॥ 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

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० नुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२४–२५ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, या विद्यापीठा अंतर्गत येणा–या सर्व संलग्नित महाविद्यालयामध्ये शैक्षणिक वर्ष २०२४–२५ पासून राष्ट्रीय शैक्षणिक धोरणानुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम लागू करण्याच्या दृष्टीकोनातून विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत येणा–या अभ्यासमंडळांनी तयार केलेल्या पदव्यूत्तर द्वितीय वर्षाच्या अभ्यासक्रमांना मा. विद्यापरिषदेने दिनांक १५ मे २०२४ रोजी संपन्न झालेल्या बैठकीतील विषय क्रमांक १५/५९–२०२४ च्या ठरावाअन्वये मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील खालील एम. एस्सी द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) लागू करण्यात येत आहेत.

1) M. Sc. II year - Analytical Chemistry (Affiliated College)
2) M. Sc. II year - Biochemistry (Affiliated College)
3) M. Sc. II year - Organic Chemistry (Affiliated College)
4) M. Sc. II year - Physical Chemistry (Affiliated College)
5) M. Sc. II year - Inorganic Chemistry (Affiliated College)
6) M. Sc. II year - Analytical Chemistry (Campus)
7) M. Sc. II year - Industrial Chemistry (Campus)
8) M. Sc. II year - Medicinal Chemistry (Campus)
9) M. Sc. II year - Organic Chemistry (Campus)
10) M. Sc. II year - Physical Chemistry (Campus)
11) M. Sc. II year - Polymer Chemistry (Campus)
12) M. Sc. II year - Computer Management (Affiliated College)
13) M. Sc. II year - Computer Sciene (Affiliated College)
14) M. Sc. II year - Software Engineering (Affiliated College)
15) M. Sc. II year - System Administration & Networking (Affiliated College)
16) M. Sc. II year - Computer Application (Campus)
17) M. Sc. II year - Computer Network (Campus)
18) M. Sc. II year - Computer Science (Campus)
19) M. Sc. II year - Zoology (Campus)
20) M. Sc. II year - Zoology (Affiliated College)
21) M. Sc. II year - Physics (Campus)
22) M. Sc. II year – Physics (Affiliated College)

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.:शै–१/एनइपी/विवत्रंविपदवी/२०२४–२५/993
दिनांक १३.०६.२०२४

डॉ. सरिता लोसरवार
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक 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		RM 5 (3 Cr)	OJT / FP 6 (3 Cr)	Research Project 7	Practicals 8	Credits 9	Total Credits 10
		(DSC) (4 Cr) 3	(DSE) (*From same Department / School*) 4						
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 SSCSOJ 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) Organic Reaction Mechanism SSCSC502 (4 Cr) Organic Spectroscopy SSCSC503 (2 Cr) Symmetry and Group Theory	SSCSE501 (4 Cr) - Chromatograhphic Methods of Analysis SSCSE502 (4 Cr)- Advanced Analytical Techniques in Industries SSCSE503 (4Cr) - Advanced Medicinal Chemistry SSCSE504 (4Cr) -Organic Synthesis SSCSE505 (4Cr) - Electrochemistry SSCSE506 (4Cr) -Polymer Processing Technology	--		SSCSR551 (4Cr) Research Project	SSCSP501 (2 Cr) Lab Course 5 SSCSE502 (2 Cr) Lab Course 6-Analytical Chemistry SSCSE503 (2 Cr) Lab Course 7-Industrial Chemistry SSCSE504 (2 Cr) Lab Course 8-Medicinal Chemistry SSCSE505 (2 Cr) Lab Course 9-Organic Chemistry SSCSE506 (2 Cr) Lab Course 10-Physical Chemistry SSCSE507 (2 Cr) Lab Course 11-Polymer Chemistry	**22**	**44**
	4	SSCSC551 (4 Cr) Synthetic Methods in Organic Chemistry SSCSC552 (4 Cr) Quality Assurance and Quality Control, Method of Analytical Development and Validation	SSCSE551 (4 Cr) -Applied Analytical Chemistry SSCSE552 (4Cr) -Environmental Industrial Chemistry SSCSE553 (4Cr) -Chemotherapy SSCSE554 (4Cr) -Advanced Organic Chemistry SSCSE555 (4Cr) -Biophysical Chemistry SSCSE556 (4Cr) -Polymers from Renewable Resources	SVECP 551 Publication Ethics (2 Cr)		SSCSR552 (6 Cr) Research Project	SSCSP551 (2Cr) Lab Course 7	**22**	
Total Credits		**44**	**16**	**05**	**03**	**10**	**10**	**88**	

M. Sc. Second Year Semester III *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSCSC501	Organic Reaction Mechanism	**04**	**--**	**04**	**04**	**--**
	SSCSC 502	Organic Spectroscopy	**04**	**--**	**04**	**04**	**--**
	SSCSC 503	Symmetry and Group Theory	**02**	**--**	**02**	**02**	**--**
Elective (DSE)	SSCSE501 SSCSE502 SSCSE503 SSCSE504 SSCSE505 SSCSE506	Chromatograhphic Methods of Analysis Advanced Analytical Techniques in Industries Advanced Medicinal Chemistry Organic Synthesis Electrochemistry Polymer Processing Technology	**04**	**--**	**04**	**04**	**--**
Research Project	SSCSR551	Research Project	**--**	**04**	**04**	**--**	**08**
DSC Practical	SSCSP 501	Lab. Course 5	**--**	**02**	**02**	**--**	**04**
DSE Practical	SSCSE 502 SSCSE 503 SSCSE 504 SSCSE 505 SSCSE 506 SSCSE 507	Lab. Course 6- Analytical Chemistry Lab. Course 6- Industrial Chemistry Lab. Course 6- Medicinal Chemistry Lab. Course 6- Organic Chemistry Lab. Course 6- Physical Chemistry Lab. Course 6- Polymer Chemistry	**--**	**02**	**02**	**--**	**04**
Total Credits			**14**	**08**	**22**	**14**	**16**

M. Sc. Second Year Semester III *(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	SSCSC501	Organic Reaction Mechanism	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 502	Organic Spectroscopy	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 503	Symmetry and Group Theory	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Elective (DSE)	SSCSE501 SSCSE502 SSCSE503 SSCSE504 SSCSE505 SSCSE506	Chromatograhphic Methods of Analysis Advanced Analytical Techniques in Industries Advanced Medicinal Chemistry Organic Synthesis Electrochemistry Polymer Processing Technology	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Research Project	SSCSR551	Research Project							
DSC Practical	SSCSP 501	Lab. Course 5	**--**	**--**	**--**	**--**	**10**	**40**	**50**
DSE Practical	SSCSE 502 SSCSE 503 SSCSE 504 SSCSE 505 SSCSE 506 SSCSE 507	Lab. Course 6- Analytical Chemistry Lab. Course 6- Industrial Chemistry Lab. Course 6- Medicinal Chemistry Lab. Course 6- Organic Chemistry Lab. Course 6- Physical Chemistry Lab. Course 6- Polymer Chemistry	**--**	**--**	**--**	**--**	**10**	**40**	**50**

M. Sc. Second Year Semester IV *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSCSC 551	Synthetic Methods in Organic Chemistry	**04**	**--**	**04**	**04**	**--**
	SSCSC 552	Quality Assurance and Quality Control, Method of Analytical Development and Validation	**04**	**--**	**04**	**04**	**--**
Elective (DSE)	SSCSE451 SSCSE452 SSCSE453 SSCSE454 SSCSE455 SSCSE456	Applied Analytical Chemistry Environmental Industrial Chemistry Chemotherapy Advanced Organic Chemistry Biophysical Chemistry Polymers from Renewable Resources	**04**	**--**	**04**	**04**	**--**
Publication Ethics	SVECP 551	Publication Ethics	**02**	**--**	**02**	**02**	**--**
Research Project	SSCSR552	Research Project	**--**	**06**	**06**	**--**	**12**
DSC Practical	SSCSP 551	Lab. Course 7	**--**	**02**	**02**	**--**	**04**
Total Credits			**14**	**08**	**22**	**14**	**16**

M. Sc. Second Year Semester IV *(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 551	Synthetic Methods in Organic Chemistry	**20**	**20**	**20**	**80**	**--**	**--**	**100**
	SSCSC 552	Quality Assurance and Quality Control, Method of Analytical Development and Validation	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Elective (DSE)	SSCSE451 SSCSE452 SSCSE453 SSCSE454 SSCSE455 SSCSE456	Applied Analytical Chemistry Environmental Industrial Chemistry Chemotherapy Advanced Organic Chemistry Biophysical Chemistry Polymers from Renewable Resources	**20**	**20**	**20**	**80**	**--**	**--**	**100**
Publication Ethics	SVECP 551	Publication Ethics	**10**	**10**	**10**	**40**	**--**	**--**	**50**
Research Project	SSCSR552	Research Project							
DSC Practical	SSCSP 551	Lab. Course 7	**--**	**--**	**--**	**--**	**10**	**40**	**50**

SSCSC501 (4 Cr): Organic Reaction Mechanism

Credits 4 (60 Contact hrs)

Course objectives:

- To understand the various types of reactive intermediates and their reaction.
- To understant quantitative structure activity relationship
- To acquire the detail knowledge of types organic reaction and their synthetic utility.
- To master the various methods of reaction mechanism determination and modern cross coupling reaction and their application in organic synthesis

Course outcomes:

After completion of the course, the student will be able to

- Understand the fundamental of organic reaction mecahniusm.
- understand the strategy to determine the reaction mechanism.
- master the the various important advance cross-coupling reactions
- to understand the concept of quantitative structure activity relationship using Hammet and Taft equation.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Reaction intermediates**	**15**
	1.1	Structure,formation and stability of commonly encountered reaction intermediates in organic synthesis. Carbanion, carbocation carbene ,nitrene and benzyne. Nonclassical carbocation and its stability and reactivity	
	1.2	Important reactions involving carbocation, carbene. nitrene and benzyne. Singlet and triplet carbene. Insertion recation of carbene, Chichibabin reaction. Pinacole- pinacolen rearrangement. Reaction Based on carbanion and their synthetic applications	
2.0		**Substitution reaction and Neighbouring group participation (NGP)**	**15**
	2.1	Introduction to nucleophilic substitution reaction. SN^1, SN^2 and SNi reaction. Their mechanisms. Factors affectiong nucleophilic substitution reaction	
	2.2	Neighbouring group participation (NGP) and Anchimmric assistance. NGP by σ and π bond. NGP by heteroatom such as S and N. NGP by aryl ring	
3.0		**Method of determining the reaction mechanism**	**15**
	3.1	Ester Hydrolysis (acid and base catalyzed). AAc1, AAC2, BAC1 and BAC2 mechanism of ester hydrolysis	
	3.2	Kinetic and nonkinetic methods of determining the reaction mechanism. Isotope labelling experiment. Stereochemical and spectroscopic study as a tool in determining the reaction mechanism	
4.0		Structure activity relationship	**15**
	4.1	Introduction to the concept of acidity and basicity. Hammet equation and its derivation. Substitution constant (σ). Reaction constant (ρ).	
	4.2	Hammet equation as Linear Free energy relationship (LFER).Through conjugation. Modified σ values such as σ^+ and σ^-	
	4.3	Limitation of Hammet equation and development of Taft euqtion. Derivation of Taft equation. Applications of Hammet and Taft equation	
		Total	**60**

Books and Reference Meterial

1. Mechanism and structure in organic chemistry E.S. Gould, Holt, Rinehart and Winston.

2. Advanced organic chemistry By-J. March.
3. Physical organic chemistry By – J. Hine.
4. Advanced organic chemistry Part A-Carey F. A. and Sundberg R. J. (Plenum Press).
5. Organic Chemistry By – Clayden, Greeves, Warren and Wothers [Oxford Press].
6 Organic reaction and their mechanisms, P. S. Kalsi, New Age International Publishers.
8. Protective groups in organic synthesis, T. W. Greene and P. G. M. Wuts, IInd Edition, John Wiley and Sons 1991.
9. Organic synthesis: the disconnection approach, Sturant warren, John Wiley and sons.

SSCSC502: Organic Spectroscopy

Credits 4 (60 Contact hrs)

Course objectives:

The students should learn

1. Different spectroscopic principles
2. Their applications like UV,IR and PMR, CMR and Mass.
3. Different 2D techniques
4. Emerging trends in spectroscopy

Course outcomes:

The learner should be able to

- Understand the different spectroscopic principles.
- Interpret different spectra .
- Elucidate the structure of organic compounds.
- Apply the knowledge in characterisation of compounds.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Elementary ideas (recapitulation) UV, IR and PMR**	**18**
	1.1	PMR (Advanced ideas) Spin couplings, different spin systems, factors affecting coupling constants, rate processes	
	1.2	Different types of couplings, methods used for simplification of PMR spectra. NOE	
	1.3	Two dimensional (2D) NMR techniques (COSY < HETCOR etc.)	
2.0		**CMR**	**12**
	2.1	elementary ideas,	
	2.2	instrumental problems, advanced idea, chemical shift features of hydrocarbons,	
	2.3	Effect of substituent on chemical shifts, different types of carbons.	
3.0		**Mass spectrometry-theory**	**12**
	3.1	instrumentation,	
	3.2	rules of fragmentation, fragmentations of different functional groups,	
	3.3	Factors controlling fragmentation.	
4.0		**Problems**	**18**
	4.1	joint applications of UV, IR, PMR, CMR and Mass	
	4.2	Applications of PMR in biological systems, structural assignments of complex molecules based on given structure	
	4.3	.Complex problem structure elucidation	
	4.4	joint applications of UV, IR, PMR, CMR and Mass	
		Total	**60**

Text Books:

1. Introduction to spectroscopy by Donald L. Pavia Gary M. Lampman, George S. Kriz (Harcourt college publications) 3rd Edition.
2. Spectrometric Identification of organic compounds by – R. M. Silverstein, T. C. Morril, G. C. Basseler.
3. 13 C-NMR spectroscopy by – G. C. Levy, R. L. Lichter, G. L. Nelson (Wiley).
4. Spectroscopic methods in organic chemistry by –D. H. Williams, Ian flemming.
5. Absorption spectroscopy of organic molecules by-V. M. Parikh.

SSCSC503: Symmetry and Group Theory

Credits 2 (30 Contact hrs)

Course pre-requisite:

1. Basic knowledge of molecular structure and shape of the systems.
2. Able to visualize the geometry in 3-dimensional space.
3. Basic mathematics at least up to X standard level.

Course objectives:

- The primary objective of this course is to introduce the concepts of symmetry and group theory in order to apply them in solving chemical problems.
- It connects the relation between group theory, subgroups and their representation towards quantum mechanics with irreducible representation of point groups.
- This course also provides an introductory treatment of bonding theories, electronic and vibrational spectroscopy.
- This course is certainly helpful for students who wish to understand the molecular spectroscopy.

Course outcomes:

- By the end of the module the student is expected to understand how to recognize symmetry elements in a molecule, assigning the point group a molecule, dealing with degenerate and non-degenerate representations, combining matrices and set up matrix for transformations, exploring the role of symmetry in vibrational spectroscopy, selection rules and also applying orbital symmetry to chemical reactions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Molecular Symmetry**	**15**
	1.1	Molecular symmetry and symmetry groups, symmetry elements and operations	
	1.2	Symmetry planes, reflections, inversion centre, proper/ improper axes of rotation, products of symmetry operations, symmetry elements and optical isomerism	
	1.3	Symmetry point groups, classes of symmetry operations	
	1.4	Classification of molecular point groups, group multiplication table.	
2.0		**Molecular properties and symmetry**	**10**
	2.1	Definitions and theorems of group theory, subgroups, Classes, Symmetry operations and their associated algebra.	
	2.2	Representations of groups, character tables, grand orthogonality theorem, other theorems/relations involving irreducible representations and characters), properties of characters of representations.	
3.0		**Applications**	**5**
	3.1	Dipole and Optical activity	
	3.2	Use of group theory in predicting IR and Raman active modes in some simple molecules of C_2V, C_3V and D_3h etc. point groups	
	3.3	Electronic spectra	
		Total	**30**

Text Books:

1. F. A. Cotton, Chemical Applications of Group Theory, John Wiley, 2008.
2. K. Veera Reedy, Symmetry and Spectroscopy of Molecules, New Age International, 2007.

Reference Books:

1. P. R. Bunker, P. Jensen, Molecular Symmetry and Spectroscopy, Edn 2, Overseas Press.
2. D. N. Sathyanarayana, "Vibrational Spectroscopy: Theory and Applications", New Age International Publishers, (2011).
3. D.N. Sathyanarayana, Handbook of Molecular Spectroscopy, I.K. International Publishing House Pvt. Ltd. (2015).
4. D. M. Bishop, Group Theory in Chemistry, Dover.
5. J. M. Hollas, Symmetry in Molecules, Chapman

6. I. Hargittai and M. Hargittai, Symmetry Through the Eyes of a Chemist, Plenum Press.
7. M. Tinkham, Group Theory and Quantum Mechanics, McGraw-Hill.
8. C. D. H. Chisholm, Group Theoretical Techniques in Quantum Chemistry, Academic Press.
9. M. Hamermesh, Group Theory and Its Applications to Physical Problems, Dover.

SSCSE501: - Chromatograhphic Methods of Analysis

Credits 4 (60 Contact hrs)

Course objectives:

- To understand the various types of chromatographic methods and principle involved in them such as liquid –liquid, liquid solid and Gas liquid chromatography
- To understand the various procedures for quantitative analysis by chromatography.
- To acquire the detail knowledge of types of columnns ,detectors etc employed in modern chromatographic techniques.
- To understand the optimisation of chromatographic parameters and performance of column.
- To master the concepts and application of various chromatogrpahics techniques through numerical problerms solving based on different topics.

Course outcomes:

After completion of the course, the student will be able to

- Understand the basic concept of chromatographic methods.
- Understand how to chose the an appropriate method, forsee the possible interferences and circumvents them for the analysis of given challanging analyte sample.
- Master the the various chromatographic techniques and enable themselves to be expert in chromatographic methods.
- To develop the chromatographic method for qualitative and quantitative analysis of new simple sample based on their expertise acquired in this course.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Chromatographic methods**	**15**
	1.1	Principles of analytical separation, Theory of chromatography, Plate theory, rate theory.	
	1.2	Efficiency of chromatographic analysis. Craig concept of counter current Eddy diffusion. Different chromatographic equations pertaining to efficicieny of column	
2.0		**Classification of chromatographic methods**	**15**
	2.1	Classification of chromatography based of physical phenomena involved. Adsorption chromatography, absorption chromatography	
	2.2	Classification based on nature euuilibria. Liquid –liquid, solid-liquid and Gas liquid chromatography. Geal pearmeation chromatography as special case of liquid –liquid chromatography. Thin Layer chromatography (TLC). Reverse phase chromatography, bonded phase chromatography	
	2.3	Important parameters and terms involved in chromatography. Stastationary phase, mobile phase, polarity of solvents, retention time, partition coefficient, resolution, number of theoritical plates. capacity factor, selectivity factor, peak width resolution	
3.0		**Gas Chromatography**	**18**
	3.1	Introduction to Gas chromatography. Principle and instrumentation	
	3.2	Types of column (packed, open tubular column, SCOT, WCOT etc). Types of detector employed in GC. Therma conductivity detector (TCD), Flame ionization detector.(FID) Electron capture detector (ECD). Electrochemical detector	
	3.3	Temperature programming in GC (gradient type elution). Derivatisation approach in GC. Methods of quantitative analysis by GC (Internal standard method and standard addition method. Applications and limitations of GC	
4.0		**High performance liquid and Thin layer chromatography (HPLC) and (HPTLC)**	**12**
	4.1	Introduction to HPLC. Principle and working of HPLC, instrumentation for HPLC. preparative HPLC	
	4.2	Introduction to HPTLC. Principle and working of HPTLC, instrumentation for HPTLC. Comparasion between conventional column chromat ography and HPTLC	
	4.3	Detector used in HPLC. Detector based on bulk property such RI detector, UV- Visible detector. Selective detector such as Fluorescensce detector. Quantification by HPLC and HPTLC.	

		Applications and limitations of HPLC and HPTLC..	
	4.4	Introduction to GPC. Basic principle and working of GPC. Specila type of Stationary phase for GPC. Instrument for GPC. Applications of Ion pair chromatography and GPC	
		Total	**60**

References

1 D. A. Skoog; J. J. Leary; Principles of Instrumental Analysis; Paperback – International Edition, 1992.
2 D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, Saunders College Publishing, Philadelphia, Holt, London. International Edition, 7th Edition (1996).
3 R. L. Pecsok, L.D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd John Wiley & Sons, New York. (1976),
4 L. R. Shyder and C. H. Harvath, An introduction to separation science, Wiley Interscience.
5 H. H. Willard; L. L. Merit; J. A. Dean & F. A. Settle, Instrumental Methods of Analysis (CBS).
6 Basic concept of analytical chemistry, S. M. Khopkar.
7 Kaur, H. Instrumental Methods of Chemical Analysis, 1st Ed., Pragati Prakashan, 2001.
8 Ewing, G. W. Instrumental Methods of Chemical Analysis, 5th Ed., Mcgraw-Hill, 1985
9 Rouessac, F.; Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques, 4th Ed., John Wiley and Sons, 1998.
10 Settle, F. A. Handbook of Instrumentation.

SSCSE502: Advanced Analytical Techniques in Industries

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic spectrophotometry and analytical techniques
- Basic knowledge of radiochemical methods

Course objectives:

- To learn about the spectrophotometry and turbidimetry/nephelometry
- To develop the sense of industrial analytical techniques.
- To know about flame photometry and solvent extraction
- To understand the importance of polarography and thermal analysis
- To improve the knowledge about radiochemical methods of analysis

Course outcomes:

- To achieve industrial analytical techniques.
- Apply their knowledge in spectrophotometry and turbidimetry/nephelometry.
- Understand the flame photometry and solvent extraction.
- Apply their knowledge in polarography and thermal analysis.
- Understanding of radiochemical methods of analysis.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Spectrophotometry and Turbidimetry/Nephelometry**	**15**
	1.1	Spectrophotometry: Types of electronic transitions, theory of spectrophotometry, Laws of absorption, deviation from Beer's law, instrumentation for absorption measurements	
		Criteria for satisfactory colorimetric analysis, choice of solvent, applications of spectrophotometry to qualitative and quantitative analysis.	
	1.2	Spectrophotometric titrations, study of composition of complex, determination of instability constant, an introduction to derivative spectrophotometry.	
	1.3	Turbidimetry/Nephelometry: Principle and instrumentation for nephelometry and turbidimetry, effect of concentration, particle size and wavelength on intensity of scattered light, applications to analysis, turbidimetric titrations, determination of molecular weight of a polymer.	
2.0		**Flame photometry and Solvent Extraction**	**15**
	2.1	Flame photometry: Introduction, principle and instrumentation of flame photometry, experimental techniques.	
	2.2	Standard addition method and internal standard method, interferences in flame photometry and applications.	
	2.3	Solvent Extraction: Distribution law, batch and continuous extractions, synergistic extraction, ion-association complexes, soxhlet extraction.	
	2.4	Extraction of drug from the biological matrix -Solid Phase Extraction.	
3.0		**Polarography and Thermal analysis**	**18**
	3.1	Polarography: Principle and instrumentation, concept and expressions of diffusion current, half-wave potential, residual current, DME, current-potential curve and reversible reactions, qualitative and quantitative applications of polarography.	
	3.2	Types of amperometric and advantages of amperometric titrations.	
	3.3	Thermal analysis: Introduction to thermal analysis, Instrumentation, types and applications of Differential Thermal Analysis (DTA), Thermogravimetry (TG) and Differential	

		Thermogravimetry (DTG), static and dynamic Thermogravimetry.	
	3.4	Introduction to Differential Scanning Calorimetry (DSC), Instrumentation, types and applications of Differential Scanning Calorimetry	
4.0		**Radiochemical Methods of analysis**	
	4.1	Radiochemical Methods of analysis: Radiation Dosimetry, Units of radiation energy, Chemical dosimetry.	
	4.2	Radiolysis of water, Free Radicals in Water Radiolysis, Radiolysis of some aqueous solutions.	**12**
	4.3	A time scale of Radiolytic Events Radiation-induced Color Centers in Crystals: Storing and release of Energy.	
		Total	**60**

Reference Books:

1. Instrumental methods of analysis, M.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle.
2. Fundamentals of molecular spectroscopy, C.N. Banwell.
3. Principles of polarography, R.C. Kapoor and B.S. Aggarwal, Wiley Eastern Ltd.
4. Principles and practice of analytical chemistry, F.W. Fifield and D. Kaley, Blackie Academic & Professional 4th Ed. (1995).
5. Introduction to thermal analysis and calorimetry, M. E. Brown, 2nd Edn, Kluwer Academic Publishers.
6. Instrumental Methods of Analysis 4th and 5th editions, G.W. Ewing.
7. Differential Thermal Analysis, R. C. Mackenzie, Academic Press.
8. Vogel's Textbook of Quantitative Chemical Analysis, Bassette and coworkers, Longman Group UK Ltd.
9. H J Arnikar: Essential of Nuclear Chemistry.

SSCSE503: Advanced Medicinal Chemistry

Credits 4 (60 Contact hrs)

Course objectives:

- Learn basic principles involved some endocrine systems, Antiviral, rDNA derived drugs.
- To know the role of medicinal chemist in development of medicinal agents for some endocrine systems, Antiviral, rDNA derived drugs
- Learn how to analyses and perform SAR and QSAR involved some endocrine systems, Antiviral, rDNA derived drugs understand Combinatorial synthesis

Course outcomes:

- Understand key component of drug discovery some endocrine systems, Antiviral, rDNA derived drugs.
- Understanding the role of medicinal chemist in development of medicinal agents for some endocrine systems, antiviral, rDNA derived drugs.
- Analyze the recent research articles.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Antiviral Agents & Anti AIDS**	**15**
	1.1	Viral diseases, viral replication and transformation of cells, Corona outbreak and strategies to control COVID-19.	
	1.2	antiviral agent, agents involving inhibition of early stages of viral replication, agents interfering with viral nucleic acid replication acyclovir, agents affecting translation on cell ribosome's, methisazone, Investigational antiviral agents.	
	1.3	Structure and life cycle of the4 AIDS virus, potential anti HIV-1 agents ,.	
	1.4	reverse transcriptase, inhibitors protease inhibitors, inhibitors of gene expression , inhibitors of viral binding, miscellaneous compounds	
2.0		**Thyroid Function And Thyroid Drugs**: .	**12**
	2.1	Introduction biochemistry and physiology, thyroid follicular cells, hormones of the Thyroid gland,	
	2.2	formation Thyroid hormones, Transport of Thyroid hormones in blood ,metabolism and Excretion,	
	2.3	action of thyroid hormone, oxygen consumption and calorigenesis, differentiation and protein synthesis, control of thyroid hormone formation,	
		diseases involving the thyroid gland , therapeutic agents, structure activity relationship	
3.0		**rmone Antagonist**:	**9**
	3.1	Hormone dependent breast cancer, hormone dependent protest cancer,	
	3.2	strategies for antihormonal therapy, inhibition of steroid action	
	3.3	inhibition of steroidal biosynthesis, inhibition of gonadotropin release.	
4.0		**Pharmaceutical Biotechnology**:	**12**
	4.1	Introduction, impact of biotechnology on	

		pharmaceutical care, techniques of biotechnology,	
	4.2	recombinant DNA technology, and general properties of biotechnology produced medicinal agents, handling and storage of Biotechnology–produced product, recombinant DNA produced medicinal agents, recombinant DNA produced pharmaceutical in	
	4.3	Development, monoclonal antibodies, and hybridoma technique. Influence of Biotechnology on drug discovery,	
	4.4	other biotechnology technologies	
5.0		**Computers in medicinal chemistry**:	
	5.1	Introduction, molecular and quantum mechanics, drawing chemical structures,	
	5.2	3D structures, energy minimization, viewing 3D molecules, molecular dimensions, molecular properties, molecular orbital's	**12**
	5.3	Conformational analysis, local and global minima, molecular dynamics, stepwise bond rotation, structure comparison and overlays. Identification of active conformation,.	
	5.4	3D pharmacophore identification, docking procedures	
		Total	**60**

Text Books:

1. Principles of medicinal chemistry, William O. Foye, Varghese publishing house
2. An Introduction to medicinal chemistry, Graham L Patric. Oxford university press.
3. Essentials of Medicinal Chemistry second edition Andrejus Korolkovas: Wiley India edition

Reference Books:

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

An introduction to drug design S. S. Pandeya and J. R. Dimmock (New age international).

SSCSE504: Organic Synthesis

Credits 4 (60 Contact hrs)

Course objectives:

- various organic reactions required for synthetic transformations
- photochemical reaction concepts
- reaction rearrangements
- application of the reactions in synthesis

Course outcomes:

The learner should be able to

- Apply different reactions in organic synthesis.
- Know photochemical outcome of reported reactions and apply them in synthesis.
- Develop mechanism based new reactions.
- Apply protection and deprotection strategies.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Rearranments**	**15**
	1.1	Rearrangement to electron deficient carbon: Pinacol-pinacolone, Wagner-Meerwein, Benzillic acid, Wolf (Arndt-Eisterts Synthesis),	
	1.2	Rearrangement to electron deficient nitrogen: Hoffman, Curtis, Schmidt, Lossen and Beckmann rearrangement,	
	1.3	Rearrangement to electron deficient oxygen: Baeyer Villiger rearrangement, Rearrangements to electron rich carbon: Fovorskii, Neber	
2.0		**Oxidation**	**15**
	2.1	Oxidation of alcohols: chromic acid, chromium (VI) oxide-pyridine complexes, manganese (IV) oxide and silver carbonate.	
	2.2	Oxidation to carbon-carbon double bonds: Potassium permanganate, Osmium tetroxide peroxy-acids, Sharples epoxidation.	
	2.3	Oxidation of ketones: Conversion of ketones into α,-β-unsaturated ketones, α-Ketols and 1,2-diketones, oxidation with ruthenium tetroxide, oxidation with thallium(III) nitrate, oppenauer oxidation	
3.0		**Reduction**	**15**
	3.1	Catalytic hydrogenation, stereochemistry and mechanism, homogeneous hydrogenation,	
	3.2	Reduction by dissolving metals: reduction with metal and acid, Reduction with metal in liquid ammonia (Birch reduction), reductive fission of alcohols and halides,	
	3.3	reduction by hydride transfer reagents: MPV, lithium aluminum hydride and sodium borohydride, Mixed lithium aluminum hydride-aluminum chloride reagents, Di-isobutylaluminium hydride, sodium cyanoborohydride, Trialkylborohydrides, Reduction with borane and dialkylboranes, di-imide	
4.0		**Photochemistry**	**15**
	4.1	Photochemistry of (π, π*) transitions: Excited states of alkenes, cis-trans-isomerisation, photo stationary state, electrocyclisation	

		and sigma tropic rearrangements, di-π methane rearrangement.	
	4.2	Intermolecular reactions, photocycloadditions, photodimerisation of simple and conjugated olefins, addition of olefins to α, β-unsaturated carbonyl compounds. Excited states of aromatic compounds, Photoisimerisation of benzene Photochemistry of (n-π*) transitions: Excited states of carbonyl compounds, homolytic cleavage of α- bond, Norrish type I reactions in acyclic and cyclic ketones and strained cycloalkanediones.	
	4.3	Intermolecular abstraction of hydrogen: photoreduction - influence of temperature, solvent, nature of hydrogen donor and structure of the substrate Intramolecular abstraction of hydrogen: Norrish type II reactions in ketones, Esters and 1, 2-diketones, Addition to carbon-carbon multiple bonds, Paterno-Buchi reaction, Photochemistry of nitrites-Barton reaction principles and applications	
		Total	**60**

Text Books:

1. Organic Chemistry, J. Clayden.
2. Some modern methods of organic synthesis, W. Carrathers, Cambridge Univ. Press
3. Modern synthetic reaction, H.O. House, W. A. Benjamin.
4. Advanced organic reactions, reactions, mechanisms and structure, J. March, Wiley.
5. Principles of organic synthesis, R.O.C. Norman and J. M. Coxon, Blackie Academic and Professional.
6. Advanced organic chemistry part-B, F, A. Carrey and R. J. Sundberg, Plenum
7. Organic reaction and their mechanisms, P. S. Kalsi, New Age International Publishers.
8. Protective groups in organic synthesis, T. W. Greene and P. G. M. Wuts, IInd Edition, John Wiley and Sons 1991.
9. Organic synthesis: the disconnection approach, sturant warren, John Wiley and sons.

SSCSE505: Electrochemistry

Credits 4 (60 Contact hrs)

Course objectives:

- To cover main aspects of subject through teaching, learning and evaluation method.
- To provide an introduction to a electrochemistry in its present state.
- To explain fundamentals of the subject by introducing the basic principles theories of electrolysis, electro kinetic phenomena, types of cells.
- To explain concept, the inter ionic attraction theory and electrode reactions processes with simple and clear aspects of electrochemical applications.
- To apply the recent electrochemistry applications overvoltage, passivity, corrosion theories in applied chemistry

Course outcomes:

At the end of this course students will be able to:

- Safely handling of electrodes, identify and construct the cells..
- Apply the knowledge in the field of nanotechnology, electronic and chemical industries for developing new electrochemical method for synthesis of various non materials in the sustainable development.
- Enhance the knowledge based skill which can be applied in industries for manufacturing of batteries, fuel cells to update and electrodes electronic equipments such as laptop, tablet, PC, computers, cell phones etc.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Free Energy and Activity**	**20**
	1.1	Basic introduction to electrolytic conductance, theory of electrolytic dissociation, mechanism of electrolytic conductance and the migration of ions	
	1.2	Activity and activity coefficient, equilibrium and free energy changes, Debye-Huckel theory, Debye-Huckel limiting law, Debye-Huckel equation of appreciable concentration, Huckel and Bronsted equation, quantitative verification of appreciable concentration,	
	1.3	tests of Debye Huckel limiting equation, activities in concentration solutions, extension of Debye- Huckel theory, ion association, equilibrium in electrolytes, strong intermediates and weak electrolytes, solubility, solubility product principle, solubility for common ions and complexion, determination of instability constant, activity coefficient form solubility, measurements solubility and Debye-Huckel theory.	
2.0		**Reversible Cells**	**15**
	2.1	Reversible and irreversible cells, reversible electrodes, application or e. m. f. measurements,	
	2.2	concentration cells with a single electrolyte, amalgam concentration cells, electrode potential, potentials in non aqueous solution, factors affecting electrode potentials, rate of electrode potentials, electrode potentials and equilibrium constants, electrode potentials and solubility products.	
	2.3	Oxidation reduction system, types of oxidations reduction systems, determination of oxidation reduction potentials, (numerical)	
3.0		**Dynamic Electrochemistry**	**15**
	3.1	Electrochemical process at electrodes, electrical double layer,	
	3.2	rate of charge transfer, polarization, electrochemical process, electrolysis, characteristics of working cells,.	
	3.3	power production and corrosion, types of electrochemical corrosions	
4.0		**Fuel Cells**	**10**
	4.1	Fuel Cell and its operation, hydrogen/ oxygen cell, Lead storage	

		battery, Nickel/ Cadmium cell.	
	4.2	power generation in fuel cells, power storage, secondary cells, thermodynamics and kinetics of corrosion and their prevention methods,	
	4.3	applications of electrolysis in electro refining, electroplating and electrotyping.	
		Total	**60**

Text Books :

1. An Introduction to Electrochemistry, S. Glasstone, Van Nostrand, East-West 1965.
2. Modern Electrochemistry, Vol. I and II, 2nd Edition, J. O'M Bockris and A. K. N. Reddy, Plenum, 1977.
3. Electrolytic Solutions, R. A. Robinson and R. H. Stokes, Butterworths, London, 1959.
4. Physical Chemistry, P. W. Atkins, ELBS, 1986.
5. Text book of Physical Chemistry, Samuel. M.Glastone, Littern Educational publishing in., New York.
6. Physical Chemistry, P.W. Atkins (ELBS)

SSCSE506: Polymer Processing Technology

Credits 4 (60 Contact hrs)

Course objectives:

- to introduce the polymer processing
- to understand the various processing techniques used in industry
- to gain knowledge about recycling the plastics
- to knowledge fibres, paints and FRP products are preparation

Course outcomes:

Student will gain knowledge in

- Various polymer processing methods used in industry to prepare sheet, film, rods, bottles, tyres, packaging etc
- Knowledge of synthetic fibers and paints
- Knowledge of manufacturing the firer reinforced plastics (FRP) for various applications
- Knowledge of recycling of waste plastics.

Curriculum Details:

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		Plastics Processing Technology	25
	1.1	Plastics technology Raw materials: types of forms, products, applications consumption pattern, Tailoring of material, quantitative aspects of polymer processing additives and compounding, fillers, plasticizers, antioxidants, colorants, flame retardants, stabilizers compounding etc.	
	1.2	Compression & Transfer Molding: Basic process, materials and applications, advantages and limitations of the process. Injection molding: Moulding process materials and applications Extrusion process: Basic process, materials and applications. Blow Molding: Basic process. materials and applications.	
	1.3	Thermoforming: Basic process, materials and applications, Rotational molding: Basic process, materials and applications Calendaring: Basic process, materials and applications. Calendering Plant layout.	
	1.4	Lamination: Basic process and materials, processing conditions. Applications for laminations Various molding defects, their causes and remedies for all above processes. List of polymer processing/product manufacturing industries/companies in India.	
2.0		Textile Fibre & Paint Technology	15
	2.1	Introduction to textile industry: Defination of textile and fibers, types and properties of textile fibres. Synthetic fiber Spinning methods a)melt spinning, b)dry spinning, and c)wet spinning process details and uses.	
	2.2	Introduction to paint industry: Defination of paint, varnish, lacquers their composition and function, General classification of surface coating, Mechanism	

		of film formation, Typical paint formation, emulsion paints and their applications.	
	2.3	List of textile/paint manufacturng industries/companies in India.	
3.0		Fibre Reinforced Plastics Technology	
	3.1	Introduction to Fiber reinforcement plastics: Raw materials used Resins, Fillers, Glass reinforcements (chopped strand mates, surface mates, needle mates and rowing) pigments, catalyst, accelerator and mould releasing agents. Typical formulation, hand layup technique, spray up technique. Application of Fibre Reinforced Plastics (FRP)	10
	3.2	List of fibre reinforced plastics product manufacturing industries/companies in India.	
4.0		Polymer Recycling Technology	
	4.1	Classification of polymer recycling processes and codes of recycling.	
	4.2	Waste polymer recovery, polymer reprocessing. Polymer incineration process and pyrolysis process with process details.	10
	4.3	List of polymer/plastics recycling industries/companies in India.	
		Total	60

Text Books:

1. R. Sinha Outlines of Polymer Technology Processing Polymers Prentice Hall India Pvt., Limited, Published: August 2004 ISBN: 9788120321885, 812032188X.
2. Manas Chanda Plastics Technology Handbook CRC Press Published: 7 November 2017 ISBN: 9781498786225, 1498786227.
3. Niranjan Karak Fundamentals Of Polymers: Raw Materials To Finish Products Phi Learning Published: December 2009 ISBN: 9788120338777, 8120338774.
4. Editors: Raghvendra Gupta, Tabli Ghosh, Vimal Katiya Advances in Sustainable Polymers Processing and Applications Springer Nature Singapore Published: 5 November 2019 ISBN: 9789813298040, 9813298049.
5. Editors: Manju Kumari Thakur, Vijay Kumar Thakur Handbook of Sustainable Polymers Processing and Applications Pan Stanford Publishing Published: 5 January 2016 ISBN: 9789814613545, 9814613541.

6. Natamai Subramanian Muralisrinivasan Introduction to Polymer Compounding Raw materials. Volume 1 Smithers Rapra Published: 2014.
7. Muralisrinivasan Subramanian Basics of Polymers Fabrication and Processing Technology Momentum Press Published: 11 May 2015 ISBN: 9781606505830, 1606505831.
8. John Gillow, Nicholas Barnard Indian textiles Thames & Hudson Original from: the University of Michigan Digitized: 8 December 2009 Published: 2008 ISBN: 9780500514320, 0500514321
9. A. A. Vaidya Production of Synthetic Fibres Prentice-Hall of India Private Limited Published: 1988 ISBN: 9780876925782, 0876925786
10. Editors: J E MacIntyre, Textile Institute (Manchester, England) Synthetic Fibres Nylon, Polyester, Acrylic, Polyolefin Taylor & Francis Published: 2005 ISBN: 9780849325922, 0849325927
11. H. V. Sreenivasa Murthy Introduction to Textile Fibres WPI India Published: 8 October 2018 ISBN: 9781315359335, 1315359332
12. Editors: Dipen Kumar Rajak, Sanjay Mavinkere Rangappa, Suchart Siengchin Natural and Synthetic Fiber Reinforced Composites Synthesis, Properties and Applications Wiley Published: 18 April 2022 ISBN: 9783527349302, 3527349308
13. Dr. Himadri Panda Manufacturing Technology & Formulations Hand Book on Thinners, Putty, Wall & Industrial Finishes and Synthetic Resins Engineers India Research Institute Published: February 2010 ISBN: 9788189765323, 8189765329
14. H. Panda Alkyd Resins Technology Handbook NIIR Project Consultancy Services Published: October 2010 ISBN: 9788178331348, 8178331349
15. H. Panda The Testing Manual of Paints, Varnishes and Resins ASIA PACIFIC BUSINESS PRESS Inc. Published: October 2011 ISBN: 9788178331416, 8178331411
16. B. Sridhar Babu, J. Paulo Davim, Kaushik Kumar Coatings Materials, Processes, Characterization and Optimization Springer International Publishing Published: February 2021 ISBN: 9783030621636, 3030621634
17. Paint, Pigment, Solvent, Coating, Emulsion, Paint Additives And Formulations Engineers India Research Institute Published: 2008 ISBN: 9788189765156, 8189765159
18. Charles R. Martens Emulsion and Water-soluble Paints and Coatings Reinhold Publishing Corporation Original from: the University of Michigan Digitized: 8 August 2009 ISBN: 9780442155582, 0442155581.
19. Editors: R. Arun Ramnath, Sanjay Mavinkere Rangappa, Suchart Siengchin, Vincenzo Fiore Cellulose Fibre Reinforced Composites Interface Engineering,

Processing and Performance Elsevier Science Published: 29 October 2022 ISBN: 9780323901260, 0323901263
20. Mohamed Zakriya G, Ramakrishnan Govindan Natural Fiber Composites Manufacturing, Characterization and Testing CRC Press Published: 28 September 2020 ISBN: 9781000180343, 1000180344
21. Editors: Inderdeep Singh, Pramendra K. Bajpai Reinforced Polymer Composites Processing, Characterization and Post Life Cycle Assessment Wiley Published: 13 August 2019 ISBN: 9783527820962, 3527820965
22. Editors: Herbert S. Schwartz, Robert T. Schwartz Fundamental Aspects of Fiber Reinforced Plastic Composites Interscience Publishers Interscience Publishers Original from: the University of California Digitized: 11 March 2008 Published: 1968 ISBN: 9780470766033, 0470766034
23. Donald V Rosato, Dominick V Rosato Reinforced Plastics Handbook Elsevier Science Published: 2004 ISBN: 9781856174503, 1856174506
24. J. Murphy The Reinforced Plastics Handbook Elsevier Science Published: 22 October 2013 SBN: 9781483292632, 1483292630
25. Editors: J. Paulo Davim, Jalumedi Babu Glass Fibre-Reinforced Polymer Composites Materials, Manufacturing and Engineering De Gruyter Published: 5 May 2020 SBN: 9783110610147, 3110610140
26. Editor: Raju Francis Recycling of Polymers Methods, Characterization and Applications Wiley Published: 19 December 2016 ISBN: 9783527338481, 3527338489
27. Vannessa Goodship Introduction to Plastics Recycling Smithers Rapra Published: 2007 ISBN: 9781847350787, 184735078X
28. Editor: Raju Francis Recycling of Polymers Methods, Characterization and Applications Wiley Published: 6 October 2016 ISBN: 9783527689033, 3527689036
29. Muralisrinivasan Natamai Subramanian Plastics Waste Management Processing and Disposal Wiley Published: 2 September 2019 ISBN: 9781119556183, 111955618X
30. Editors: Abderrahim Boudenne, S. Kishor Kumar, Yang Weimin, Yves Grohens Recycling and Reuse of Materials and Their Products Apple Academic Press Published: 23 January 2013 ISBN: 9781466568693, 1466568690
31. Editors: Arpitha Gulihonnehalli Rajkumar, Jyotishkumar Parameswaranpillai, Sanjay Mavinkere Rangappa, Suchart Siengchin Recent Developments in Plastic Recycling Springer Nature Singapore Published: October 2021 ISBN: 9789811636271, 9811636273

32. Muralisrinivasan Natamai Subramanian Plastics Waste Management Processing and Disposal Wiley Published: 2 September 2019 ISBN: 9781119556183, 111955618X.
33. SAI BHASKAR REDDY NAKKA Innovative Solutions to Plastic Pollution SAI BHASKAR REDDY NAKKA.
34. Editors: John Scheirs, Walter Kaminsky Feedstock Recycling and Pyrolysis of Waste Plastics Converting Waste Plastics Into Diesel and Other Fuels Wiley Original from: Indiana University Digitized: 3 June 2010 Published: 12 May 2006 ISBN: 9780470021521, 0470021527.

SSCSP501: Lab Course 5- Laboratory Course for Chemistry

Course objectives:

- To handle reagents with safety
- To handle solvents with safety
- To handle Instruments with safety
- To prepare solutions for column chromatography

Course outcomes:

- Students will be able to handle safely the reagents, solvents, instruments along with solutions preparation for column chromatography.

Curriculum Details: (Other similar Experiments can also be incorporated involving usage of reagents, solvents and instrument safe handling)

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**To use of reagents/Metals**	**15**
	1.1	Na	
	1.2	$LiAlH_4$/$NaBH_4$	
	1.3	K_2CO_3 /$MgSO_4$/$CaSO_4$	
	1.4	Pyridinium chlorochromate	
2.0		**Purification of solvents**	**15**
	2.1	Benzene/Toluene	
	2.2	DCM/$CHCl_3$	
	2.3	THF /Acetonitrile	
3.0		**To handle Instruments with safety**	**5**
	3.1	Autoclave, Furnace	
	3.2	Hot Air Oven, Hot Gun	
	3.3	Rotary Evaporator,	
	3.4	Centrifuge	
4.0		**Chromatography and Solvent Preparation**	**25**
	4.1	separation of Pyrrole and n-methyl pyrrole	
	4.2	separation of organic acid and ester	
	4.3	separation of alcohol and aldehyde	
	4.4	separation of pyrrole and pyrrole carboxaldehyde	
	4.5	Separation of $KMnO_4$ and $K_2Cr_2O_7$	
	4.6	Separation and identification of metal ions by paper chromatography	
		Total	**60**

Reference Books:

1. Vogel's Textbook of Practical Organic Chemistry by B. S. Furniss, Pearson India.
2. Vogel's Qualitative Inorganic & Chemical Analysis Bundle, Pearson India

SSCSE502: Lab Course 6-Analytical Chemistry

Credits 2 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic operations required in chemistry laboratory such as preparation of solution, heating of solutions, filtration, precipitation, use of reagents, use of calculation factors etc.
- Knowledge of basic instruments in the laboratory such as conductometer, pH-meter, polarimeter, colorimeter etc.
- Theoretical knowledge of advanced sophisticated instruments such as AAS, Flame Photometry, GC, HPLC, TGA, DTA etc.

Course objectives:

- To strengthen the knowledge of classical chemical and instrumental analysis principles.
- To learn practical applications of classical chemical analysis methods.
- To strengthen the knowledge of advanced chemical analysis techniques and practical applications of sophisticated techniques.
- To be able to quantify the analyte in different matrix.
- To understand and interpret the results

Course outcomes:

At the end of the course student will be able to

- Understand the importance of classical and instrumental analysis in chemistry.
- Validating their theoretical knowledge through experiments.
- Understand when and how to apply classical methods of chemical analysis.
- Able to choose and design appropriate method for chemical analysis.
- Able to work independently on analytical chemistry problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Volumetric Analysis**	**15**
	1.1	To estimate the amount of sodium carbonate and sodium bicarbonate present in given mixture by Warder's method.	
	1.2	To determine the percentage of calcium carbonate in precipitated chalk.	
	1.3	To determine both the temporary and permanent hardness of water	
	1.4	To determine the amount of ferric ammonium sulphate in given solution by titrating against std. $KMnO_4$ solution.	
	1.5	To estimate the strength of ferrous and ferric ions in given solution by titrating against std. $KMnO_4$ solution.	
	1.6	To determine strength of given Mohr's salt solution using std. $K_2Cr_2O_7$ solution.	
	1.7	To determine the percentage of copper in copper sulphate crystals using std. $Na_2S_2O_3$ solution.	
	1.8	To determine the strength of given sodium thiosulphate solution by iodometric method.	
	1.9	EDTA titrations.	
	1.10	Silver nitrate titrations.	
2.0		**Gravimetric Analysis**	
	2.1	Estimation of sulphate as barium sulphate.	**15**
	2.2	Estimation of copper as cuprous thiocyanate.	
	2.3	Estimation of nickel as nickel dimethylglyoxime.	
	2.4	Estimation of zinc as zinc ammonium phosphate.	
	2.5	Estimation of calcium as calcium oxalate.	
	2.6	Estimation of aluminium as aluminium oxide.	
	2.7	Estimation of magnesium as magnesium pyrophosphate	
	2.8	Estimation of magnesium as magnesium oxinate.	
	2.9	Estimation of iron as ferric oxide.	
	2.10	Estimation of barium as barium chromate	
3.0		**Instrumental (Part A: Simple instruments)**	
	3.1	Determination of ferrous ammonium sulphate	

		potentiometrically with standard ceric sulphate solution (Direct and back titration).	
	3.2	Determination of concentration of iron in ferric salicylate complex spectrophotometrically.	
	3.3	Simultaneous determination of chromium and manganese spectrophotometrically.	
	3.4	Determination of strength of acetic acid from the commercial vinegar sample by potentiometric titration and its confirmation by conductometric/pH-metric titration using std. NaOH solution	
	3.5	Determination of acid and basic dissociation constants of an amino acid and its isoelectric point using pH-metry.	
	3.6	Determine pH values of various mixtures of sodium acetate and acetic acid in aqueous solutions and hence dissociation constant of acid.	
	3.7	Determine the concentration of Cu^{2+} ion in given solution titrating with EDTA solution by colorimetric measurements.	**15**
	3.8	Estimate the amount of lead present in a solution of lead nitrate by conductometric titration with sodium sulphate.	
	3.9	Determine the relative strength of given two acids by polarimetric measurments.	
	3.10	Investigate the effect of substitution of chloride ion on rate constant of inversion of cane sugar by using mono, di and trichloro acetic acid as catalyst.	
4.0		**Instrumental (Part B: Sophisticated instruments)**	
	4.1	Determination of magnesium and calcium in tap water by Atomic Absorption Spectroscopy	
	4.2	Estimation of Na, K and Ca in a mixture using Flame photometry	
	4.3	Determination of alcohol in beverages by Gas Chromatography.	
	4.4	Estimation of $CuSO_4$ and NaCl in a mixture using a TGA curve.	
	4.5	Determination of carbon monoxide in automobile exhaust by FT-IR spectroscopy.	**15**
	4.6	Determination of pesticides (Organophosphates) in soil sample using HPLC	
	4.7	Determination of Trace metals (Fe, Cu, Ni, Cr and Zn) in environment water samples by Flame Atomic Absorption Spectrometry (FAAS).	
	4.8	Determination of anions in aqueous samples using ion	

		chromatography.	
	4.9	Determination of organics in ground water using gas chromatography/mass spectrometry.	
	4.10	Determination of Cu, Pb and Cd in water sample by Differential Pulse Anodic Stripping Voltammetry (DPASV)	
		Total	**60**

Notes: i) Minimum 12 practicals should be completed.
ii) In section Instrumental (Sophisticated instruments), in case of any unavailability, opt for experiments from simple instruments section.
iii) Any other related practicals can also be performed.

Reference Books:

1. Gurdeep Raj, "Advanced Practical Inorganic Chemistry", Goel Publishing House, India (2013).
2. A. V. R. Reddy, K. K. Swain, K. Venkatesh, "Experiments in Analytical Chemistry", Perfect Prints, Thane 400601, India (2012).
3. B. P. Levitt, "Findley's Practical Physical Chemistry", 9th Edition, Longman Group Limited.
4. V. D. Athawale, P. N. Mathur, "Experimental Physical Chemistry", New Age International Limited.
5. S. Leshe, "Practical Analytical Chemistry", Department of Chemistry, Debre Markos University, (2015). (Online Lab Manual)
6. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, "Vogel's Textbook of Quantitative Chemical Analysis", 5th Edition, Longman Scientific & Technical Publications, New York (1989).
7. G. Svehla, "Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis", 5th Edition, Longman Group Limited, London (1979).
8. Shikha Gulati, J. L. Sharma and Shagun Manocha, "Practical Inorganic Chemistry", CBS Publishers & Distributors Private Limited, India (2017).
9. Amita Dua and Dr. Navneet Manav, "Practical Inorganic Chemistry", Manakin Press Private Limited, New Delhi, India (2016).
10. Michael J. Prushan, "Lab Manual Advanced Inorganic Chemistry Laboratory", Department of Chemistry and Biochemistry, La Salle University (2002-2003).
11. M. Pranjoto Utomo, "Laboratory Manual of Practical Inorganic II

Chemistry", Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University (2011).

12. S. W. Rajbhoj, T. K. Chondhekar, "Systematic Experimental Physical Chemistry", Anjali Publication, Aurangbabd, (2000).

SSCSE503: Lab Course 7-Industrial Chemistry

Credits 2 (60 Contact hrs)

Course pre-requisite:

- Basic knowledge of different techniques for industrial analysis

Course objectives:

- To learn the methods of analysis for various chemical components and processes
- To determine the values of particular property of chemical component present
- To study viscosity, refraction, adsorption etc phenomenon
- Investigation of properties by instruments.
- To train students to work on instruments like pH meter, polarimeter etc.
- To habituate students to handle the instruments skilfully
- To bridge mainstream discipline-market and industry

Course outcomes:

- Students can experiment about surface phenomenon like physical and chemical adsorption.
- Students can determine the values for specific properties like acid value, saponification value, aniline point, turbidly point, pour point, cloud point of oil.
- Students can handle and performe experiments skillfully on the instruments like conductometer, polarimeter, stalagmometer, pH meter, Abbe refractometer, etc.
- As students are able to handle the instruments they will be offered job in industries.this indicates strong correlation between academics and industries also shows relation theoretical and experimental knowledge.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**30**
	1.1	Approximate analysis of a fuel (a) Determination of carbon residue of coal (b) Determination of ash point of coal sample (c) Determination of smoke point of kerosene	
	1.2	Determination of viscosity and fluidity of given oil sample (a) edible oil (b) lubricating oil	
	1.3	Determination of flash point and fire point of a fuel [petrol, diesel, kerosene, 2-Toil] by (a) Cleveland's open cup apparatus (b) Abel's closed cup apparatus (c) Pensky-Martin Claved cup apparatus.	
	1.4	Determination of acid value and rancidity of an oil (Lubricating oils, edible oils.	
	1.5	Determination of (a) Saponification value (b) Iodine value of an oil	
	1.6	Determination of (a) aniline point (b) turbidity point (c) pour point (d) cloud point of a lubricating oil	
	1.7	Determination of rate of distillation (a) Simple distillation (b) Steam distillation (c) Vacuum distillation	
	1.8	Estimation of surfactant from detergent and soap by method of emulsion.	
2.0			**30**
	2.1	To determine the critical micelle concentration of surfactant (sodium lauryl sulphate, sodium dodecylsulfate etc.) in aqueous solution conductometrically.	
	2.2	Study the effect of salts on critical micelle concentration of surfactant conductometrically.	
	2.3	Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using acetic acid and chloroacetic acid etc. as a catalyst polarimetrically.	
	2.4	To determine the hydrolysis constant of aniline hydrochloride by pH measurements.	
	2.5	Determine the percentage composition of given mixture of two liquids by stalagmometer.	
	2.6	Investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms.	
	2.7	Determine the specific and molar refraction of given liquid by Abbé's refractometer.	
		Total	**60**

Reference Books:

1. A text book on experiment and calculations Engg. Chemistry Dara S. S. S. Chand and Company Ltd. (1997).
2. Systematic experimental physical chemistry by S. W. Rajbhoj and Dr. T.K. Chondhekar

SSCSE504: Lab Course 8-Medicinal Chemistry

Credits 2 (60 Contact hrs)

Course objectives:

- To handle various reactions set up
- To handle various reactions regents
- reactions should be monitored by TLC.

Course outcomes:

Students will be able to

- Expertise the various techniques of preparation and analysis of organic substances
- Understand the technique involving drying and crystallization
- Students will Understand TLC technique

Curriculum Details

Module No.	Unit No.	synthesis of bioactive scaffolds	Hrs. Required to cover the contents
1.0		**A.** Two stage preparations of heterocyclic and biologically active molecules: At least 10 preparatives should be carried out on micro scale using 10 mmol of starting material. 1. Acetophenone → Phenacyl bromide → Epoxide 2. Benzaldehyde → Benzalacetophenone → Epoxide 3. Acetophenonephenylhydrazone → 2-Phenyl indole → Bis-indolyl methane 4. Ethylacetoacetate→6-Methyl-4-oxo-1,2,3,4-tetrahydro-2-thiopyrimidine→6-Methyl uracil 4. Acetophenone → Chalcone → Pyrazoline 5. Glycine→Hippuric acid → Azlactone 6. Acetophenone → Phenacylbromide → 2-Benzoyl benzofuran 7. Ethylacetoacetate→ 3,5-diethoxycarbonyl-1,4-dihydro-2,6-dimethyl-4-(m-nitrophenyl)pyridine→3,5-diethoxy carbonyl-2,6-dimethyl-4-(m-nitrophenyl)pyridine 8. 2-Chlorobenzoic → n-Phenylanthranilic → 9-Acridone 9.2-Aminobiphenyl → o-Formamidobiphenyl → Phenanthridine 9. Fluorenone → Fluorenone oxime → 6-Phenanthridone 10. Anthranilic acid → o-Carboxybenzenediazonium fluoroborate → Xanthone 11. p-Toluidine → 4-(p-tolylamino)pent-3-en-2-one → 2,4,6-Trimethylquinoline 12. Salicylaldehyde → o-Formylphenoxyacetic acid → Benzofuran 13. Diethylmalonate → Barbituric acid → Nitrobarbituric acid 14 o-Phenylenedimine→Diphenyl quinoxaline → 5,6-diphenylpyrazine-2,3-dicarboxylic acid	**60**

		15 O-Nitrobenzaldehyde → □□□-Diformamido-o-nitrotoluene → Quinazoline 16 O-Hydroxyacetophenone → Chalcone → Flavonone and Flavonol Preparation should be carried out on micro scale using 10 mmols or 1.0 gm of starting material and	
		Total	**60**

Text Books:

1. A Text-Book of Practical Organic Chemistry: Including Qualitative Organic Analysis.
2. Practical books of Medicinal Chemistry. Abhishek Tiwari.
3. A Practical book of Medicinal Chemistry-Pragati Online

Reference Books:

1. Advanced practical in Medicinal Chemistry –Ashutosh Kar
2. Advanced Practical Organic Chemistry-Barry Lygo.

SSCSE505: Lab Course 9-Organic Chemistry

Credits 2 (60 Contact hrs)

Course objectives:

- To handle various reactions set up
- To handle various reactions regents
- reactions should be monitored by TLC.

Course outcomes:

Students will be able to

- Exposure to multistep organic synthesis
- Develop expertise in various techniques involved in preparation
- Develop expertise in analysis of organic compounds
- Understand the technique involving drying and crystallization
- Students will Understand TLC technique

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Two stage preparations of heterocyclic and biologically active molecules: At least 10 preparative's should be carried out on microscale using 10 mmol of starting material**	
		1. Benzaldehyde → Benzalacetophenone → Epoxide 2. Acetophenonephenylhydrazone → 2-Phenyl indole → Bis-indolyl methane 3. Acetophenone → Chalcone → Pyrazoline 4. Glycine → Hippuric acid → Azlactone 5. 2-Chlorobenzoicacid → n-Phenylanthranilic → 9-Acridone 6. 2-Aminobiphenyl → o-Formamidobiphenyl → Phenanthridine 7. Fluorenone → Fluorenone oxime → 6-Phenanthridone 8. p-Toluidine → 4-(p-tolylamino)pent-3-en-2-one → 2,4,6-Trimethylquinoline 9. Salicylaldehyde → o-Formylphenoxyacetic acid → Benzofuran 10. Diethylmalonate → Barbituric acid → Nitrobarbituric acid → 11. o-Phenylenedimine → Diphenyl quinoxaline → 5,6-diphenylpyrazine-2,3-dicarboxylic acid 12. o-Nitrobenzaldehyde → -Diformamido-o-nitrotoluene → Quinazoline 13. o-Hydroxyacetophenone → Chalcone → Flavonone and Flavonol 14. Benzene → Benzil → benzilic acid. 15. Benzene → 2-benzoyl benzoic acid → Anthraquinone 16. Cyclohexanone → Phenylhydrazone → 1, 2, 3, 4-tetrahydrocarbazole 17. Phenol → Salicyladehyde → Coumarin	**60**
		Total	**60**

Text Books:

1. A Text-Book of Practical Organic Chemistry: Including Qualitative Organic Analysis.
2. Practical books of Medicinal Chemistry. Abhishek Tiwari.
3. A Practical book of Medicinal Chemistry-Pragati Online

Reference Books:

1. Advanced practical in Medicinal Chemistry –Ashutosh Kar
2. Advanced Practical Organic Chemistry-Barry Lygo.

SSCSE506: Lab Course 10-Physical Chemistry

Credits 2 (60 Contact hrs)

Course objectives:

- The basic objective of this course has three fold dimensions like to strengthen the knowledge of fundamental physical chemistry principles while dealing with dissociation of electrolytes into ions, dealing with surface tension and applying thermodynamic principles to the chemical systems..

Course outcomes:

At the end of the course, the student will have enough knowledge about measuring the strength of ions by applying traditional techniques like potentiometer, pH meter, refractometer and knowledge of thermodynamics and surface tensions. Student will make use of simple physical chemistry principles like redox potentials, dissociation constant, equilibrium constant, activity coefficient, Hammett constant and ligand stability constants while performing the experiments. Also be enriched with knowledge in the area of solution chemistry by measuring parameters like surface tension and parachor of solids along with thermodynamic aspects like partial molar quantities and heat of dissociation

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Potentiometer**	**15**
	1.1	Titrate ferrous ammonium sulphate with cerric sulphate and find out formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{3+}/Ce^{4+} system	
	1.2	Titrate potentiometrically phosphoric acid solution against NaOH and calculate pK^1, pK^2 and pK^3 of the acid	
	1.3	Titrate potentiometrically NaCl solution against $AgNO_3$ and find out the concentration of NaCl and hence determine the solubility product of AgCl	
	1.4	To determine the standard free energy change G^0 and equilibrium constant for the reaction $Cu+ 2Ag^+ \rightarrow Cu^{++} + Ag$	
	1.5	Determine the activity coefficient of silver ions using a concentration cell without transference	
2.0		**pH metry**	**15**
	2.1	To determine the ligand stability constant of an organic acid and the metal ligand stability constant of its complex by pH measurements(Bjerrum-Calvin titration)	
	2.2	Determine the Hammett constant of a given substituted benzoic acid by pH measurements	
	2.3	Determine the pH value of various mixtures of sodium acetate and acetic acid in aqueous solution and hence find out the dissociation constant of the acid	
	2.4	To determine the hydrolysis constant of aniline hydrochloride by pH measurements	
3.0		**Surface tension and Thermodynamics**	**15**
	3.1	Study the effect of surfactant (n-propyl alcohol) at various concentrations on the surface tension of water and hence determine the limiting cross sectional area of alcohol molecule by stalagnometer	
	3.2	Determine the parachor of a solid by stalgnometer	
	3.3	Determine the partial molar volume of ethanol and water in a given composition by density measurements	
	3.4	To determine the heat of dissociation of benzoic acid in water	
4.0		**Refractometry**	**15**
	4.1	Determine the refractive indices of series of solution of a salt and	
	4.2	Determine the concentration of the salt in the given unknown solution .	
	4.3	12. Determine the molar refraction of ethyl, propyl and butyl acetate and	
	4.4	Show the constancy of contribution to the molar refraction amide by CH_2 group.	
		Total	**60**

SSCSE507: Lab Course 11-Polymer Chemistry

Credits 2 (60 Contact hrs)

Course objectives:

- to develop expertise in various polymerization techniques.
- to understand the synthesis of polymers
- to get exposure to preparation of polymer composite methods
- to understand how plastic films are prepared
- to get exposure to preparation of biodegradable polymer
- to get exposure to simple identification techniques for various plastics
- to get exposure to simple identification techniques for various fibres
- to understand various polymer characterization methods (molar mass, thermal, etc).

Course outcomes:

Skill development of students in

- various techniques of polymerization
- polymer characterization methods (molar mass, thermal, etc)
- Polymer fibre composite making method
- film casting of various polymers
- identification techniques for various plastics/ fibre
- recycling of waste plastics
- recycling of waste plastics

Curriculum Details

Module no	Unit no.	Topic	Hrs Required to cover the contents
1.0	**1.1**	• Bulk polymerization of (vinyl monomer)e.g. styrene by heating. • Bulk polymerization of (vinyl monomer) e.g. styrene by microwave radiation. • Synthesis of copolymer of styrene : Maleic anhydride copolymer (St : MA) • Synthesis of glyptol resin and application in encapsulant. • Synthesis of water soluble polymer (polyacrylamide) and its application. • Preparation of biodegradable polymer poly(lactide) from lactic acid. • Preparation of polymer-fiber composite & study its properties. • Casting the thin films for polymers for e,g, i) Polystyrene ii) Cellophane iii) Cellulose acetate iv)polyvinyl alcohol and study its properties. • Separation and Identification of plastics by heating and burning tests. • Identification of textile fibers by heating and burning tests. • To determine Intrinsic, Inherent viscosity of polymer in dilutes solutions at various concentrations on Ubelhode viscometer and molecular weight of polymer. • To study effect of molecular weight of polymer on viscosity by Ostwald's viscometer by using PEG-200, PEG-400, PEG-600, etc. • Thermal de-polymerization of plastics (PET, Nylon, polyester etc) sample in suitable solvent • Study the molar mass concept (Mn Mw) using neckles or bead chain or paper clips. • Preparation of PVA slime and study its effect behavior at various pH solutions.	60

		• Precipitation polymerization of (vinyl monomer) e,g, styrene.	

Laboratory Manuals:

- Sourcebook of Advanced Polymer Laboratory Preparations. **S. Sandler and W. Karo**, 2nd Edition, Academic Press, 1998.
- Polymer Synthesis (Three Volumes) **S. R. Sandler and W. Karo**, nd Edition Academic Press, (1997)
- Preparative Methods of Polymer Chemistry **W. F. Sorenson and T. W. S. Campbell**, 3rd Edition, John Wily, (2001)
- Experimental Method in Polymer Science **T. Tanaka**.,1st Edition, Academic Press, (1999).
- Laboratory Preparation of Macromolecular Chemistry. **E. M. McCaffery**., McGraw Hill Book C. NY.
- A Practical Course in Polymer Chemistry, **H. Pinner**
- Macromolecular Synthesis: Coll. Volumes, **J. A. Moore**., John Wiley and Sons, NY.
- Experimental Methods in Polymer Chemistry: Physical Principles and Applications, **J. R. Rabek**, Wiley Interscience. (1980).
- A Practical Course in Polymer Chemistry **S. H. Pinner,**
- Experimental Methods in Polymer Chemistry: Physical Principles and Applications, **J. R. Rabek**, Wiley Interscience. (1980).
- D. G. Hundiwale Experiments In Polymer Science New Age International (P) Limited Published: 2009 ISBN: 9788122423884, 8122423884

SSCSC551: Synthetic Methods in Organic Chemistry

Credits 4 (60 Contact hrs)

Course objectives:

The students should

1. Understand synthetic strategies and retro synthesis
2. Apply them for synthesis of new molecules
3. Use different protection and deprotection techniques
4. Know enamines and their applications

Course outcomes:

The learner would be able to

1. Perform Retrosynthesis of a given molecule.
2. Design synthesis using suitable building blocks.
3. Confirm the product structure.
4. Apply enamines in organic synthesis

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Umpolung in organic synthesis**	**10**
	1.1	Defination and Concept of Umpolung . Reversal of polarity. Types of Umpolungs	
	1.2	Dithianes, Cyclic and open chain counterpart. Stability of various 1,3dithiane reagents. Reversal of polarity of aldehyde using 1,3 dithianes. Synthetic utility of 1,3 dithianes	
	1.3	Hydrazone of aldehydes. Reversal of polarity of carbonyl (aldehyde) based on hydrazone Umpoloung. Selectivity (N vs C substitution) in hydrazone based Umpolung. Synthetic utility of Hydrazone based Umpolung strategy	
2.0		**Disconnection approach (Synthetic Strategy I)**	**10**
	2.1	Introduction to disconnection approach. Terminologies: Target molecule, Reterosynthetic analysis, synthon, synthetic equivalent,functional group interconversion (FGI), functional group addition, functional group elimination	
	2.2	Criteria for selection of target. Linear and convergent synthesis. Retrosynthetic and synthesis involving chemoselectivity, regioselectivity, reversal of polarity and cyclizations	
	2.3	Order of events in retrosynthetic analysis , explanation with examples such as Solbutamol, Propoxycaine and Dinocap. Introduction to one group C-C and C-X disconnections. One group C-C disconnections, Alcohols and carbonyl compounds. One group C-X disconnections ,Carbonyl compounds, alcohols, ethers and sulphides	
3.0		**Disconnection approach (Synthetic Strategies II)**	**15**
	3.1	Introduction to two group C-C and C-X disconnections , Two group C-X disconnections; 1,1- difunctionalised, 1,2-difunctionalised and 1,3-difunctionalised compounds. Advantages of two group disconnection over one group disconnection as illustrated by mercaptum synthesis	

	3.2	C-C disconnections: Diels-Alder reaction, 1,3-difunctionalised compounds, 1,5- difunctionalised compounds, Michael addition and Robinson annulation	
	3.3	Strategic bond: definition, choosing disconnection/ guidelines for disconnection; disconnection of C-X bonds, disconnect to greatest simplification using symmetry in disconnection, disconnection corresponding to known reliable reaction, high yielding steps and recognizable starting materials	
4.0		**Protecting and deprotecting groups in organic synthesis**	
	4.1	Introduction to protection and deprotection . Need for protection in organic Commonly encountered functional groups to be protected in synthetic chemistry(Hydroxyl carbonyl, amine and carboxylic group)	
	4.2	Protecting group for hydroxyl group as alcohol, phenol diols etc)and carbonyl group (acetal and thioacetal) and their deprotection	**15**
	4.3	Protecting and deprotecting group for amino group and carboxylic group with special emphasise on solid phase peptide Synthesis. Coupling reagents such as DCC and Merrifield resin	
5.0		**Organo borane and enamines in organic synthesis**	
	5.1	Enamines in organic synthesis: Introduction, synthesis, mechanism of enamine synthesis. Stability of enamines. Limitation of enamine syntheissed from aldehyde and primary amine	
	5.2	Syntheic utility of enamines as regards to the 1,2, 1,3, 1,4 and 1,5- dicarbonyl campounds. Ring opening of epoxide and aziridines via nucleophilic addition of enamine	**10**
	5.3	Orgnoborane: Introdcution to organoborane. Hydraboration, Hydraboration -oxidation reaction and their mechanism. Synthetic utility of organoborane	
		Total	**60**

Books:

1. Modern synthetic reactions By – H. O. House and Benjamin.
2. Organic Chemistry By – Clayden, Greeves, Warren and Wothers (Oxford press).
3. Designing organic synthesis by S. Warren (Wiley).
4. Some Modern methods of organic synthesis by – W. Carruthers (Cambridge)
5. Organic synthesis by – M. B. Smith
6. Organometallics in organic synthesis by – J. M. Swan and D. C. Black (Chapman and Hall).

SSCSC552: Quality Assurance and Quality Control, Method of Analytical Development and Validation

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Basic knowledge of concepts in analytical chemistry such as quality of product, quality control, quality assurance, sampling processes, primary and secondary standards etc.

Course objectives:

- To understand the importance of Standards/reference Materials in Analytical chemistry.
- To understand the concept of Analytical Method Development. Know how to validate the developed Analytical methods.
- To study the concept of Quality Assurance and Quality Control.
- To learn various statistical methods to monitor and implement QC system in various industries.

Course outcomes:

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

- To utilize primary/secondary and various standards of Reference Materials.
- Able to develop competent Analytical Methods.
- Shall be able to Validate the new analytical methods.
- Able to implement, administer and monitor QA/QC Programme

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Quality Assurance, Quality Control and Reference Materials**	**15**
	1.1	Basic concepts, Principles or prescription; Needs, requirements and expectations, the characteristics of quality; Achieving, sustaining and improving quality; Quality dimensions and costs of quality.	
	1.2	Elements of quality Assurance, Quality Management System, Quality management concepts and principles: ISO 9001:2000 QMS Case studies on ISO 9001: 2000 in chemical industries. ISO 14000 Series of Standards	
	1.3	Analytical standards, primary and secondary standards, high purity substances, reference materials, use of RMs in statistical control schemes and in inter-comparisons,	
	1.4	Role of certified reference materials (CRMs), production and requirements, obtaining reference value and certified value. Parameters that Characterize RM, Applications.	
2.0		**Quality Assessment in Chemical Industries and Quality Assurance in Water Industry**	**20**
	2.1	Internal and External methods of Quality assessment. Quality characteristics of chemical analysis, errors occurring at the start, during or by the end of analysis.	
	2.2	Evaluating Quality assurance data: Prescriptive approach and Performance based approach. Control charts: Shewhart Chart, CUSUM chart and EWMA chart interpretation and presentation of results; QA schemes, experimental designs for optimization studies and	
	2.3	Water quality field sampling QA/QC program, QA/QC documentation, QA project plan, designing a water quality monitoring plan, Site selection, sampling frequency and sample size, cost considerations, training of field personnel, field trip preparations,	

	2.4	Water quality sampling, toxic chemicals in bottom sampling and biota, bacterial sample collection, sequential triplicate sampling, sample handling, preservation, storage and transport, chain of custody, field safety, field audit program, laboratory QC procedures inter- and intra-laboratory QC, detection limits, reporting of analytical results, data handling and data management	
3.0		**Development of Analytical Methods**	**15**
	3.1	Theory and factors affecting resolution – a reminder of the importance of resolution, separation factor (selectivity), retention factor (capacity factor) and column efficiency). Selecting the HPLC separation mode (reversed-phase, normal-phase *etc.*)	
	3.2	Selecting the most appropriate detector: peak purity determination (Diode array and MS detectors), Gradient/isocratic operation, Selecting the column for analysis,	
	3.3	Selecting and optimizing the mobile phase, the effect of pH, considering pKa of the analyte. Requirements for a stability-indicating analytical method, Anticipation of likely degradation products, from experience with compound, from forced degradation (stress testing) of drug substance, as per ICH guidance,	
	3.4	Note findings of stress-testing industry comparison, degradation products and their enantiomers or diastereoisomers, calculation of mass balance and its significance	
4.0		**Validation of Analytical Methods**	**10**
	4.1	Introduction to ICH guidelines: ICH Q2(R1),	
	4.2	A detailed discussion on the parameters to be validated, Specificity, Linearity, Range, Accuracy, Precision, Detection Limit, Quantitation Limit, Robustness	
	4.3	Extent of validation: how much work at each phase of development, Acceptance criteria,	
	4.4	Validation procedures and protocols, Dealing with validation failures, Method Validation Example in HPLC	
		Total	**60**

SSCSE551: Applied Analytical Chemistry

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basic concepts such as volumetric and gravimetric analysis, basic instrumentation as pH meter, colorimeter/spectrophotometer etc.

Course objectives:

- To learn basic terms and operational procedures related to metallurgy.
- To learn basic principles and various analytical procedures used in the analysis of ores.
- To study basic principles involved and chemical analysis methods (gravimetric and volumetric) for analysis of various alloys.
- To understand basic terms such as soil, soil pH, importance of soil pH, measurement of soil pH and to learn various method of soil analysis.
- To learn basic information regarding coal, types of coal and analysis of coal.

Course outcomes:

- The student will understand basic information regarding metallurgy, mineral and ores, alloys, various techniques used in analysis of ore and alloy samples, theoretical principles lying behind ore and alloy analysis.
- He/she will gain each and every minute detail necessary for performing analysis of ores and alloys samples using classical methods of analysis.
- He/she will gain basic knowledge regarding soil, soil profile, composition of soil, types of soil, soils and crops, properties of soil, soil erosion, cause and effects of soil erosion, prevention of soil erosion, soil pollution, prevention of soil pollution.
- He/she will understand theoretical principles involved in the analysis of soil sample, importance of soil analysis, various procedures used for analysis of soil sample, each and every minute detail of all the procedures used for soil analysis.
- He/she will understand theoretical principles involved in the analysis of coal, proximate and ultimate analysis of coal, types and uses of coal

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Metallurgy**	**10**
	1.1	Introduction to minerals and ores, types of ores, naming of ores.	
	1.2	Extraction of ores, Crushing and grinding of ores (pulverization), Concentration of ores, methods of concentration of ores including hand picking method, electromagnetic separation, hydraulic washing, chemical leaching, froth flotation process.	
	1.3	Calcination and roasting, difference between calcination and roasting, changes occurring during calcination and roasting. Reduction of metal oxide to metal, reduction by heat, chemical reduction, electrolytic reduction.	
	1.4	Purification or refining of impure metals, Physical methods (liquation, fractional distillation, zone refining/fraction crystallization and Parke's process), Chemical methods (Oxidation method, Polling process, Thermal decomposition (Mond's process, van Arkel de Boer's process/iodine refining process), amalgamation	
2.0		**Analysis of Ores**	**20**
	2.1	Bauxite: Introduction, purification (Baeyer's process, Hal Heroult's process), Analysis of bauxite ore (loss on ignitio estimation of impure silica, total iron oxide, titanium oxid aluminium oxide),	
	2.2	Hematite: Introduction, Extraction of Fe from hematite ore, Analysis of hematite ore (loss on ignition, estimation of impure silica, iron, aluminium and manganese from the ore sample), Dolomite: Introduction, properties, uses, analysis of dolomite (estimation of calcium and magnesium from dolomite sample),	

	2.3	Galena: Introduction, uses, analysis of galena ore (loss on ignition, estimation of lead and sulphur from the ore sample)	
	2.4	Inorganic phosphate: Introduction, importance of phosphate measurement, biochemical importance of phosphate, analysis of phosphate.	
3.0		**Analysis of Alloys**	**15**
	3.1	Bronze: Introduction, types of bronze, properties, applications, analysis of bronze alloy (estimation of copper and tin from alloy sample),	
	3.2	Brass: Introduction, applications, analysis of brass alloy (estimation of tin, lead, copper, iron and zinc from alloy sample). German silver: Introduction, analysis (estimation of tin, copper, iron and nickel from alloy sample),	
	3.3	Gun metal: Introduction, analysis (estimation of tin). Solder and type metal: Introduction, analysis (estimation of tin, lead and antimony from alloy sample),	
	3.4	Steel: Introduction, stainless steel, properties, applications, estimation of nickel and tin from steel sample.	
4.0		**Soil and Coal Analysis**	**15**
	4.1	Introduction to soil, soil profile, composition of soil, types of soil, soils and crops, properties of soil, soil erosion, cause and effects of soil erosion, prevention of soil erosion, soil pollution, prevention of soil pollution.	
	4.2	Soil Analysis: Determination of moisture, pH, conductivity, total nitrogen, phosphorous, silica, lime, magnesium, manganese, sulphur, Determination of metals such potassium, calcium, Magnesium and sodium using flame photometer, Soil alkalinity, determination of soil alkalinity.	
	4.3	Introduction to coal, uses of coal, types of coal.	
	4.4	Coal Analysis: Proximate analysis of coal (determination of moisture, volatile carbonaceous matter, ash, fixed carbon content), advantages of proximate analysis, ultimate analysis of coal (determination of carbon and hydrogen, nitrogen, sulphur, ash and oxygen content).	

		Total	**60**

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, 7^{th} 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.
7. Awareness Science. Lakhmir Singh, Manjit Kaur, S. Chand Publications.

SSCSE552: Environmental Industrial Chemistry

Credits 4 (60 Contact hrs)

Course pre-requisite:

- Knowledge of basics of water pollution and wastewater management
- Basic knowledge of environmental chemistry and pollution

Course objectives:

- To learn about the concept of water pollution
- To know about wastewater management
- To know about soil and air pollution
- To develop the sense of responsibility about environment in society
- To understand important issues, causes of industrial pollution
- To understand the removal of heavy toxic metals

Course outcomes:

- Students will know the details of water pollution
- Apply their knowledge in wastewater management
- Understanding of soil and air pollution
- Understanding of different types of pollution and apply knowledge for the protection and improvement of the environment
- Understanding different environmental segments
- Apply their knowledge in controlling the pollution
- Students will understand the removal of heavy toxic metals

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Water pollution and wastewater management**	
	1.1	Introduction, use and conservation of water resources, water quality management, rainwater harvesting, and water management in agriculture rain fed systems, irrigated systems, industries.	
	1.2	Water pollution: Definition, types of water pollution (Physical, Chemical, biological and physiological), water pollutants.	
	1.3	Ground water pollution and its protection, surface, river, sea and lake water pollution, effect of excess nutrients and oil on water pollution. Sea water for agriculture, remedial measures for water pollution.	**15**
	1.4	Industrial waste treatment: Characteristics and types of industrial waste, principles of industrial waste treatment and disposal, protection of biosphere and surface water form industrial pollution.	
2.0		**Soil Pollution**	
	2.1	Soil Pollution: Introduction, industrial, agricultural, radioactive, sewage, domestic, chemical and metallic wastes, soil pollution by mining, by sediments and biological agents.	
	2.2	Effect of heavy metals, diseases caused by soil pollution and impact of soil pollution on air quality.	**15**
	2.3	Control of soil pollution: Control of sewage, domestic and industrial waste, eco-farming and ecotechnology, biotechnology, integrated nutrient, pest, genetic resource and water management, land use systems.	
3.0		**Air pollution**	
	3.1	Air pollution: Definition, composition and reactions occurring in atmosphere, Sources of air pollution, units of measuring air pollutants.	**15**
	3.2	Classification and effect of air pollution; oxides of	

		nitrogen, Sulphur and carbon, Hydrocarbons, organic and inorganic particulates and ozone as pollutants.	
	3.3	WHO Standards, Indoor air pollution, occupational air pollution, outdoor air pollution, Air pollution episodes; Bhopal gas, Seveso disaster, Chernobyl tragedies.	
	3.4	Noise pollution: Sources of Noise, Units and Measurements of Noise, Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise, Auditory Effects, Non-Auditory Effects, Control of Noise Pollution.	
4.0		**Environmental Chemistry and Removal of Heavy toxic metals**	
	4.1	Environmental segments, atmospheric structure, photochemical smog, Global warming, consequences of global warming.	
	4.2	Green house effect, ozone layer and its depletion and its effects.	**15**
	4.3	Removal of Heavy toxic metals: Chromium, mercury, lead, cadmium, arsenic, analytical methods of determination of small amounts of metal pollutants, copper recovery,	
	4.4	Treatment of waste water to remove heavy metals, recovery techniques.	
		Total	**60**

Reference Books:

1. F. A. Henglein: Chemical safety Management andEngineering (Pergamon).
2. B. K. Sharma EnvironmentChemistry,
3. M. K. Hill; Understanding Environmental Pollution A Primer, Cambridge University Press,2004.
4. I. L. Pepper, C. P. Gerba, M. L. Brusseau, Environmental & PollutionScience, Elsevier,2006.
5. 5. G. M. Masters, Introduction to Environmental Engineering and Science, Pearson, 2004.
6. Antony Milne, “Noise Pollution: Impact and Counter Measures”, David & Charles PLC, 1979.
7. Peterson And E.Gross Jr., “Hand Book Of Noise Measurement”, 5 Th Edition, 1963
8. Industrial chemistry – B.K.Sharma

9. Environmental chemistry – Banerji Samir K.
10. Environmental Water Pollution – Mishra, S.G. Prasad, D Gaur H.S.
11. Environmental Pollution Causes Effect and Control – Sethi I, sethi M.S., EqbalS.

SSCSE553: Chemotherapy

Credits 4 (60 Contact hrs)

Course objectives:

- Learn basic principles involved antihistaminic, cholinergic, Adrenergic, opium analgesics, Local anesthetics, Combinatorial synthesis.
- To know the role of medicinal chemist in development of medicinal agents for involved antihistaminic, cholinergic, Adrenergic, opium analgesics, Local anesthetics, and Combinatorial synthesis
- Learn how to analyze and perform SAR and QSAR involved antihistaminic, cholinergic, Adrenergic, opium analgesics, Local anesthetics,
- understand Combinatorial synthesis.

Course outcomes:

- Understand key component of drug discovery of involved antihistaminic, cholinergic, Adrenergic, opium analgesics, Local anesthetics, Combinatorial synthesis.
- Understanding the role of medicinal chemist in development of medicinal agents for involved antihistaminic, cholinergic, Adrenergic, opium analgesics, Local anesthetics, Combinatorial synthesis.
- Analyze the recent research articles.

Curriculum Details:

IoduleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		**imetidine A Rational approach** :	**10**
	1.1	Introduction, in the beginning-ulcer therapy in 1964,	
	1.2	histamine, the theory-two histamine receptors, searching for lead- histamine, searching for a lead- N^{α}-	
	1.3	Guanylhistamine, developing the lead- a chelation bonding theory, from partial agonist to antagonist- the development of burimammide, development of metiamide, development of cimetidine, cimetidine,	
	1.4	recent drugs.	
2.0		**Cholinergics, anticholinergics, and anticholinesterases** : & **Adrenergics :**	**20**
	2.1	The peripheral nervous system, oxidation, motor nerves of the peripheral nervous system, the neurotransmitters, action of the peripheral nervous system, the cholinergic system, agonist of the cholinergic receptor, acetylcholine-structure, SAR, and receptor binding, the instability of acetylcholine, the design of acetylcholine analogues, the clinical uses of cholinergic agonists, agonist of muscarinic cholinergic receptor, antagonists of nicotinic cholinergic receptor, other cholinergic antagonist, the nicotinic receptor structure, the muscarinic receptor structure, anticholinesterases and acetyl cholinesterase, anticholinesterase drugs, praldioxie- an organophosphate antidote.	
	2.2	Adrenergic nervous system, adrenergic receptor, Neurotransmission,	
	2.3	adrenergic agonist, adrenergic receptor antagonist, metabolism.	
3.0		**Combinatorial synthesis** :	**12**
	3.1	Introduction,	
	3.2	parallel synthesis, planning and	
	3.3	designing a combinatial synthesis, testing activity.	
4.0		**The opium analgesics & Local anesthetics** :	**18**
	4.1	Isolation of morphine, morphine, development of	

		morphine analogues, receptor theory of analgesics.	
	4.2	eagonists and antagonists, enkephalins and endorphins, receptor mechanism, the futur	
	4.3	Introduction, sites of action of local anesthetics, nerve tissue,	
	4.4	mode of action, classification, structure activity relationship.	
		Total	**60**

Text Books:

1. Principles of Medicinal chemistry, William O. Foye
2. Burgers medicinal chemistry and drug discovery, John Diley.
3. An Introduction to medicinal chemistry, Graham L Patric. Oxford university press
4. Principles of Medicinal chemistry by Kadam, Mahadik, Bothara. Nirali Prakashan.
5. Essentials of Medicinal Chemistry second edition Andrejus Korolkovas: Wiley India Edition
6. An introduction to drug design S. S. Pandeya and J. R. Dimmock (New age international)

Reference Books:

7. The organic chemistry of drug design and drug Action - R. B. Silverman (Academic Press)
8. Strategies for organic drug synthesis and design D. Lednicer Wiley
9. Pharmacological basis of therapeutics Goodman and Gilman's

SSCSE554: Advanced Organic Chemistry

Credits 4 (60 Contact hrs)

Course objectives:

The student will understand the

- The steriochemical principles.
- Application of organomettalic reagents,
- Most common reagents used in organic synthesis.
- Principles of asymmetric synthesis

Course outcomes:

The learner should know

- common organic reagents,
- organometallic reagents
- concepts for asymmetric synthesis
- application of application of different reagents in total synthesis

Curriculum Details:

IoduleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		**Principles of asymmetric synthesis**	**20**
	1.1	Introduction and terminology: Topicity in molecules Homotopic, stereoheterotopic (enantiotopic and diastereotopic) groups and faces-symmetry, substitution and addition criteria.Prochirality Stereoselective reactions: Substrate stereoselectivity, product stereoselectivity, enantioselectivity and diastereo selectivity. Conditions for stereoselectivity: Symmetry and transition state criteria, kinetic and thermodynamic control.	
	1.2	Methods for inducing enantio and diastereoselectivity. Analytical methods: % Enantiomeric excess, enantiomeric ratio, optical purity, % diastereomeric excess and diastereomeric ratio.	
	1.3	Techniques for determination of enantiomeric excess, specific rotation, Chiral NMR; Chiralderivatizing agents, Chiral solvent, Chiral shift reagents and Chiral HPLC	
2.0		**Use of organometallic reagents**	**20**
	2.1	Synthesis and applications of Li and Mg reagents, nucleophilic addition to aldehyde, ketones, ester, epoxide, CO2, CS2, isocyanates, ketenes, imines, amides, lactones, o-metallation of arenes using organolithium compounds.	
	2.2	Organozinc reagents: Preparation and applications, Reformatsky reaction, Simon-Smith reaction.	
	2.3	Organo Cd and Pd reagents in organic synthesis, transition metal complexes in organic synthesis.	
3.0		**Reagents in organic synthesis**	**15**
	3.1	Use of following reagents in organic synthesis and functional group transformation: Gilman's reagent (lithium dimethyl cuprate), lithium diisopropylamide (LDA), trimethylsilyl iodide or chloride,	
	3.2	phase transfer catalyst, crown ether and Merrifield resin,	
	3.3	Peterons's synthesis, Wilkinson's catalyst, Baker's	

		yeast, diazomethane, polyphosphoric acid, dicyclohexylcarbodiimide (DCC), yields, organoboranes.	
4.0		**Green chemistry**	**5**
	4.1	use of microwave and ultrasonic techniques in organic synthesis	
		Total	**60**

Books:

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of Organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic Chemistry 2nd Ed. R R. Carey and R. J. Sundburg.
9. Tetrahedron reports in Organic Chemistry- Vol.1, No. 8.
10. Organic Synthesis-(Prentice Hall)R. E. Ireland.
11. Homogeneous Hydrogenation-(J. K.) B. R. James.
12. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
13. Organic reactions- various volumes- R. Adams.
14. Some modern methods of Organic synthesis-(Cambridge)W.Carruthares.
15. Advanced Organic Chemistry – J. March
16. Lehninger's Principles of Biochemistry,(4thEd.) David L. Nelson, Michael M. Cox

SSCSE555: Biophysical Chemistry

Credits 4 (60 Contact hrs)

Course pre-requisite:

Knowledge of basic concepts such as biological cell structure, difference between prokaryotic and eukaryotic cell,

Course objectives:

- To understand the basic structure of the biological cell
- To learn importance of cell constituents, its functions and forms of various transport processes.
- To learn basic terms and operational terminologies of bio molecules.
- To determine macromolecular structures.
- To develop the applications of quantitative methods to analyze biological systems.
- To understand the cell micro-constituents, its functions with biochemical reactions.
- To know the physical and chemical properties, of bio macromolecules

Course outcomes:

At the end of this course students will be able to:

- The student will understand determine macromolecular structures.
- Develop the applications of quantitative methods to analyze biological systems
- Know the basic structure of the biological cell and its compounds.
- Apply the physical and chemical properties of bio macromolecules.
- Aware the functions and construction as well as importance of cell constituents. .
- Aware the functions and construction as well as importance of cell constituents. .

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Bio Macromolecules in Living System**	**15**
	1.1	Protein: Classification of amino acids, structure of proteins, classification of proteins, functions of proteins, polypeptide and protein structures, introduction to protein folding problem.	
	1.2	Enzymes: Structure and functions, nomenclature of the enzymes, classification of enzymes, chemical nature of enzymes, factors affecting enzyme activity, function of enzymes.	
	1.3	Nucleic Acids: Deoxyribose Nucleic Acid (DNA), double helix structure of DNA Ribonucleic Acid (RNA), types of RNA , structure and functions of RNA.	
2.0		**Bioenergetics**	**15**
	2.1	Bioenergetics, Gibb's free energy change and feasibilit offf biochemical reaction,	
	2.2	An exergonic reaction and endergonic reaction, standard free energy changes and additive values, role of high energy phosphates in energy capture and transfer,	
	2.3	Hydrolysis of ATP, bioenergetics significance of ATP, Calculations of free energy change from standard reduction potentials. hydrogen ion titration curves. synthesis of ATP from ADP.	
3.0		**Statistical Mechanics and Thermodynamics of Biopolymers**	**10**
	3.1	Statistical Mechanics in Biopolymer: Chain configuration and conformation of macromolecules, statistical distribution end to end dimensions, Thermodynamic probability of polymer chain	

	3.2	Thermodynamics of Biopolymer: Thermodynamics of biopolymer solutions, entropy and heat of mixing of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy production and biochemical activities in muscle contraction, functional and structural basis classification of muscles.	
4.0		**Cell Membrane and Transport of Ions:**	**20**
	4.1	Forces Involved in Biopolymer Interactions: Elctrostatic Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions, multiple equilibria and various types of binding processes in biological systems,	
	4.2	Structure and functions of cell membrane.	
	4.3	Ion transport through cell membrane, irreversible thermodynamics treatment of membrane transport, nerve conduction Introduction to coal, uses of coal, types of coal.	
	4.4	Calculation of average dimension of various chain structures biopolymers and their molecular weight evaluation of size, shape, molecular weight and expect of hydration of biopolymer by various experimental technique, sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity, viscosity, electrophoresis and rational motions.	
		Total	**60**

SSCSE556: Polymers from Renewable Resources

Credits 4 (60 Contact hrs)

Course objectives:

- to importance of renewable materials
- to introduce the polymers prepared from renewable resources
- to know how biodegradable polymers are prepared
- to understand uses of bioplastics in daily life

Course outcomes:

Student will understand the

1. Importance of renewable materials and their use in daily life
2. Knowledge of biorefinary and its activities.
3. Knowledge of preparing bioplastics from renewable resources for various applications
4. Knowledge of bioplastics product manufacturing

Curriculum Details:

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		**Renewable resources as feedstock**	
	1.1	Introduction, importance and scope of monomers and polymers from renewable resources Polymers from plant source, polysacchrides, protein, lipids, wax, plant oils etc. e.g. wood, biomass, vegetable oil etc.	
	1.2	Polymers from animal source protein, lipids, wax, oils etc.	15
	1.3	Polymers from Carbon dioxide, agro industry waste, agricultural waste, industrial waste and muncipal waste etc. Polymers from microorganisms e.g. PHA etc.	
	1.4	Advantages and disadvantages of renewable resources based monomers, polymers.	
2.0		**Biorefinery**	
	2.1	The concept of biorefinery: Comparisons between biorefinery and petroleum refinery, Advantages of biorefinary. Classification of biorefinery systems, Economic viability and environmental impact of biorefinary systems. Levulinic acid platforms and its details.	10
	2.2	Examples of biorefinary systems and industry/companies names with details of activities	
	2.3	Future of biorefineries	
3.0		**Biodegerdable polymers**	
	3.1	Definition, scope importance of biodegradable polymers. Definition, difference with suitable examples between a) fossil fuel based polymers, b) biobased polymers, c) biodegradable polymers, Bioplastics, Green plastics d) compostable polymers, e) Environmental friendly (sustainable polymers), f) edible polymers	20
	3.2	Types of Biodegradable polymers 1) polymers from biomass such as the agro-polymers from agroresources (e.g., starch, cellulose) 2) polymers obtained by microbial production (i.e. polyhydroxyalkanoates) 3) polymers conventionally and chemically synthesized and whose the monomers are obtained from agro-	

		resources (e.g., poly(lactic acid) 4) polymers whose monomers and polymers are obtained from fossil fuel, by chemical synthesis (e.g., polyvinyl alcohol).	
	3.3 **3.4**	Comparison between BioPET, BioPP, BioPE, BioPVC, BioPS, BioABS, BioSAN Vs their fossil fuel based polymers, comparison between PLA vs ABS plastics and PHBH vs PP and or PE. Biobased polyamides, Thermoplastic starch blends. Compostable polymers, Definition structure, preparation, characterization, applications, blends. Edible polymers, definition, raw materials, forms, preparation, applications, commercial aspects of edible polymers, biocompatibility, edibility testing methods. Sustainable polymers, Definition, difference between ordinary and sustainable polymers, Sustainability development, examples of sustainable polymers. Circular economy in sustainable polymers. Biodegradation standard testing methods (ASTM, ISO, BSI etc). composting methods (Home and industrial composting methods). Recycling of biodegradable polymers to value added products. Applications of biodegradable polymers. List of names of biodegradable polymers, sustainable polymers, edible polymers, Biobased polymers, compostable polymers, fossil fuel based biodegradable polymers etc.	
4.0		**Processing of Bioplastics**	
	4.1	Fundamentals of bioplastics processing, General overview, formulation, compounding, blending, fillers, additives, colorants, catalyst, modifiers, additives, plasticizers, nucleating agents, blends, compatalizers used in bioplastics processing. Typical formulation of bioplastics processing.	15
	4.2	Coating, Film formation, Compression molding, Casting articles, material properties, processing conditions, development of formulation, equipments used, typical problems and their solution. Various applications of bioplastics products. List of Bioplastics manufacturing/processing industries/companies in India.	

		Total	60

Text Books:

1. Belgacem, M. N. Gandini, A. Monomers, Polymers and Composites from Renewable Resources, Elsevier, London, 2008, 560pp.
2. Gandini, A., The Irruption of polymers from renewable resources on the scene of macromolecular science and technology. Green Chem., 2011, 13, 1061.
3. Fakirov, S., Bhattacharyya, D., Engineering of Biopolymers, Homopolymers, Blends and Composites, Hansen, 2007, 896pp.
4. Long Yu, Biodegradable Polymer Blend and Composites from Renewable Resources, John Wiley & Sons, Inc. Published in 2009 ISBN 978-0-470-14683-5 (cloth).
5. Ed de Jong, Gerfried Jungmeier CHAPTER 1 Biorefnery Concepts in Comparison to Petrochemical Refneries in Industrial Biorefneries and White Biotechnology Elsevier Publications (2015).
6. Ray Smith Biodegradable polymers for industrial applications; Taylor & Francis ISBN: 9780849334665, 0849334667 published 17 May 2005 Wood house publishing ISBN 1855739348 and CRC Press LLC ISBN: 0849334667.
7. Niranjan Karak. Vegetable Oil-Based Polymers Properties, Processing and Applications Woodhead Publishing in Materials New Delhi (published 2012) ISBN 978-0-85709-710-1.
8. Vimal Katiyar, Raghvendra Gupta, Tabli Ghosh Advances in Sustainable Polymers Processing and Applications ISSN: 9789813298040, 9813298049, ISBN: 978-981-32-9806-4 soft copy ISBN: 978-981-32-9803-3 Hard copy Springer Nature Singapore Published 2019.
9. Catia Bastioli Handbook of Biodegradable Polymers eBook Published: March 9, 2020 ISBN: 9781501511967 Hardcover Published: March 9, 2020 ISBN: 9781501519215.
10. Ewa Rudnik Compostable Polymer Materials Elsevier Science June 2019 Hardback ISBN: 9780080994383 eBook ISBN: 9780080994420.
11. Manjari Sharma Biodegradable Polymers Materials and their Structures CRC Press published 2021.Tyler Francis. ISBN: 9781000385182, 1000385183. ISBN 9780367774769.
12. Prof. Andreas Lendlein, Dr. Adam Sisson Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications W -VCH V g H & C . K First published:29 June 2011 ISBN:9783527324415 |Online ISBN:9783527635818 ISSN: 9783527324415, 3527323310.

13. Muhammed Lamin Sanyang, Mohammad Jawaid Bio-based Polymers and Nanocomposites
14. Preparation, Processing, Properties & Performance Springer Nature Switzerland AG 2019 Hardcover ISBN978-3-030-05824-1 eBook ISBN978-3-030-05825-8 ISBN: 978330058258, 3030058255.
15. Babak Ghanbarzadeh and Hadi Almasi Biodegradable Polymers Published in June 2013 Open access book IntechOpen Limited 5 Princes Gate Court, London, SW7 2QJ, UNITED KINGDOM.
16. Abraham J. Domb, Joseph Kost, David M. Wiseman HANDBOOK OF BIODEGRADABLE POLYMERS CRC Press ISBN: 10: 90-5702-153-6 (Hardcover) Taylor & Francis Group ISBN: 13: 978-90-5702-153-4 (Hardcover) Published in 1997.
17. Jo Dewulf and Herman Van Langenhove Renewables-based technology : sustainability assessment John Wiley & Sons Ltd, Published in 2006 ISBN-13: 978-0-470-02241-2 (cloth : alk. paper) ISBN-10: 0-470-02241-8 (cloth : alk. paper)
18. Roland Ulber, Dieter Sell, Thomas Hirth Renewable Raw Materials New Feedstocks for the Chemical Industry Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany Published in 2011 ISBN: 978-3-527-32548-1 ePDF ISBN: 978-3-527-63421-7 oBook ISBN: 978-3-527-63419-4 EPub ISBN: 978-3-527-63420-0 Mobi ISBN: 978-3-527-63422-4
19. Angela Dibenedetto, Franck Dumeignil, Michele Aresta Biorefineries An Introduction ublisher: De Gruyter Published in 2015. ISBN: 9783110331585, 3110331586.
20. Hesham El-Ensashy, Nuttha Thongchul, Shang-Tian Yang Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals, and Polymers Publisher Wiley and Sons Published in 2013. ISBN: 9781118641941, 111864194
21. Johannes Karl Fink The Chemistry of Bio-based Polymers John Wiley & Sons, Inc. and Scrivener Publishing LLC, Salem, Massachusetts. Published in 2014. ISBN 978-1-118-83725-2
22. Qirui Sun Development of Bio-based and Biodegradable Film from Carbon Dioxide Based Polymer and Poly(Lactic Acid). Published by University of Guelph in 2015.
23. Ewa Rudnik Compostable Polymer Materials, Elsevier Science Publications Published in 2019, ISBN: 9780080994383, 0080994385.

24. Vimal Katiyar Sustainable Polymers for Food Packaging An Introduction Publisher: De Gruyter Published in 2022 ISBN: 9783110648034, 3110648032.
25. Tomy J. Gutiérrez Polymers for Agri-Food Applications Springer International Publishing Published in 2019 ISBN: 9783030194161, 3030194167
26. Manuel Palencia, Tulio A. Lerma, Viviana Garcés, Mayra A. Mora, Jina M. Martínez, Sixta L. Palencia Eco-friendly Functional Polymers An Approach from Application-Tar.
27. Editors: Amit Kumar, Neha Mulchandani, Vimal Katiyar Advances in Sustainable Polymers Synthesis, Fabrication and Characterization Springer Nature Singapore Published: 3 March 2020 ISBN: 9789811512513, 9811512515.
28. Niranjan Karak Fundamentals Of Polymers: Raw Materials To Finish Products Phi Learning Published: December 2009 ISBN: 9788120338777, 8120338774.
29. Manas Chanda Plastics Technology Handbook CRC Press Published: 7 November 2017 ISBN: 9781498786225, 1498786227.
30. Editors: Manju Kumari Thakur, Vijay Kumar Thakur Handbook of Sustainable Polymers Processing and Applications Pan Stanford Publishing Published: 5 January 2016 ISBN: 9789814613545, 9814613541.

SSCSP551: Lab Course 7

Credits 2 (30 Contact hrs)

Course objectives:

- Students to interpret spectra
- Understand the physical examination of spectra, deduce structure

Course outcomes:

- Understand the basic interpretation of spectroscopy.

Curriculum Details:

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		Identification of organic compounds by spectral analysis.	***60***
	1.1	Minimum 10 problems based on joint applications of UV, IR, PMR, CMR and mass should be carried out	
		Total	**60**

Text Books:

1 Introduction to spectroscopy by Donald L. Pavia Gary M. Lampman, George S. Kriz (Harcourt college publications) 3rd Edition.

2. Spectrometric Identification of organic compounds by – R. M. Silverstein, T. C. Morril, G. C. Basseler.

3. 13 C-NMR spectroscopy by – G. C. Levy, R. L. Lichter, G. L. Nelson (Wiley).

4. Spectroscopic methods in organic chemistry by –D. H. Williams and Ian flemming.

Reference Books:

1. Absorption spectroscopy of organic molecules by-V. M. Parikh.