrochemical Methods of Analysis

Credits 3 (45 Contact hrs)

Course objectives:

- To understand the basics concepts of different spectrochemiocal methods of analysis such as atomic absorption and emission and luminesecence spectrochemical methods.
- To understand in detail the instrumentation and applications of above methods.
- To understand the suitability of appropriate methods depending upon the accuracy desired and economical aspect of the method.
- To master the course by solving challenging numerical problems based on the above topics.

Course outcomes:

After learning this course the students shall able

- To understand the principle, operation and applications of different spectrochemical methods of analysis.
- To develop the method of quantification for a given sample of analyte.
- Understand to make a judicious choice of the analytical methods from the available methods as per requisite of situation.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		**Molecular Absorption and luminescence spectrophotometry**	**15**
	1.1	Introduction, Lambert, Beer's law, deviations, quantitative analysis	
	1.2	Theory of spectrometry and colorimetry, instrumentation, classification of methods of colour measurements	
	1.3	standard curve /calibration graph method, derivative spectrometry and applications, standard addition method, qualitative and quantitative Applications	
	1.4	Infrared Spectrophotometry: Instrumentation, Quantitative Applications, Qualitative Applications, Characterization Applications	
	1.5	Fluorescence, phosphorescence, Instrumentation and applications, Molecular Fluorescence and Phosphorescence Spectra, Instrumentation, Quantitative Applications Using Molecular Luminescence	
2.0		**Atomic Absorption spectrometry**	**15**
	2.1	Principle, instrumentation, burners	
	2.2	production of atoms and ions, Electrothermal Atomizers, cold-vapor method, detectors	
	2.3	HCL, EDL, background correction method and application	
	2.4	interferences, Minimizing Interference, advantage and disadvantage of AAS	
3.0		**Atomic emission and Mass spectrometry**	**15**
	3.1	introduction, elementary theory, instrumentation, type of burners, fuel-oxidant composition, interferences, internal standard method	
	3.2	Introduction, equipment, qualitative and quantitative analysis with AES, plasma emission spectrometry, direct current plasma, inductively coupled plasma, ICP-AES, high energy sources (plasma, arc, and spark), sample introduction and measurements	
	3.3	Introduction, mass spectrometer interface, mass analyzers, transducers, interface in ICP MS, applications	
		Total	**45**

Reference Books:

1. D.A. Skoog, D.M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, (2004), Thomsan Brooks/Cole, Cengage Learning Ind. Pvt. Ltd, New Delhi.
2. Ewing's Analytical Instrumentation Handbook, Ed. J. Cazes, (2005), Marcel Dekker, Inc., New York.
3. G.H. Morrison and H. Freiser, Solvent Extraction in Analytical Chemistry, 1st Edition (1958), John Wiley, New York.
4. B.L. Karger, L.R. Snyder and C. Howarth, An Introduction to Separation Science, 2nd Edition (1973), John Wiley, New York.
5. E.W. Berg, Chemical Methods of Separation, 1st Edition (1963), McGraw Hill, New York.
6. D.G. Peters, J.M. Hayes and C.M. Hieftj, Chemical Separation and Measurements, 2nd Edition (1974), Saunders Holt, London.
7. J.D. Seader and E.J. Henley, Separation Process Principles, 1st Edition (1998), John Wiley & Sons. Inc., New York.

SSCSE452: Transportation Processes in Unit Operation

Credits 3 (45 Contact hrs)

Course objectives:

- To learn about the concept and laws of heat and mass transfer processes
- To understand the construction and working of heat transfer and mass transfer equipments
- To evaluate heat transfer by conduction and radiation
- To study evaluate mass transfer diffusion and gas absorption
- To be able solve numerical on heat and mass transfer processes.

Course outcomes:

- Students will understand the basic laws governing the heat and mass transfer operations.
- Students will be able to understand the construction and working of different equipments used for the heat and mass transfer operations.
- They can help/involve in the design of equipments for heat and mass transfer operations.
- They can apply their knowledge of equipments used for the heat and mass transfer operations when actually working in the industry.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		**Heat Transfer Process**	
	1.1	Fluid Mechanics: Nature of fluids, viscosity, Reynolds number, application of Bernoulli's Equation, methods of transportation of fluids, pump characteristics, reciprocating gear and centrifugal pumps, blowers, compressors, frictional losses in pipe fitting (problems)	
	1.2	Heat Exchange Equipments: Introduction, double pipe heat exchanger, shell and tube heat exchanger, fixed tube-sheet exchanger, fixed tube-sheet, 1-2 heat exchanger removable- bundle heat exchanger (problems)	**20**
	1.3	Heat Transfer by Conduction: Introduction, fourier's law, thermal conductivity, compound resistances in series, heat flow through a cylinder, heat flow through sphere (problems)	
	1.4	Heat Transfer by Radiation: General terms involved in radiations – absorptivity, reflectivity, transmissivity, black body, Kirchoff's Law, Steafan-Boltzman Law, radiation heat transfer, concept of black body (problems)	
2.0		**Mass Transfer Operation**	
	2.1	Introduction to Mass-Transfer Operation: Classification of the mass-transfer operations, method of conducting the mass transfer operations	
	2.2	Principles of Diffusional Processes: Ficks' Law, molecular diffusion, molecular diffusion in liquid, diffusivity of liquid, diffusion in solids, unsteady-state diffusion, types of solid diffusions	**20**
	2.3	Mass-Transfer Equipments: Mechanical agitated vessels for gas-liquid contact, tray towers, venture scrubber, packed tower, tower packings and types of packing	
3.0		**Gas Absorption**	**5**

	3.1	Introduction, equilibrium solubility of gases in liquids, two components and multicomponent system, choice of solvent for absorption, material balances one component system, minimum liquids gas ratio, pressure drop in packed columns (problems).	
		Total	**45**

Reference Books:

1. Mass Transfer Operation – Robert E. Treybal
2. Unit Operation of Chemical Engineering – Warren L. Mc Cabe, Julian C.Smith
3. Unit Operation I & II – K.A. Gavhane

SSCSE453: Drug-Design

Credits 3 (45 Contact hrs)

Course pre-requisite:

2. BSc in chemistry

3. Course objectives:

- To learn basic principles involved in drug discovery and designing process
- To know the role of medicinal chemist in development of medicinal agents
- Learn how to analyze and perform SAR and QSAR

Course outcomes:

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

- Analyze the important aspects involved in drug discovery process in designing
- Know the role of medicinal chemist in development of medicinal agents
- Have understanding about functional group modification and chemical parameters for the utility in SAR and QSAR.
- Appreciate the concept of receptor and its interaction for the utility in drug design.
- Analyze the recent research articles related with drug design.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		Development of new drugs	
	1.1	Introduction, procedure followed in drug design,	
	1.2	The search for lead compounds, various approaches with emphasis over drug design involving known and unknown receptor structure.	**6**
	1.3	Molecular modification of lead compounds.	
2.0		Prodrugs and Soft Drugs:	
	2.1	Introduction, Pharmaceutical, Pharmacodynamics and Pharmacokinetic phases. Analogs and prodrugs, Prodrug Designing groups, and various examples with different functional groups.	
	2.2	Types of Prodrugs (Double Multiple and Bifunctional), advantages of prodrugs approach	**9**
	2.3	Concept and design of Soft Drugs, need and Importance of soft drugs and various relevant example. Activated soft compound with example	
3.0		Chemical Parameters in Drug Design:	
	3.1	Importance of structural aspects as like stereochemistry, rigidity, and flexibility. Determination of structure.	
	3.2	Crystallographic information file and use of mercury software, To get CIF from Crystal Structure Data, Cambridge Crystallographic Data Centre CCDC.	**9**
	3.3	Biological properties of simple functional groups and biological Isosterism (true and partial isosterism)	
4.0		Drug-Receptor interaction theories and examples	
	4.1	Drug receptor interaction, Theories of drug receptor and drug activity, Clark's occupation theory, Rate theory, Induced fit theory.,	
	4.2	Competitive (reversible) inhibitors examples 9-alkylpuriness, 6-mercaptopurine and Allopurinol, and non-competitive reversible (allosteric) inhibitors with examplePhosphofructikinase inhibition, active site directed irreversible enzyme inhibition, inhibition of chymotrypsin and adenosine deaminase, suicide enzyme in-activators: K CAT inhibitors, mechanism based inhibitorwith example 4-amino-5-hexanoic acid (vigabatrin).	**9**
	4.3	Structure based drug design, process of structure-based drug design, example of enzyme Purine Nucleoside Phosphorylase (PNP)	
5.0		Quantitative structure activity relationship:	
	5.1	QSAR, introduction, graphs and equation, physiochemical parameters,	12

		Fergusson principal and related theories,	
	5.2	Craig's plot, The Topliss scheme, Batch selection method, batch wise Toplis operational schemetree, cluster analysis.	
	5.3	QSAR methods, Hansch method, Free Wilson method, Planning a QSAR Study.	
		Total	**45**

Reference Books:

1. An Introduction to Drug Design, S. S. Pandeya and J. R. Dimmock, New Age International
2. An Introduction to medicinal chemistry, Graham L. Patrick. Oxford university press.
3. Burger's Medicinal Chemistry and Drug Discovery, John Wiley.
4. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.

SSCSE454: Chemistry of Natural Products

Credits 3 (45 Contact hrs)

Course objectives:

Exposure to different natural products, and their

1.Nomenclature

2. Biogenesis,

3. Stereochemistry and structure elucidations

4. Synthetic routes and biological role played by them

Course outcomes:

The learner will be familiar with different natural products with respect to

1. Extraction methods, structure elucidation, degradation, stereochemistry.
2. Synthetic strategies for total synthesis of natural products.
3. Therapeutic application of different natural products and prostaglandins.
4. Rotenones and their applications.
5. Resents advances in natural products.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		**Terpenoids and Carotenoids**	
	1.1	Classification, nomenclature, occurrence, isolation	
	1.2	General methods of structure determination, isoprene rule, structure determination, stereochemistry	**8**
	1.3	Biosynthesis and synthesis of the following representative molecules (only two) : B-Carotene a-Terpeneol	
2.0		**Alkaloids**	
	2.1	Definition, nomenclature and physiological action, occurrence, isolation	
	2.2	general methods of structure elucidation, degradation	**8**
	2.3	classification based on nitrogen heterocyclic ring, role of alkaloids in plants	
	2.4	Structure, stereochemistry, synthesis and biosynthesis of the following: Atropine, ajmaline	
3.0		**Steroids**	
	3.1	Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry	
	3.2	Isolation, structure determination	**8**
	3.3	synthesis of Cholesterol and Testosterone, Biosynthesis of steroids, Synthesis of Bile acids, Androsterone, Estrone, Progestrone, Aldosterone, estradiol	
4.0		**Plant Pigments**	
	4.1	Occurrence, nomenclature and general methods of structure detrmination	**8**
	4.2	Isolation and synthesis of Apigenin and Myrcetin,	
	4.3	biosynthesis of Flavonoids: Acetate pathway and shikimic acid pathway	
5.0		**Prostaglandins**	
	5.1	Occurrence, nomenclature, classification, biogenesis and physiological effects	8
	5.2	synthesis of PGE2, PGE2a and other derivatives	
6.0		**Pyrethroids, Rotenones and pheromones**	
	6.1	Synthesis and reactions of pyrethroids, Rotenones and pheromons (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).	**5**
		Total	**45**

Reference Books:

1. Natural Products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J. B. Hobbs, D. V. Banthrope and J. B Harborne, Longman, Essex.
2. Organic Chemistry, Vo. 2. I. L. Finar, ELBS.
3. Stereoselective synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal plants from the Americas, Ed. Kurt Hostettmann, M. P. Gupta and A. marston, Harwood Academic publishers.
6. Introduction to Flavonoids, B. A. Bohm, harwood Academic Publishers.
7. New Trends in Natural Product chemistry, Atta-ur-Rahman and M. I. Choudhary, Harwood Academic Publishers.
8. Insectcides of Natural Origin, Sukh Dev. Harwood AdemicPblishers.
9. Chiral auxilliaries and ligands in asymmetric synthesis-seyden-penne (Wiley Interscience).
10. Biotechnological innovations in chemical synthesis-Butterworth-Heinemenn, Biolot.

SSCSE455: Statistical Thermodynamics

Credits 3 (45 Contact hrs)

Course objectives:

- The main goal of this course is to acquire fundamental knowledge of classical and quantum statistical mechanics, construct a bridge between macroscopic thermodynamics and microscopic statistical mechanics by using mathematical methods.
- To be specific, the objective of statistical thermodynamics is to give a molecular basis for thermodynamics.
- Thus, it is necessary to define the concepts and evaluation of thermodynamic properties at the molecular level in order to understand the properties of system under study at bulk level.

Course outcomes:

- Upon completion of the course, the students will understand basic principles, and be able to use principles and ideas to calculate properties of simple statistical systems.
- It includes, learning different statistical ensembles, their distribution functions, ranges of applicability and the corresponding thermodynamic potentials.
- Application of quantum and statistical distributions in circumstances varying from standard examples such as gases, solutions, polymer solutions, solids and electrolytic charge carriers to statistics will be greatly acknowledged.
- Also, students become aware of the richness and complexity of statistical behavior exhibited by interacting systems and various approaches (phenomenological and microscopic) developed to comprehend such systems.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required
1.0		**Background concepts**	
	1.1	Combinatorial problems, number ways in which particles can be arranged in order or placed in container	
	1.2	the situations of this distribution in Boltzman, Fermi-Dirac and Bose-Einstein statistics	**10**
	1.3	illustrations Stirling approximation, Lagrange method of undetermined multipliers, distribution and most probable distribution, problems	
2.0		**Statistical Mechanics of a system of Independent Particles**	
	2.1	Introduction: distribution laws, partition functions and its significance	
	2.2	limit of applicability of various distribution laws, relation between partition function and thermodynamics function	**10**
	2.3	Illustrative examples and problems	
3.0		**Application of statistical Mechanics**	
	3.1	Ideal gases: Partition function of a monoatomic gas, thermodynamics function of a molecule, heat capacity and the residual entropies of polyatomic molecules	
	3.2	Solids: Introduction, thermal characteristics of crystalline solids, Einstein model, Debye modifications, limitations and modifications of Debye theory and comparision between Debye theory and Einstein model	**15**
	3.3	Solutions: Introduction, lattice models, ideal solution, non-ideal solutions, polymer solutions	
4.0		**Nuclear spin Statistics**	
	4.1	Introduction, the mean symmetry and the nuclear-spin	**5**
	4.2	ortho and para nuclear states, ortho and para hydrogen, nuclear spin statistics of deuterium	
5.0		**Fluctuations**	
	5.1	Introduction, the mean distribution and mean square deviation	5
	5.2	fluctuation in energy in a canonical ensemble, fluctuations in density and radioactive disintegrations, the Brownian movement	
		Total	**45**

Reference Books:

1. Statistical Thermodynamics, Donald A Mc Quarrie, Happer and Row, Newyork, 1973
2. Statistical Thermodynamics, M. C. Gupta, Wiley Eastern Ltd, New Delhi

3. Elements of Statistical Thermodynamics, L. K. Nash, Addison Wesley, Menlo park
4. Text book of Physical Chemistry, Samuel M. Glasstone
5. Physical Chemistry, P. W. Atkins (ELBS).
6. Theoretical Physical Chemistry, S. M. Glasstone

SSCSE456: Polymer Characterization & Testing

Credits 3 (45 Contact hrs)

Course per-requisite

Students (Undergraduate/postgraduate) from chemistry background

Course objectives:

1. to get awareness of different testing methods used for plastics
2. to get exposure to polymeric material characterization technique
3. to understand the different standard testing methods
4. to know the weather ability of plastic material

Course outcomes:

1. Student will understand testing methods for polymers/plastics
2. student will know how spectroscopic methods used for testing polymer/plastics
3. Student will gain knowledge about how weather affects polymer/plastics performance

Curriculum Details

Module no	Unit no.	Topic	Hrs Required
1.0		**Polymer Molecular Weight**	**13**
	1.0	Molecular weight control and its commercial importance, Arithmetic mean - molecular weight average (Mw, Mn and Mv), Molecular weight distribution (MWD) and its importance.	
	1.1	Determination of molecular weight: Theory, principles, instrumentation, applications of membrane osmometry, vapour phase osmometry, viscometry, Gel permeation chromatography and End group analysis.	
2.0		**Spectroscopic Techniques for Polymer Analysis**	**12**
	2.1	UV-Visible Spectroscopy: Principle and theory instrumentation applications.	
	2.2	Fourier Transform Infrared Spectroscopy: Principle and theory, instrumentation applications – Establishment of chemical structure of polymers.	
	2.3	Nuclear Magnetic Resonance (^{1}H and ^{13}C NMR): Principle, theory, instrumentation applications.	
3.0		**Thermal Analysis Methods for Polymers**	**10**
	3.1	Differential Scanning Calorimetry (DSC): Theory, principle instrumentation & interpretations of DSC thermogram, applications.	
	3.2	Thermogravimetric analysis: Principle, theory, instrumentation applications.	
4.0		**Polymer Testing Methods**	**10**
	4.1	Mechanical properties, Electrical properties, **O**ptical properties,	
	4.2	Miscellaneous properties: Simple tests for identification of plastics/fibres (density, flame test, solubility, etc)	
	4.3	Polymer/plastics standards in India and abroad. Lust of laboratories testing polymer/plastics in India.	
		Total	**45**

Reference Books:

1) Handbook of Plastics Testing Technology, **Vishu Shah**, Wiley Interscience Publications, 2nd Edition, 1998.
2) Experiments in Polymer Science, **Collins Bares, F.W. Billmeyer**, Wiley Interscience, 1973.
3) Physical Chemistry of Macromolecules. **D.D. Deshpande, Vishal** Publications, Jalandhar, 1989.

4) Physical Chemistry of Polymers - **Paul C. Hiemenzs and Timothy P. Lodge** Second edition CRC Press (2007)
5) Mechanical Properties of Polymers and Composites **L. E. Nielsen**, Marcel Dekker.
6) Polymer Chemistry: **M. P. Stevens**, 2nd Ed., Oxford Univ. Press., (1990)
7) Polymer Characterization **E. Schroder, G. Muller and K.F. Arndt**. Hanser publishers, Munich.
8) Polymer Characterization: Physical Techniques **D. Campbell and J.R. White** Champan and Hall London (1989).
9) Polymer Spectroscopy **A.H. Faweett** 1st Edition, John Wiley (1996).
10) NMR of Polymers **F. Bovey and P. Miran**. Ist edition, Academic Press (1996)
11) NMR of Macromolecules: A practical approach **G. C. K. Roberts**, 1st Edition, Oxford University Press (1993).
12) Introduction to spectroscopy by **Donald L. Pavia Gary M. Lampman, George S. Kriz** (Harcourt college publications) 3rd Edition.
13) Hand Book of Plastic Test Methods, **R.P. Bown**, 3rd Edition, Longman Scientific & Technical, 1988.
14) Introduction to Polymer Science and Chemistry, A Problem Solving Approach, **M. Chanda**, CRS Press, 2006.
15) **Edgar** David, Edgar Robin Fantastic recycled plastic 2009, Sterling Publishing Co Inc. NY USA. ISBN 13; 978-1-60059-342-0.

SSCSP-451 Laboratory *course-3: (Organic Chemistry)*

2 Credits (30 contact hrs)

Course pre-requisite:

- Knowledge of basic practical concepts in organic chemistry such as preparation, technique o separation, identification of elements, and estimation of organic compounds

Course objectives:

- To learn the techniques of separation of organic mixtures
- To apply the skill in two stage preparation
- To adopt skill of purification and crystallization
- To able to understand the estimation of given organic compound
- To understand micro scale technique.

Course outcomes:

- Learn the pilot separation of the binary mixture
- Familiarize the systematic procedure of organic mixture analysis
- The preparation involving nitration, bromination, Sandmayer reaction, and Aldol condensation
- Learn the test involving identification of special elements
- Learn the confirmatory test for various functional groups
- Understand the technique involving drying and crystallization by various methods
- Expertise the various techniques of preparation and analysis of organic substances
- Learn the estimation of various organic compounds.
- Understand micro scale technique.

Curriculum Details:

Module No.	Practicals	Hrs. Required to cover the contents
1. 0	**Qualitative analysis (Separation of binary mixture)**	**16**
	• Separation, purification and identification of compounds from binary mixture solid-solid, solid-liquid and liquid-liquid mixtures are to be given for separation. Chemical methods (no ether), ether separation as well as physical methods are used for separation of mixtures. • Not more than one gram of each solid and 3 ml of each liquid should be used for preparing mixtures. Following list of mixtures is given for guidance or any other combination of mixture may be given. **Separation by chemical methods (Any Four)** 1. Benzoic acid +Acetanilide 2. β-Naphthol +Aniline 3. p-Nitrobenzoic acid + Anthracene 4. Salicylic acid +p-toluidine 5. Naphthalene + p-Nitroaniline 6. Benzophenone + Cinnamic acid 7. α -Naphthol + m-Dinitrobenzene • The purity of recrystallized compounds should be checked by TLC. • Quality and quantity of the compounds and purity should be shown to the teacher/examiner	
2.0	**Qualitative analysis (Separation of binary mixture)**	**12**
	Separation by using ether (Any Three) 1. Thiourea + Cinnamic acid 2. Oxalic acid +p-Nitro aniline 3. Acetone +Nitrobenzene 4. Ethyl acetate +p-Cresol 5. O-Cresol +Nitrobenzene **6.** m-cresol +p-Dichlorobenzene	
3.0	**Organic synthesis on micro-scale (Any four)** (using 10 mmol of starting material)	**16**
	1. 4-chloro toluene from p-toluidine (Sandmayer reaction) 2. Synthesis of triphenyl methanol from benzoic acid. 3. Synthesis of Dibenzylacetone from benzaldehyde	

	(Aldol-condensation) 4. Preparation of p-nitro/p-bromo-aniline from acetanilide. 5. Synthesis of 7-hydroxy coumarin from resorcinol. 6. Synthesis of 2,4-dihydroxy benzaldehyde from salicyladehyde. 7. Synthesis of 2,4-dihydroxy acetophenone from resorcinol. 8. Preparation of 1,2,4-tri-acetoxy benzene from hydroquinone (Other suitable experiments may be added)	
4.0	**Quantitative analysis (Any four)**	**16**
	1. Determination of iodine and saponification values of an oil sample. 2. Estimation of nitro group by reduction. 3. Estimation of glucose by iodination. 4. Estimation of –COOH group. 5. Estimation of $CONH_2$ group. 6. Estimation of –COOR group. 7. Estimation of unsaturation in the given compounds.	
	Total	**60**

Reference Books:

1. A. I. Vogel, A Text book of practical organic chemistry, Longman Sc. And Tech, 4^{th} edition.
2. Gnanapragasam N. S., Rammurthy G., Organic Chemistry Lab Manual, S. Vishawnath Publisher Pvt. Ltd. Chennai.
3. Practical organic chemistry Mamm and Saunders.
4. A handbook of Quantitative and Qualitative Analysis- H.T. Clarke.
5. Comprehensive Practical Organic Chemistry Preparation and Quantitative analysis, Renu Agrawal and V. K. Ahluwalia.
6. Organic Synthesis collective Volumes –Blat.
7. Systematic Lab. Experiments in Organic Chemistry –Arun Sethi, New Age Publication.

SSCSP 452: *Laboratory Course II Analytical Chemistry (Practicals)*
2 Credits (30 contact hrs)

Course pre-requisite:

- Knowledge of preparation of solutions, practice of accurately prepared molar and norma solutions, expertise in handling the glassware and apparatus etc.
- Information of use of equipments and standardization of equipments

Course objectives:

- To understand the error analysis and statistical analysis
- To be able to perform the experiments on chromatography, conductometry, pH metry, Colorimetry, potentiometry, flame photometry, kinetics etc. and become expertise in the qualitative and quantitative analysis which will have industrial applications

Course outcomes:

- Students will be able to understand the error analysis and statistical analysis
- Students will be able to perform the experiments on chromatography, conductometry, pH metry, Colorimetry, potentiometry, flame photometry, kinetics etc. and become expertise in the qualitative and quantitative analysis which will have industrial applications

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Performance of following Instrumentation experiments (Any Ten)**	**40**
	1.1	**Chromatography:** (1) Separation of cations and anions by paper chromatography and determination of their Rf values (2) Determination of ion-exchange capacity of a Cation exchange and anion exchanger. **Conductometry:** (1) Determination of the strength of strong acid and weak acid from mixture solution conductometrically (2) Analysis of aspirin by conductometric method. **pH metry:** (1) Acid-base titration in non-aqueous media by pH-metry (benzoic acid in ethanol/NaOH). (2) Determination pKa of weak acid by pH metry. (3) Determination of degree of dissociation of weak electrolyte and to study the deviation from ideal behavior that occurs with a strong electrolyte. **Colorimetry:** (1) Verification of Beer's law of (a) $KMnO_4$ and Cu^{+2} ammonia complex solution. (2) Determination of empirical formula for the formation of ferric salicylate complex by Job's method. (3) Determination of stability constant for the formation of complex between Fe^{+3} ions and 5-sulphosalicylic acid. **Polarimetry:** (1) Determination of rate constant for inversion of cane sugar by Polarimetry. (2) Study of inversion of cane sugar by enzyme kinetics. **Potentiometry:** (1) Determination of the strength of halides in the given mixture using potentiometry	

		Kinetics: (1) To study the kinetics of iodination of acetone. **Flame photometry:** (1) Estimation of Na^+/K^+ by flame photometry (2) Determination of hardness of water by complexometric titration. (Any other related experiments may be added)	
		Performance of following Instrumentation experiments (Any five)	
2.0	**2.1**	**Error analysis and statistical analysis:** 1. Determination of relative error and percentage relative error for the experimental data 2. Calculation of mean derivation and standard derivation for the experimental data 3. Application of't' test for experimental data. 4. Application of rejection criteria ('Q' test) for experimental data. 5. Treatment of analytical data with least square method applied to Beer's law for $KMnO_4$ solutions. 6. Find out the correlation coefficient for given data	**20**
		Total	**60**

Recommended study materials (Books):

1. B. Viswanathan and P.S. Raghavan, **"**Practical Physical Chemistry**"**.
2. B.P. Levitt Longman,Findley's , **"**Practical Physical Chemistry**"**.
3. A.M. James and F.F. Prichanrd Longman, **"**Practical Physical Chemistry**"**.
4. R.C. Das and B.Behra , **"**Experimental Physical Chemistry**"**, , Tata McGraw Hill.
5. V.D. Athanale and Parul Mathur , "Experimental Physical Chemistry**"**, New age International.
6. Dr. T.K. Chandhekar & S.W. Rajbhoj, **"**Systematic experimental Physical Chemistry**"**.
7. J.B. Yadao,Advance, **"**Practical Physical Chemistry**"** Goel Pubs. House.
8. Dr. D.V.Jahagirdhar, **"**Experimentals in Physical Chemistry **"**.
9. D.P.Shoemaker, **"**Experiments in Physical Chemistry**"**.

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col. 6).

B. End Semester Assessment (80% of the Maximum Marks):

(For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

Note: **Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three credit course 45 lectures.**