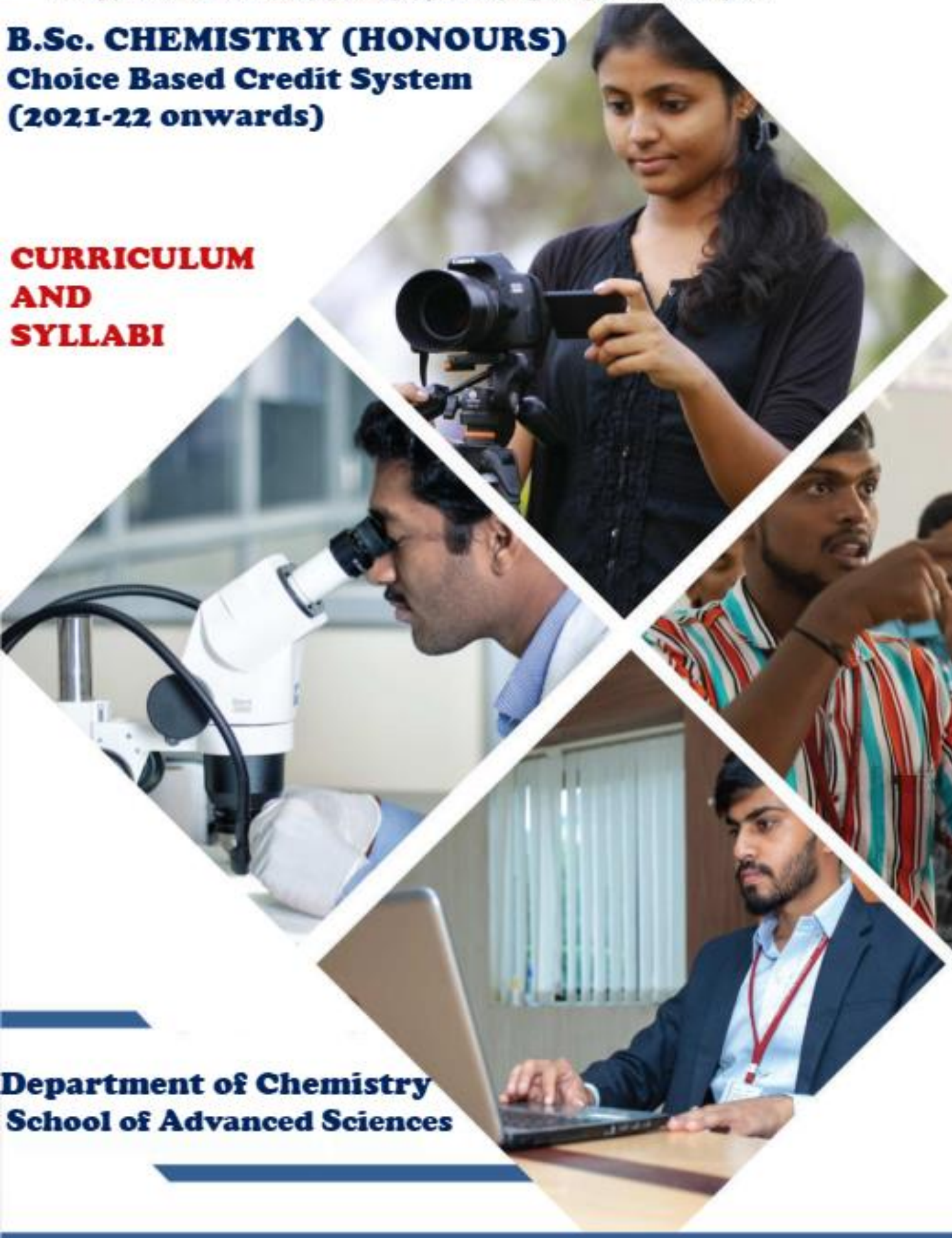
KALASALINGAM
ACADEMY OF RESEARCH AND EDUCATION
(DEEMED TO BE UNIVERSITY)
Under sec. 3 of UGC Act 1956. Accredited by NAAC with "A" Grade
Anand Nagar, Krishnankoil - 626126. Srivilliputtur (Via), Virudhunagar (Dt), Tamil Nadu | Info@kalasalingam.ac.in | www.kalasalingam.ac.in

B.Sc. CHEMISTRY (HONOURS)

Choice Based Credit System
(2021-22 onwards)

CURRICULUM AND SYLLABI



Department of Chemistry
School of Advanced Sciences

CURRICULUM AND SYLLABI

B.Sc. (HONOURS) IN CHEMISTRY

Choice Based Credit System (2021-22 onwards)

DEPARTMENT OF CHEMISTRY

SCHOOL OF ADVANCED SCIENCES

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

(Deemed to be University)

Anand Nagar, Krishnankoil - 626 126

Virudhunagar District, Tamil Nadu

2021

UNIVERSITY VISION

To be a Center of Excellence of International Repute in Education and Research.

UNIVERSITY MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research.

VISION OF THE DEPARTMENT

To be a centre of excellence of international repute in education and research in the field of chemistry and other related interdisciplinary sciences.

MISSION OF THE DEPARTMENT

To promote the advancement of science and technology in the broadest in chemistry in all of its branches and other related interdisciplinary areas through quality education, research and service missions that produce technically competent, socially committed technocrats and scientists.

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO1 **Expertise in Chemistry**:
Will be able to nurture the needs of industries/laboratories related to chemistry including pharmaceutical/analytical chemistry.

PSO2 **Professional Growth:**
Will be able to demonstrate information literacy skills for acquiring knowledge of chemistry, as a chemist/researcher and also as a life-long learner.

PSO3 **Analytical Skills**:
Will be able to communicate effectively the scientific information and research results in written and oral formats, to both professional scientists and to the public.

PROGRAMME OUTCOMES (POs)

PO1 **Scientific knowledge:** Gain and apply the fundamentals of mathematics, natural sciences, and applied sciences for the usage of modern scientific instrumentation, laboratory techniques and solving the challenges in modern scientific society

PO2 **Problem analysis:** Identify, formulate, and analyze the complex scientific problems reaching substantiated conclusions.

PO3 **Design/development of solutions:** Develop the solutions for complex problems using research based knowledge including design of experiments, analysis and interpretation of data that meet the specified needs with appropriate consideration for the public health and safety, cultural, societal, and environmental considerations.

PO4 **Modern tools usage:** Create, select, and apply appropriate techniques, resources, and modern computing/electronic tools.

PO5 **Social responsibility:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional practice.

PO6 **Environment and sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge for the sustainable development.

PO7 **Ethics and Values:** Apply and commit towards professional ethical principles, ethical responsibilities, and norms of the scientific practice.

PO8 **Individual and team work:** Function effectively in multidisciplinary settings as an individual or leader in group.

PO9 **Communication:** Communicate effectively on complex activities with the scientific community and with the society at large, being able to comprehend and write effective reports, design documentation and make effective presentations.

PO10 **National and International Perspectives:** Contribution towards the national development and projecting our national priorities at the international level pertaining to their field of interest and future expertise.

PO11 **Project management:** Capable of identifying/mobilizing appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct; and safety and laboratory hygiene regulations and practices

PO12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning towards the broadest context of scientific and societal change

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DEPARTMENT OF CHEMISTRY

CURRICULUM STRUCTURE

BROAD STRUCTURE

Course Types	No. of Courses	Total Credits
Foundation Core Courses	08	30
Program Core Courses (6×6=36; 4×4.5=18; 4x4=16)	14	70
Generic Electives (4×4=16)	04	16
Discipline Specific Electives (3×4=12; 1x2=2)	04	14
Skill Enhancement Courses (2×2=4) + Project (6)	03	10
Total	**33**	**140**

LIST OF FOUNDATION CORE COURSES

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
211ENG1302	English – I	4	0	0	3	7	5	5
211ENG1305	Professional Skills	1	0	0	3	4	2	2
211ENG1303	MIL / English – II	3	0	0	3	6	4	4
211BCA1301	Digital Skills	3	0	2	3	8	5	5
211ENG1306	Communicative English	3	0	2	3	8	5	5
211MAT1304	Basic Statistics	2	0	0	3	5	3	3
211CHY1101	Environmental Studies	3	0	0	0	3	3	3
211ENG1304	Human Values	2	0	0	3	5	3	3
	Total	**21**	**0**	**4**	**21**	**46**	**30**	**30**

LIST OF PROGRAM CORE COURSES

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
212CHY2301	Inorganic Chemistry-I	4	0	4	0	8	6	6
212CHY2302	Organic Chemistry-I	4	0	4	0	8	6	6
212CHY2303	Physical Chemistry-I	4	0	4	0	8	6	6
212CHY2305	Inorganic Chemistry-II	4	0	4	0	8	6	6
212CHY2307	Organic Chemistry-II	4	0	4	0	8	6	6
212CHY2308	Physical Chemistry-II	4	0	4	0	8	6	6
212CHY3309	Inorganic Chemistry-III	3	0	3	0	6	4.5	4.5
212CHY3310	Organic Chemistry-III	3	0	3	0	6	4.5	4.5
212CHY3312	Physical Chemistry-III	3	0	3	0	6	4.5	4.5
212CHY2313	Heterocyclic Chemistry	3	0	3	0	6	4.5	4.5
212CHY2106	Organic Spectroscopy	3	0	0	3	6	4	4
212CHY2104	Synthetic Reagents and Green Chemistry	4	0	0	0	4	4	4
212CHY2111	Materials Chemistry	4	0	0	0	4	4	4

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
212CHY2114	Nuclear and Radiation Chemistry	4	0	0	0	4	4	4
	Total	**51**	**0**	**36**	**3**	**90**	**70**	**70**

LIST OF GENERIC ELECTIVE COURSES

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
213MAT1101/ 213BIT1301	Mathematics-I/ Biotechnology-I*	4 3	0 0	0 2	0 0	4 5	4	4
213MAT1102/ 213BIT1302	Mathematics-II/ Biotechnology-II*	4 3	0 0	0 2	0 0	4 5	4	4
213PHY1301	Physics-I	3	0	2	0	5	4	4
213PHY1302	Physics-II	3	0	2	0	5	4	4
	Total	**14**	**0**	**4**	**0**	**18**	**16**	**16**
***For Non-Maths (PCB), L -12; T-0; P-8; X-0 (= 20 h)*								

LIST OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
213CHY2301	Organometallics and Bioinorganic Chemistry	3	0	2	0	5	4	4
213CHY2302	Electrochemistry	3	0	2	0	5	4	4
213CHY2303	Chemistry of Biomolecules and Natural Products	3	0	2	0	5	4	4
213CHY2104	Advanced Analytical Chemistry	1	0	0	3	4	2	2
213CHY2305	Medicinal Chemistry	3	0	2	0	5	4	4
213CHY2306	Polymer Chemistry	3	0	2	0	5	4	4
213CHY2107	Nanochemistry	4	0	0	0	4	4	4
213CHY2108	Organic Photochemistry and Pericyclic Reactions	4	0	0	0	4	4	4
(Any three 4-credit courses & one 2-credit course)	**Total**	**10**	**0**	**6**	**3**	**19**	**14**	**14**

LIST OF SKILL ENHANCEMENT COURSES / EXPERIENTIAL ELECTIVE

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
214CHY1101	Biofertilizers	1	0	0	3	4	2	2
214CHY1102	Fermentation Science and Technology	1	0	0	3	4	2	2
214CHY1103	Herbal Science and Technology	1	0	0	3	4	2	2
214CHY1104	Fuel Chemistry	1	0	0	3	4	2	2
215CHY4201	Project Work*	0	0	15	0	15	6	6

Course Code	Course Title	L	T	P	X	Hr	Credits	
							PCM	PCB
	Total	**2**	**0**	**15**	**6**	**23**	**10**	**10**
*(Any three courses; *Mandatory)*								

SEMESTER-WISE DISTRIBUTION OF COURSES

Sem.	Category	Course Code	Course Title	L	T	P	X	Hr	Credits	
									PCM	PCB
I	FC	211ENG1302	English - I	4	0	0	3	7	5	5
	FC	211ENG1305	Professional Skills	1	0	0	3	4	2	2
	CORE$_{6c}$	212CHY2301	Inorganic Chemistry-I	4	0	4	0	8	6	6
	CORE$_{6c}$	212CHY2302	Organic Chemistry-I	4	0	4	0	8	6	6
	GE	213MAT1101/ 213BIT1301	Mathematics-I/ Biotechnology-I*	4 3	0 0	0 2	0 0	4 5	4	4
			Total	**17**	**0**	**8**	**6**	**31**	**23**	**23**
			***For Non-Maths (PCB), L -16; T-0; P-10; X-6 (=32 h)**							
II	FC	211TAM1301/ 211ENG1303	MIL / English - II	3	0	0	3	6	4	4
	FC	MBA21RXXX	Digital Skills	3	0	2	3	8	5	5
	CORE $_{6c}$	212CHY2303	Physical Chemistry-I	4	0	4	0	8	6	6
	CORE $_{4c}$	212CHY2104	Synthetic Reagents and Green Chemistry	4	0	0	0	4	4	4
	GE	213MAT1102/ 213BIT1302	Mathematics-II/ Biotechnology-II*	4 3	0 0	0 2	0 0	4 5	4	4
	SEC	214CHYXXXX	SEC-I	1	0	0	3	4	2	2
			Total	**19**	**0**	**6**	**9**	**34**	**25**	**25**
			***For Non-Maths (PCB), L -18; T-0; P-8; X-9 (= 35 h)**							
III	FC	211ENG1306	Communicative English	3	0	2	3	8	5	5
	FC	211MAT1304	Basic Statistics	2	0	0	3	5	3	3
	CORE $_{6c}$	212CHY2305	Inorganic Chemistry-II	4	0	4	0	8	6	6
	CORE$_{4.5c}$	212CHY2106	Organic Spectroscopy	3	0	0	3	6	4	4
	GE	213PHY1301	Physics-I	3	0	2	0	5	4	4
			Total	**15**	**0**	**8**	**9**	**32**	**22**	**22**
IV	FC	211CHY1101	Environmental Studies	3	0	0	0	3	3	3
	FC	211ENG1304	Human Values	2	0	0	3	5	3	3
	CORE $_{6c}$	212CHY2307	Organic Chemistry-II	4	0	4	0	8	6	6
	CORE $_{6c}$	212CHY2308	Ph ysical Chemistry-II	4	0	4	0	8	6	6
	GE	213PHY1302	Physics-II	3	0	2	0	5	4	4
	DSE	213CHYXXXX	Discipline Specific Elective-I	3	0	2	0	5	4	4
			Total	**19**	**0**	**12**	**3**	**34**	**26**	**26**

Sem.	Category	Course Code	Course Title	L	T	P	X	Hr	Credits	
									PCM	PCB
V	$CORE_{4.5c}$	212CHY3309	Inorganic Chemistry-III	3	0	3	0	6	4.5	4.5
	$CORE_{4.5c}$	212CHY3310	Organic Chemistry-III	3	0	3	0	6	4.5	4.5
	$CORE_{4c}$	212CHY2111	Materials Chemistry	4	0	0	0	4	4	4
	DSE	213CHYXXXX	Discipline Specific Elective-II	3	0	2	0	5	4	4
	DSE	213CHYXXXX	Discipline Specific Elective-III	3	0	2	0	5	4	4
	SEC	214CHYXXXX	SEC-II	1	0	0	3	4	2	2
			Total	**17**	**0**	**10**	**3**	**30**	**23**	**23**
VI	$CORE_{4.5c}$	213CHY3312	Physical Chemistry-III	3	0	3	0	6	4.5	4.5
	$CORE_{4c}$	212CHY2313	Heterocyclic Chemistry	3	0	3	0	6	4.5	4.5
	$CORE_{4c}$	212CHY2114	Nuclear and Radiation Chemistry	4	0	0	0	4	4	4
	DSE	213CHYXXXX	Discipline Specific Elective-IV	1	0	0	3	4	2	2
	Project	215CHY4201	Project	0	0	15	0	15	6	6
			Total	**11**	**0**	**21**	**3**	**35**	**21**	**21**

FC: Foundation Core; GE: Generic Elective; SEC: Skill Enhancement Course; DSE: Discipline Specific Elective; $CORE_{6c/4.5c/4c}$: 6 / 4.5 / 4 Credit Core Courses.

CONSOLIDATED HOURS & CREDITS

Semester	L	T	P	X	Hr	C
I	17	0	8	6	31	23
II	19	0	6	9	34	25
III	15	0	8	9	32	22
IV	19	0	12	3	34	26
V	17	0	10	3	30	23
VI	11	0	21	3	35	21
Total Credits	**98**	**0**	**62**	**33**	**196**	**140**

Total Hrs: 196 h & 198 for Non-maths (PCB) students

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Non-CGPA COURSES

Group	Course	Credit(s)	Remarks
I	NCC	3	One Course from among this Group is to be successfully completed before proceeding to II Year
	NSS	3	
	Sports	3	
II	Industrial/ R&D Lab Training (Two Weeks)	3	

	Industrial/ R&D Lab Visit (3 Nos.)	3	Two Courses from among this Group is to be successfully completed before proceeding to III Year
	Scientific Lecture (90 min.- 4 Nos.)	3	
	Certification Course (BEC, Tally, JAVA)	3	
	Workshop/ Conference Participation (5 Nos.)	3	
	Extra-Curricular Activities (Association & Club Activities: YRC, Nature Club, Fine Arts, Photography Club, Yoga etc.)	3	
	Short-Term Course/ Internship Course (2 Weeks)	3	
	Aptitude Proficiency Certification (Soft Skills Training)	3	
	Foreign Languages (French/ German /Japanese /Korean)	3	
Minimum Credit Requirement: 09			

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FOUNDATION CORE COURSES

211ENG1302	ENGLISH-I	L	T	P	X	H	C
		4	0	0	3	7	5

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Objective:

This course aims at facilitating the student to understand the nuances of English Language through poetry, literary essays, biographies of eminent personalities, short stories of renowned writers and Grammar.

Course Outcomes:

CO1: To understand the fundamentals of Grammar
CO2: To understand simple literary texts.
CO3: To apply the reading skills and practice it.
CO4: To develop the quality of practical application of Grammar
CO5: To apply the conversation practice in day-to-day life.

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1										3		1
CO2	3	3	1	1							1		3	1	2
CO3	3	2										1	3	2	
CO4	3	2	1	1									3		
CO5	3	2	2	1	1							1	3	2	

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit I: Poetry

The Umbrella Man; Television -Roald Dahl
La Belle Dame Sans Merci - John Keats
Homecoming -R.Parthasarathy
Ulysses - Alfred Tennyson

Unit II: Prose

Bill Gates: A Biography - Michael B. Becraft
I Dare! Kiran Bedi- Parmesh Dangwal
My Autobiography- Charlie Chaplin
Swami Vivekananda – Chicago Speech of 1893

Unit III: Short Stories

The Ballad of Father Giligan -W.B.Yeats
The Conjurer‘s Revenge-Stephen Leacock
Little Girls Wiser than Men-Leo Tolstoy

Unit IV: Grammar

Parts of the Speech
Prefix, Suffix
Idioms and phrases
Sentence Pattern, Tenses

Unit V: Composition

Letter Writing,
Email Writing
Report Writing;
Cover Letter and Resume Writing

Text Books

1. Henderson, Archibald. George Bernard Shaw, His Life and Works: A Critical Biography; India:Wentworth Press (2016)
2. Gupta, Prashant, *The Life and Times of Bill Gates*; Prabhat Prakashan Publications, 2020

Reference Book

1. Sparkles English For Communication. Board of Editors, Emerald Publishers, 2015

211ENG1305	PROFESSIONAL SKILLS	L	T	P	X	H	C
		1	0	0	3	4	2

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Objective:

Professional skills are required for an individual to be gainfully employed for a successful and satisfied life. Professional skills are part of life skills. An individual should be able to demonstrate professional skills involving the use of intuitive, logical and critical thinking, communication and interpersonal skills, not limited to cognitive/creative skills. These skills, behavior and quality of output enhance employability.

Course Outcomes:

CO1: To provide opportunity for realizing one's potential through practical experience.

CO2: To increase one's knowledge and awareness of emotional competency and emotional intelligence at place of study/work.

CO3: To develop interpersonal skills and adopt good leadership behavior for empowerment of self and others.

CO4: To set appropriate goals, manage stress and time effectively.

CO5: To manage competency- mix at all levels for achieving excellence with ethics.

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1										3	1	
CO2	3	2		1									3	1	1
CO3	3		1										3	2	
CO4	3		1	2									3		1
CO5	3	2	2	1	1								3	2	1

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit I: Career Skills

Goal Setting – Critical Thinking- Self-esteem – Social skills– Interpersonal Skills —Public Speaking

Unit II: Team skills

Communication- Active Listening - Preparing resume/CV – Interview –

Unit III: Presentation Skills

Creative Thinking – Social Cultural Etiquettes – Presentation Skills – Body Language

Unit IV: Leadership Skills

Problem Solving – Strategic Thinking Skills – Creativity

Unit V: Management Skills

Decision Making –Stress Management – Tips to relieve from stress – Yoga - Meditation

Text Books:

1. Kevin Retz. *The Professional Skills Handbook for Engineers and Technical Professionals*, CRC Press, Taylor and Francis Group, London, 2019.
2. Stephanie Lynn Slocum. *SHE Engineers.* Engineers Rising LLC; 1st edition, 2018. USA.

Reference Books:

1. Sangeetha Sharma and Binod Mishra. *Communication Skills for Engineers and Scientists*. PHI Learning, New Delhi. 2010.
2. Wolfgang Linden. *Stress Management: From Basic Science to Best Practice.* Sage Publications, New Delhi. 2005.

211ENG1303	ENGLISH II	L	T	P	X	H	C
		3	0	0	3	6	4

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Objective:

The course aims to help the students achieve fluency and accuracy in English

Course Outcomes:

CO1: To introduce world-renowned poets to students.
CO2: To introduce world-renowned prose writers to students.
CO3: To make them understand the nuances of Indian plays.
CO4: To excel in Grammar.
CO5: To excel in Composition.

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	1										3	1	
CO2	3	2		1									3		1
CO3	3											1	3		
CO4	3		1	2									3		2
CO5	3	1	2	1	1							1	3	2	1

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit I: Poetry

Nissim Ezekiel- Enterprise
Kamala Das - The Dance of Eunuchs
Toru Dutt - Our Casuarina Tree
Sri Aurobindo- The Tiger and the Deer

Unit II: Prose

B. K. Bhattacharya – The Golden Goddess (Assamese)
Himanshu Vohra - A Member of the Family (Gujarati)
Lalithambika Antharjanam- Daughter of Man (Malayalam)
P. Lankesh – Bread (Kannada)

Unit III: Play

Girish Karnad - Hayavadana

Unit IV: Grammar

a) Parts of Speech
b) Articles
c) Sentence: Kinds, Types
d) Tense
e) Reported Speech
f) Degrees of Comparison
g) Conditional Clause
h) Voice: Active & Passive
i) Concord

Unit V: Composition

a) Expansion of Proverb
b) Letters, Email
c) Reading Comprehension
d) Cloze Test
e) Precis Writing
f) Note-Making
g) Writing Dialogues
h) Notices, Agenda, Minutes

211TAM1301	TAMIL-I இக்கால இலக்கியம்	L	T	P	X	H	C
		3	0	0	3	6	4

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

அலகு 1

மரபுக் கவிதை

சஞ்சீவி பர்வதத்தின் சாரல் – பாரதிதாசன்

அலகு 2

புதுக்கவிதை

1. பாரதியார் – முரசு
2. கவிமணி – பெண்கள் உரிமைகள்
3. கண்ணதாசன் – ஒன்று எங்கள் ஜாதியே
4. வைரமுத்து – தேசப் பாடகனுக்குத் தெருப்பாடகனின் அஞ்சலி
5. சிற்பி – அப்துல் கலாமின் வீணை
6. கல்யாண்ஜி - கண்டும் காணாமல்
7. தமிழச்சி தங்கபாண்டியன் – புன்னகையின் வன்முறை
8. அ. வெண்ணிலா – அம்மாக் குழந்தை
9. சல்மா – விலகிப் போகும் வாழ்க்கை
10. சுகிர்தராணி – அம்மா
11. சக்தி ஜோதி – மீன்களை வரைபவள்
12. ஷக்தி – சந்தேகமேயில்லை

அலகு 3

சிறுகதை

1. கு.அழகிரிசாமி – ராஜா வந்திருக்கிறார்
2. ச. தமிழ்ச் செல்வன் – வெயிலோடு போய்
3. அம்பை – வாகனம்
4. ஜெயமோகன் – சோற்றுக் கணக்கு
5. புதுமைப்பித்தன் – காலனும் கிழவியும்
6. இரா. தமிழ்நேசன் – ஆதி மூதாதையரின் ஜீன்கள்
7. புதியமாதவி – ஒரு பெரியாரிஸ்டின் தீபாவளி
8. சோ. தர்மன் - சோகவனம்
9. எஸ்.ராமகிருஷ்ணன் – தனிமையின் வீட்டிற்கு ஆயிரம் ஜன்னல்கள்
10. வண்ணதாசன் – ஒரு சிறு இசை

அலகு 4

நாவல்

கீதாரி – சு.தமிழ்ச்செல்வி

அலகு 5

நாடகம்

ஔவை – இன்குலாப்

பாடநூல்கள்

1. சஞ்சீவி பர்வதத்தின் சாரல் – பாரதிதாசன் (உரையாசிரியர் முனைவர் கமலா முருகன்), சாரதா பதிப்பகம், சென்னை, 2012.
2. கீதாரி – சு. தமிழ்ச்செல்வி, நியு செஞ்சுரி புக் ஹவுஸ், சென்னை, 2008
3. ஔவை – இன்குலாப், அன்னம் அகரம் பதிப்பகம், தஞ்சாவூர்.

211BCA1301	DIGITAL SKILLS	L	T	P	X	H	C
		3	0	2	3	8	5

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Course Topics:

Unit I

Introduction to Computer - Basic Concepts - Basics of Operating System - Drive File Organization -File concepts and operations - File Directory - Working with command prompts- Internet- Concept of Internet - Applications of Internet - Connecting to the Internet, Troubleshooting-Internet Concept of Internet. Applications of Internet.Connecting to the Internet, Troubleshooting.

Unit II

Various applications of Internet - Dial up, ISDN and broadband- Introduction to Internet - addressing, Internet protocols - (TCP/IP, FTP and HTTP, IPV4, IPV6) - Instant messaging, - Use of Social Networking Sites. Word Processing Basics – I -Text Creation and manipulation, . Tables, pictures, Adjusting Page setting, Working with styles, Understand desktop publishing

Unit III

Google Apps – Drive - Docs and Sheet - Forms and Meet - Microsoft Excel – I - Understanding excel Interface - Typing and editing cell content - Calculating with formulas - Microsoft Excel – II - Formatting a worksheet -. Printing Worksheet - Creating Charts

Unit IV

Application of Digital Financial Services- Banking products - Payment Mode - Digital Signature- Basic Concepts of PowerPoint presentation -. Preparation of slides -. Digital Emotional Intelligence -Digital Empathy - Self-Awareness and Management - Relationship Management.

Unit V

Cyber Security - Basic concepts of threats, security policies- Security mechanisms- Data Security and protection concept - .Identifying a secure web site Https, lock symbol. Security Considerations - Digital Safety - Behavioral Cyber- Risk Management. -.Content Cyber. Risk Management. - Commercial and Community Cyber.Risk Manag

211ENG1306	COMMUNICATIVE ENGLISH	L	T	P	X	H	C
		3	0	2	3	8	5

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Objectives:

This course aims to impart better writing skills by sensitizing the learners to the dynamics of effective writing. To build up the learners confidence in oral and interpersonal communication by reinforcing the basics of pronunciation specially focusing on interviews / corporate meetings / international business travels.

Course Outcomes:

CO1: To improve and mould students interactive skills in different environments
CO2: To develop and improve students listening capacity
CO3: To enrich and understand students in speaking ability in different situations
CO4: To enhance students reading in through the text
CO5: To gain knowledge about written statements

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		1										3	1	
CO2	3			2									3	1	1
CO3	3	1										1	3		
CO4	3	1	1										3		1
CO5	3	2	2									1	3	1	1

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit – I Language in Professional context

Conversation - types of Conversation - steps involved in conversation - role of body language in conversation- face-to-face conversation - telephone conversation - telephone etiquette- telephone phrases- situational conversation - advantages and disadvantages - etiquettes of conversation.

Unit – II – Listening

Listening - types - techniques of effective listening – importance of active listening- barriers of listening - steps to effective listening - listening to the audio (including lyrics, telephone calls)- listening to the seminar (understanding the questions asked in seminar)- questioning skills & techniques- types of questions- question structure.

Unit – III – Speaking

Speaking - types - importance of speaking skill - fluency - self-introduction - on the spot topic - story telling - narrate any incident –story telling- Power Point Presentation- group discussion - debate.

Unit – IV – Reading

Reading - types - strategies of effective reading - skimming - scanning - reading the text - interpret the text - reading comprehension - cloze reading.

Unit – V – Writing

Writing - types - process of writing skill – general writing & professional writing- essay writing & paragraph writing- structure of an essay- blog writing- structure of blog writing- letter

writing – formal & informal writing-giving instructions.

Text Books

1. Cambridge English: BEC Preliminary with answers. Cambridge University Press, New Delhi 2016.
2. Aruna Koneru, Professional Communication, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

Reference Books

1. Dr. A. Vimala, *Career Preparation and Talent Management*, Oviya Publication, Coimbatore
2. V. Shasikumar and P V Dhanija, *Spoken English*. Pub. By: Tata Mcgraw Hill, New Delhi
3. Mohan ,Krishna &MeeraBannerji . *Developing Communication Skills*. Macmillan India Ltd., Chennai. 2001.
4. Raman, Meenakshi & Sharma, Sangeetha. *Technical Communication*. Oxford University Press, 2011.

211MAT1304	BASIC STATISTICS	L	T	P	X	H	C
		2	0	0	3	5	3

Pre-requisite: Nil **Course Category:** Foundation Core

Course Type: Theory Course

Objective:

The objective of this course is to provide an understanding for the graduate student on statistical concepts to include data, measurements of location and dispersion, probability, correlation and regression

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: understand the concept of data and presentation of data

CO2: analyse statistical data using measures of central tendency

CO3: know the concept of various measures of dispersions

CO4: understand the basic concept of probability

CO5: calculate and interpret the correlation and regression between two variables

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1											3	1	
CO2	3	2	1	2									3		2
CO3	3	1	1										3	2	
CO4	3	1	2										3		1
CO5	3	2											3	2	

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit I: Introduction to Statistics **15 Hours**

Definition of Statistics – Scope and Limitations of Statistics – Statistical investigation – Stages in conducting survey – Primary data vs Secondary data – Classification, Tabulation and presentation of data diagram (Simple problems on the above topics)

Unit II: Measures of Central Tendencies **15 Hours**

Measures of Central tendency definition; Types of averages, median, mode, Arithmetic mean, Geometric mean, Harmonic mean, Quadratic mean, Relation between mean, median and mode(Simple problems on the above topics)

Unit III: Measures of Dispersion **15 Hours**

Definition and properties of dispersion – Absolute vs relative measure of dispersion – Skewness, Kurtosis, Range, Quartile deviation, Mean deviation and Standard deviation (Simple problems on the above topics)

Unit IV: Introduction to Probability **15 Hours**

Definitions of Probability – Axioms on probability – Conditional probability (Simple problems on the above topics)

Unit V: Correlation and Regression **15 Hours**

Introduction – Types of correlation – Coefficient of Correlation – Rank Correlation – Regression – Principles of least square techniques – Fitting a straight line – Fitting a second-degree parabola (Simple problems on the above topics)

Text Books:

1. Arumugam and Issac, *Statistics*, New Gamma Publishers, July 2013.
2. A.M. Goon. M.K.Gupta and B.Dasgupta – Fundamentals of Statistics. Vol. I & II.

Reference Books:

1. S.C Gupta- Fundamental of statistics- Himalaya publishing house- 2014.

211CHY1101	Environmental Studies	L	T	P	X	Hr	C
		4	0	0	0	3	3
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Foundation Course		**Course Type: Theory**					

Course Outcome

On completion of the course, the students will be able to

CO1: Know the importance of environmental studies and methods of conservation of natural resources

CO2: Describe the structure and function of an ecosystem and explain the values and conservation of bio-diversity

CO3: Explain the sources, environmental effects and control measures of various types of pollutions

CO4: Select the appropriate methods for waste management

CO5: Recall social issues and legal provision and describe the necessities for environmental act

Unit-1: Natural resources **9 hours**

Environmental Science: Definition, scope, importance and need for public awareness – Natural resources: forest resources, water resources, land resources, mineral resources, food resources and energy resources – Alternate renewable energy resources: Anaerobic digestion, Bio-gas production – Role of alternate renewable energy resources in environmental impact – Role of an individual in conservation of natural resources.

Unit-2: Ecosystem and biodiversity **9 hours**

Ecosystem: Concept of ecosystem and ecology, types of ecosystem, structure of ecosystem (biotic and abiotic components) – Function of an ecosystem: Energy and nutrient flow, biogeochemical cycle (C, N, S and O cycle), food chains, food webs and ecological pyramids.

Biodiversity: Definition, values of biodiversity – Hot spots of biodiversity – Threats to biodiversity – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-3: Environmental pollution **9 hours**

Sources, consequences and control measures of air pollution, water pollution, soil pollution, thermal pollution and nuclear pollution – Environmental threats: Photochemical smog, London smog, acid rain, climate change, global warming (Greenhouse effect) and ozone layer depletion. – Pollution by trace elements (Hg, As, F, Pb and Cd): Biochemical effects, toxicology, toxicity, control and treatment – Fireworks: current environmental issues.

Unit-4: Management of environmental pollution **9 hours**

Causes, effects, treatments methods and control measures of solid waste, municipal waste, biomedical waste, E-waste – Removal of heavy metals by adsorption methods: Zeolite process, Ion-Exchange process, ultrafiltration and reverse osmosis – Waste minimization techniques – Cleaner technology -- Disaster management: floods, earthquake, cyclone, landslides and Tsunami.

Unit-5: Social issues and the environment **9 hours**

Water conservation, rain water harvesting- Environmental impact assessment- Precautionary and polluters pay principle- environment protection act - air (prevention and control of pollution) act - water (prevention and control of pollution) act - Population explosion - Family Welfare Programmes - Environment and human health - Human Rights - Women and Child Welfare. Green Campus: Definition, need for green campus, room for

improvement (waste water recycling and solar powered appliances).

Reference books:

1. E.R. Nagarajan and A. Murugan, Environmental Science, Wiley Publishers, New Delhi, 2017
2. S.K. Dhameja, Environmental Engineering and Management, S.K. Kataria and Sons, New Delhi, 2015.
3. A. Kaushik and C.P. Kaushik, Environmental Science & Engineering, New Age international Publishers, New Delhi, 2010.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., 2nd edition, 2004.
5. Erach Bharucha, Textbook for Environmental Studies, UGC, New Delhi, 2004.

211ENG1304	HUMAN VALUES	L	T	P	X	H	C
		2	0	0	3	5	3
Pre-requisite:		**Course Category:** Foundation Core **Course Type**: Theory Course					

Objectives:

- To know about universal human values and understand the importance of values in individual, social circles, career path, and national life.
- To learn from case studies of lives of great and successful people who followed and practised human values and achieved self-actualization.
- To become conscious practitioners of human values.
- To realise their potential as human beings and conduct themselves properly in the ways of the world.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Know about universal human values and understand the importance of values in individual, social circles, career path, and national life.

CO2: Learn from case studies of lives of great and successful people who followed and practised human values and achieved self-actualisation.

CO3: Become conscious practitioners of human values.

CO4: Realise their potential as human beings and conduct themselves properly in the ways of the world.

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1										3		3
CO2	3	1	1										3		
CO3	3	1											3	1	2
CO4	3	3											3	2	1
CO5	3	2	1										3	3	

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

Unit I

Values – Meaning and Definition – Types **–** Importance – Love & Compassion **:** Introduction – Meaning – Forms of Love – Love for self, Parents, Family, Friends, Spouse, Community, Nation, Humanity and other beings, both Living and Non living – Interrelation between Love & Compassion – Empathy – Sympathy – Non Violence – Practicing and non Practicing of Love and Compassion.

Unit II

Truth – Introduction – Meaning – Accuracy – Curiosity – discrement – Fairness – Fearlessness –honesty – honesty – integrity (unity of thought, word and deed) – Intution – Justice – Optimisim – Purity – Quest for knowledge – Reason - Self analysis – Sincerity – sprit of Enquiry – Synthesis – Trust – Truthfulness and determination – Practicing and Non Practicing of Truth.

Unit III

Non Violence – Introduction – Meaning – Need of Non Violence – Prerequisites for Non Violence – Ahimsa (Non Violence and Non- killing) – Values related to Non Violenck (Pshychological

and Social) – Practicing and Non Practicing of Non Violence

Unit IV

Righteouseness – Introduction – Meaning – Righteouseness and dharma – Righteouseness and propriety – Values related to Righteouseness – Values related to Right Conduct or Righteouseness (Self help skills, Social skills and Ethical skills) – Practicing and Non Practicing of Righteouseness

Unit V

Peace and Services – Introduction – Meaning - Need of Peace – Peace vs harmony and balance – Attention – Calmness – Equality – Equanimity – Faithfulness – Focus – Gratitude – Happiness - humanity – Inner Silence – optimism – Patience – Selfconfidence – Self Control – Self discipline – Self Esteem – Self respect – Self Control – tolerence and Understanding – Practicing and Non Practicing of Peace

Services – Introduction and Meaning – Forms of Services – Service for Self, Parents, Family, Friend, Spouse, Community, Nation, Humanity and other beings—Living and Non-living, Persons in Distress or Disaster – Practicing and Non Practicing of Services.

Renunciation - Introduction – Meaning – Renunciation and sacrifice – Self restrain and ways of overcoming greed – Practicing and Non Practicing of Renunciation

Reference Books:

1. Joshi Rokeach (1973). The Nature of Human Values. New York: The Free Press
2. R S Nagarazan (2006) A text book of professional ethics and Human values, New age international publishers

PROGRAM CORE COURSES

212CHY2301	Inorganic Chemistry – I	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type:** Integrated Course (IC)						

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the basics of atomic structure and quantum mechanics

CO2: Analyze the physical and chemical properties of s-block elements

CO3: Explain the concepts behind the bond formation and identify the types of bonds

CO4: Summarize the reasons behind the structure and shapes of a molecule

CO5: Discuss the role of non-aqueous solvents in reactions and deciding the acidity and basicity

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-I: Atomic structure and basic quantum mechanics **12 hours**

Rutherford's and Bohr's model an atom- Bohr's theory and origin of hydrogen spectrum. Sommerfield's extension of Bohr's theory. Electromagnetic radiation- definitions for λ, υ and velocity. Dualism of light - Particle nature of radiation- black body radiation and Planck's quantum theory, photoelectric effect and Compton effect of matter. De Broglie hypothesis and Davisson and Germer experiment. Heisenberg's uncertainty principle. Schrodinger wave equation (Derivation - Time independent wave equation). Physical significance of $\Psi_1$and Ψ_2. Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.

Unit-II *s*-block elements **12 hours**

General characteristics of group I elements: Atomic and ionic radii, ionization enthalpy, electropositive character, formation of univalent positive ions, hydration of ions, reducing properties, Electrode potentials, characteristic flame coloration, lattice enthalpy, general physical and chemical properties, uses of alkali metals.

General characteristics of group II elements: Atomic and ionic radii, ionization enthalpy, reducing properties, electrode potentials, characteristic flame coloration, chemical properties, gradation in properties. Uses of alkaline earth metals.

Hydrogen: Position of hydrogen in the periodic table, Atomic, chemical and physical properties of hydrogen; Preparation of hydrogen. Nascent, atomic and active hydrogen- Ortho and para hydrogen Uses of hydrogen. Deuterium and tritium (preparation alone sufficient).

Unit-III: Chemical bonding – I **12 hours**

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

Covalent bond: Valence Bond theory (*Heitler-London* approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules such as O_2, N_2, CO, NO, HCl (idea of s-p mixing and orbital interaction to be given).

Unit-IV: Chemical bonding - II **12 hours**

VSEPR Theory: Lewis structure, Valence shell electron pair repulsion theory (VSEPR), shapes of the simple molecules and ions containing lone pairs and bond pairs of electrons.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). Effect of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process.

Unit-V: Acids, bases and non-aqueous solvents **12 hours**

Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Lowery-Bronsted and Lewis concepts of acids and bases-introduction to HSAB principle. General properties - classification- self ionization and levelling effect- reaction in non-aqueous solvents - protic and aprotic non aqueous solvents- examples- solutions of metals in liquid ammonia- self ionization of liquid ammonia- liquid SO_2, liquid HF, alkali metals in liquid ammonia.

Laboratory component: **60 hours**

To find out the cations and anions present in the simple salt and mixture of salts provided

1. Simple salt analysis (Salt - 1)
2. Simple salt analysis (Salt - 2)
3. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
4. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
5. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
6. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
7. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
8. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
9. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**

10. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
11. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**
12. Mixture of salts – 1 (Combination of 2 cations & 2 anions**)**

Cations and anions will be analyzed from the mixture of salts containing common cations and interfering anions.

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. R.D. Madan, "Modern Inorganic Chemistry", 2nd edition, S. Chand & Company Ltd., 2019.
2. P.L. Soni, "Text book of Inorganic Chemistry", 20th revised edition, Sultan Chand & Sons, 2013.
3. B.R. Puri, L.R. Sharma and K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, Shoban Lal Nagin Chand & Co., 2020.
4. D.F Shriver, P.W Atkins and C. H. Langford, Inorganic Chemistry, 5th edition, Oxford University Press, London, 2020.
5. B. Douglas, D. McDaniel and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd edition., John Wiley, 2015.
6. Svehla and Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson, 7th edition, 2012.

212CHY2305	Inorganic Chemistry – II	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type:** Integrated Course (IC)						

Course Outcome

On completion of the course, the students will be able to

CO1: Analyze the physical and chemical properties of p-block elements

CO2: Explain the nature and uses of compounds formed by non-transition elements

CO3: Understand the nomenclature and boning in coordination compounds

CO4: Evaluate the mechanism of inorganic reactions and interpret the properties of f-block elements

CO5: Summarize the properties of second and third row transition elements

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			L		L			S
CO2	S	M	S	M		M				M	M	
CO3	S	S	S	M		L		L		L		S
CO4	S	M	M	S		M		L		M		S
CO5	S	S	S	M	M	S		M		L		M

Unit-I: Chemistry of p-block elements **12 hours**

General characteristics of p-block elements (Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electro negativity, Catenation). Comparative study of elements of III A & their compounds. Compounds of boron – borazine, diborane boric acid. Allotropy of Carbon; inert pair effect, diagonal relationship between B and Si Compounds of nitrogen and phosphorous – NH_3, $NH_2.NH_2$, N_3H, N_2O_5, NO_2 H_3PO_4, HPO_3 $POCl_3$, PCl_3, PCl_5. Chemistry of oxides of carbon (CO, CO_2).

Unit-II: Compounds of non-transition elements **12 hours**

Classification of oxides – acidic, amphoteric, neutral oxides, peroxides and superoxides. Interhalogen compounds, Pseudohalogens, Oxyacids of halogens, Polyhalides and basic nature of iodine. Manufacture and uses of the following Glass – different types of glasses, Silicates, Zeolites and Silicones.

Unit-III: Coordination chemistry – I **12 hours**

IUPAC nomenclature of coordination compounds. A brief idea about chelate effect, labile and inert complexes. Valence bond theory and its application to complexes of coordination numbers 4 and 6. Examples of inner and outer orbital complexes. Crystal field theory, measurement of Δo. Calculation of CFSE in weak and strong fields, concept of pairing energies, factors affecting the magnitude of Δo. Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry.

Unit-IV: Reaction mechanism and lanthanoids and actinoids **12 hours**

Inorganic reaction mechanism: Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Substitution reactions in octahedral and square planar complexes, Trans- effect, theories of trans-effect. Thermodynamic and Kinetic

stability (using VBT).

Lanthanoids and actinoids: A brief discussion of electronic configuration, oxidation states, color, spectral and magnetic properties. Lanthanoid contraction (causes and effects) separation of lanthanoids by ion exchange method.

Unit-V: Elements of second and third transition series **12 hours**

A brief study on the extraction of the following elements: Zirconium, rhodium, ruthenium, palladium, silver, osmium, platinum, gold and mercury – Study of compounds of following elements: Zirconium, molybdenum, rhodium, ruthenium, palladium, tungsten, platinum, gold and mercury.

Laboratory component: **60 hours**

1. Acid-Base Titration – Strong acid vs strong base
2. Acid-Base Titration – Strong acid vs weak base
3. Acid-Base Titration – Strong base vs mixture of strong and weak acids
4. Acid-Base Titration – Strong acid vs mixture of strong and weak bases
5. Argentometry Titration – Estimation of halide ion by Mohr's method
6. Argentometry Titration - Estimation of halide ion by Volhard's method
7. Redox Titration – Estimation of oxalic acid
8. Redox Titration – Estimation of ferrous ion
9. Complexometric Titration – Estimation of calcium ion using EDTA
10. Complexometric Titration – Estimation of magnesium ion using EDTA
11. Complexometric Titration – Estimation of copper ion using EDTA
12. Complexometric Titration – Estimation of zinc ion using EDTA

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. B.R. Puri, L.R. Sharma and K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, Shoban Lal Nagin Chand & Co., 2020.
2. R.D. Madan, Modern Inorganic Chemistry, 2nd edition, S. Chand & Company Ltd., 2019.
3. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Sultan Chand & Sons, 2016.
4. H.J. Arnikar, Essentials of Nuclear Chemistry, New Age International Publishers, 2011.
5. J. E. Huheey, E. A. Keiter, and R. L. Keiter, Inorganic Chemistry, 4th Edition., Harper and Row, New York, 2006.
6. Svehla and Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson, 7th edition 2012.
7. Gurdeep Raj, Advanced Practical Inorganic Chemistry, GOEL Publishing House Krishna Prakashan Media (P) Ltd, 1st edition, 2013.

212CHY3309	Inorganic Chemistry – III	L	T	P	X	Hr	C
		3	0	3	0	6	4.5
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Analyze the periodicity of properties in s and p block elements

CO2: Understand the redox behavior of metals and their use in metallurgy

CO3: Illustrate the chemistry of noble gases and their compounds; application of VSEPR theory in explaining structure and bonding

CO4: Understand the major aspects of photochemical reactions

CO5: Understand the transition metals stability in reactions, origin of color and magnetic properties

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	M	S			L		L			S
CO2	S	M	S	M		M				M	M	
CO3	S	S	M	M		L		L		L		M
CO4	S	M	M	S		M		L		M		S
CO5	S	S	S	M	M	S		M		L		M

Unit-I: Periodicity of elements **9 hours**

The long form of periodic table: s, p, d, f block elements - Detailed discussion of the following properties of the elements (s and p block): Effective nuclear charge, shielding or screening effect, Slater Rules, variation of effective nuclear charge in periodic table. Trends in Atomic radii, Ionic and crystal radii, Covalent radii. Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Trends of electron gain enthalpy. Electronegativity: Pauling, Mullikan, Allred Rachow scales

Unit-II: Oxidation-Reduction and general principle of metallurgy **9 hours**

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zone refining.

Extraction of Ti from rutile and ilmenite. Extraction of V and U from carnotite. Extraction of Cr from chromite ore. Extraction of Mo from molybdenite and W from wolframite. Manufacture of cast iron and wrought iron.

Unit-III: Noble gases **9 hours**

Occurrence and uses – Isolation of gases from atmosphere: Fractionation of liquid air – Compounds of noble gases: Hydrates and clathrates. Preparation, properties, structure and shape of fluorides, oxofluorides and oxides of Xe. MO treatment and VSEPR concepts. Fluorides of krypton.

Unit-IV: Inorganic photochemistry **9 hours**

Laws of photochemistry – Colorimetric analysis, Quantum Yield or Efficiency: Reactions showing high, low and extremely high quantum yield (examples). General mechanism of reactions showing high quantum yield and low quantum yield. Photochemical equilibrium –Photosynthesis of HCl and HBr. Molecular excitation: Radiative and non-radiative transition. Fluorescence and phosphorescence. Chemiluminescence and thermoluminescence. Photosensitization in photography and photosynthesis.

Unit-V: Coordination chemistry – II **9 hours**

Stability of coordination complexes: Stability constants and factors affecting the same – Irving William series – Isomerism in Coordination compounds: Structural isomerism, hydrate isomerism, coordination isomerism, linkage isomerism, coordination position isomerism. Stereochemistry of complexes with the coordination number 4 and 6. Magnetic properties of transition metal complexes: VB approach and CFT approach. Determination of magnetic susceptibility: Guoy's method.

Laboratory component: **45 hours**

1. Analysis of ore – I
2. Analysis of ore – II
3. Determination of magnetic susceptibility of coordination complex – I
4. Determination of magnetic susceptibility of coordination complex – II
5. Preparation of coordination compound – I
6. Preparation of coordination compound – II
7. Gravimetric estimation of metal cations – I
8. Gravimetric estimation of metal cations – II
9. Determination λ_{max} of coordination complex – I
10. Determination λ_{max} of coordination complex – II
11. Colorimetric analysis of metal photochemically active metal cations – I
12. Colorimetric analysis of metal photochemically active metal cations – II

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. B.R. Puri, L.R. Sharma and K.K. Kalia, Principles of Inorganic Chemistry, 23rd edition, New Delhi, Shoban Lal Nagin Chand & Co., 2020.
2. R.D. Madan, Modern Inorganic Chemistry, 2nd edition, S. Chand & Company Ltd., 2019.
3. J.D. Lee, Concise Inorganic Chemistry, 5th edition, Sultan Chand & Sons, 2016.
4. Gurdeep Raj, Essentials of Nuclear Chemistry, H.J. Arnikar, New Age International Publishers, 2011.
5. B. Douglas, D. McDaniel, and J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd edition, John Wiley, 2015.
6. Svehla and Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson, 7th edition 2012.
7. Amita Dua, Navneet Manav, Practical Inorganic Chemistry, Manakin Press, 1st edition, 2017.
8.

212CHY2302	Organic Chemistry – I	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the basics of organic molecules, structure, bonding, reactivity and reaction mechanisms

CO2: Analyze the stereochemistry of organic molecules – Configuration, and nomenclature

CO3: Explain the structure, conformation and reactivity of alkanes and alkenes

CO4: Illustrate the structure and reactivity of alkynes and dienes

CO5: Explain the structure, aromaticity and reactivity of selected aromatic hydrocarbons

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			L		L			S
CO2	S	M	S	M		M				M	L	
CO3	S	S	M	S		L		L		L		L
CO4	M	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		L		M

Unit-1: Fundamentals of organic chemistry **12 hours**

Classification of organic compounds: Based on functional group and structure – Electronic displacements: Concept of inductive effect, mesomeric effect (resonance), electromeric (field) effect, hyperconjugation and their application. Comparison between inductive, resonance and hyperconjugation effect.

Organic reactions and mechanism: Electron movement in organic reactions, Usage of curly arrows – Energy requirements of organic reactions: Exothermic and endothermic reactions, activation energy, transition state and reactive intermediate. Types of reagents: Electrophile and Nucleophile. Nucleophilicity versus basicity. Order of nucleophilicity – Reactive intermediates: Shapes and stabilities of carbocations, carbanions, free radicals and carbenes.

Unit-2: Stereochemistry **12 hours**

Isomerism: Structural and stereoisomerism with examples - Optical isomerism: Concept of chirality, specific rotation, and optical activity, enantiomers, diastereoisomers, meso-compounds and racemic mixtures – Representation of organic molecules in 3D: Flying wedge, Fischer, Newman and Sawhorse projection formulae and their inter-conversions – Configurational notations of optical isomers: D/L notation and its limitations, Erythro and Thereo notation, R/S notation.

Geometrical isomerism: Alkenes, dienes and C = N containing compounds – Configurational notations of geometrical isomers: cis–trans, syn-anti and E/Z notations – Characterization of geometrical isomers by physical and spectroscopic methods - CIP sequence rule: Application of CIP rule for writing R/S notation for optical isomers and E/Z notation of geometrical isomers.

Unit-3: Aliphatic hydrocarbons: Alkanes, cycloalkanes and alkenes **12 hours**

Preparation of alkanes: Sabatier and Senderens reaction, Wurtz reaction, Fittig reaction, Wurtz Fittig reaction, Corey-house alkane synthesis and Kolbe's electrolytic method (mechanism and its limitations) – Reactions: Halogenation, nitration, aromatization, isomerization, pyrolysis, combustion and sulphonation.

Cycloalkanes: Preparation of cycloalkanes – Reactions of cycloalkane: Substitution and ring opening reactions. Conformational analysis: Energy diagrams of ethane, propane, butane and cyclohexane. Stability of cycloalkanes: Baeyer Strain Theory, Sache-Mohr theory and Molecular orbital theory.

Preparation of alkenes: From alkynes (Lindlar's catalyst and Birch reduction), alcohols, alkylhalides, alkanes and vicinal di-halides – Reactions of alkenes: Markownikoff and Anti Markownikoff addition. Addition of carbenes – Mechanistic study of following reactions: Hydroboration, syn and anti-hydroxylation – Allylic substitution: Bromination using NBS and thermal radical substitution (with mechanism).

Unit-4: Aliphatic hydrocarbons: Alkynes and dienes **12 hours**

Preparation of dienes: 1,3-Butadiene from ethyne, 1-butene, 1,4-butanediol and n-butane. Stability of conjugated dienes – Reactions of dienes: Energy diagram of 1,2 and 1,4 addition. 1,2 and 1,4 addition of HX, X_2, H_2O, and H_2 of 1,3-butadiene – Polymerisation of 1,3-butadiene to BUNA rubber.

Preparation of alkynes: From vicinal dihalides and tetrahalides, using sodium acetylides and hydrolysis of CaC_2 – Reactions of Alkynes: Addition reactions, catalytic hydrogenation, chemical reduction (Na/NH_3), addition of HX, HOX, HCN, hydration using mercuric ion, hydroboration (oxidation), formation of acetylides, ozonolysis and polymerization. Reactions of acetylene: Oxidation using alkaline $KMnO_4$, dimerization and neoprene formation.

Unit-5: Aromatic hydrocarbons **12 hours**

Structure elucidation of benzene: Evidence for cyclic structure, Kekule's structure, Molecular orbital structure of benzene and Resonance energy of benzene – Aromaticity: Requirements for aromaticity. Huckel's rule and its application in determining aromatic character of benzene and its homologues, annulenes, heterocyclic compounds and charged species (cyclic carbocations and carbanions) – Reactions of aromatic hydrocarbons (case benzene): Halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism

Laboratory component: **60 hours**

1. Qualitative analysis of given organic compound-I
2. Qualitative analysis of given organic compound-II
3. Qualitative analysis of given organic compound-III
4. Qualitative analysis of given organic compound-IV
5. Qualitative analysis of given organic compound-V
6. Qualitative analysis of given organic compound-VI
7. Qualitative analysis of given organic compound-VII
8. Qualitative analysis of given organic compound-VIII
9. Qualitative analysis of given organic compound-IX
10. Identification of organic compound by mixed melting point method
11. Separation of organic compounds by paper chromatography/TLC
12. Estimation of unsaturation in given organic compound

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. Paula Yurkanis Bruice, Organic Chemistry, 8th edition, Pearson Education, 2013.
2. Morrison Boyd and Bhattacharjee, Organic Chemistry, 7th edition, Pearson Education, 2010.
3. W Carruthers and Iain Coldham, Modern Methods of Organic Synthesis, 4th edition (South Asia Edition), Cambridge University Press, 2015.
4. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.
5. Francis A.Carey, Organic Chemistry, 8th edition, McGraw Hill Education, 2017.
6. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry: Part A: Structure and Mechanisms, 5th edition, Springer, 2008.
7. V. K. Ahluwalia and Renu Agarwal, Comprehensive Practical Organic Chemistry: Preparation and quantitative analysis, 1st edition, Universities Press, 2004.
8. Mann and Saunders, Practical Organic Chemistry, 4th edition, Pearson Education, 2009.
9. B.S. Furnis, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell,Vogel's Textbook of Practical Organic Chemistry, 5th edition, Pearson Education, 2003.

212CHY2307	Organic Chemistry – II	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the preparation of alkyl and aryl halides and their important chemical reactions

CO2: Explain the preparation, reactions of alcohols and phenols

CO3: Illustrate the synthetic importance of carbonyl compounds

CO4: Analyze the reactions of carboxylic acids and their derivatives

CO5: Discuss the synthesis of ethers, epoxides, thioethers and their importance

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			L		L			S
CO2	S	M	S	M		M				M	L	
CO3	S	S	M	S		L		L		L		L
CO4	M	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		L		M

Unit-1: Halogenated hydrocarbons **12 hours**

Alkyl halides: Nomenclature and preparation of alkyl halides from alkanes, alkenes, alcohols (HX, $SOCl_2$, PX_3 and PX_5), and halogen exchange reactions – Reactions of alkyl halides: Nucleophilic substitution with aqueous KOH, moist Ag_2O, alcoholic ammonia, alcoholic NaCN/KCN, AgCN, acetylides, KSH, K_2S, $NaNO_2$ and $AgNO_2$ – Nucleophilic substitution reactions: Mechanism, stereochemistry, energy profile diagram and factors affecting the S_N1 and S_N2 reactions – Mechanism and stereochemistry S_Ni reactions.

Preparation of aryl halides: Direct halogenation of benzene – Reactions of aryl halides: Low reactivity of aryl halides in nucleophilic substitution reactions. S_NAr mechanism and its energy profile diagram – Reactivity of benzyl, allyl, alkyl, vinyl and aryl halides in nucleophilic substitution reactions – Benzyne mechanism and evidence for the formation of benzyne intermediate.

Unit-2: Alcohols and phenols **12 hours**

Alcohols preparation: Using alkyl halides, alkenes, aldehydes, carboxylic acids, acid chlorides, esters and epoxides – Reactions of alcohols: Dehydration of alcohols using acids (including E1 and E2, Zaitsev elimination and 1,2 shifts), $POCl_3$ and pyridine along with mechanism, reduction of alcohols with HI and Bouvelt-Blanc reduction – Inter-conversion of alcohols: Primary to secondary alcohols, secondary to tertiary alcohols, primary to tertiary alcohols, higher to lower alcohols and lower to higher alcohols.

Preparation of glycols: Preparation of ethylene glycol by hydroxylation of ethylene, hydrolysis of ethylene oxide, ethylene dibromide and ethylene chlorohydrin – Reactions of ethylene glycol:

Formation of terylene, formation of acetals and ketals, oxidation with nitric acid, periodic acid and lead tetraacetate. Pinacol-Pinacolone rearrangement.

Preparation of phenols: Dow process, cumene process (with mechanism), hydrolysis of benzene sulfonate. Reactions of phenols: Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions.

Unit-3: Carbonyl compounds **12 hours**

Structure of carbonyl group – Preparation of aldehydes and ketones: Oxidation of alcohols, ozololysis, using 1,3-dithiane and alkyl halide – Reactions of aldehydes and ketones: Nucleophilic addition of water, alcohol, HCN and sodium bisulphite molecules with aldehydes and ketones. Reaction of aldehydes and ketones with ammonia, hydroxyl amine, hydrazine, semicarbazide and 2,4-DNP with mechanism.

Mechanisms of Aldol and Benzoin condensation, Claisen-Schmidt condensation, Knoevenagel condensation, Perkin, Cannizzaro and haloform reaction, Baeyer Villiger oxidation, Clemmensen, and Wolff-Kishner reduction

Unit-4: Carboxylic acids and acid chlorides **12 hours**

Preparation of monocarboxylic acids: Oxidation of primary alcohols or aldehydes, oxidation of alkenes, hydrolysis of nitriles or esters, Koch reaction – Reactions of carboxylic acids: Reduction with $LiAlH_4$, and borane, HVZ reaction – Typical reactions of diacids: Formation of succinamide from succinic acid, electrolysis of potassium salt of succinic acid – Typical reactions of unsaturated carboxylic acids: Synthesis of malic acid and meso-tartaric acid from maleic acid – Typical reactions of hydroxy acids: Pyruvic acid from lactic acid and synthesis of maleic and fumaric acid from malic acid.

Preparation of acid chlorides: By the action of $SOCl_2$ or PCl_3 on carboxylic acids. Reactions of acid chlorides: Reaction with water, alcohol, ammonia, organocuprates, primary amine and secondary amine, reduction with metal hydrides and Friedel-Craft reaction.

Unit-5: Ethers, epoxides and sulphur containing compounds **12 hours**

Preparation of ethers: By dehydration of alcohols, Williamson ether synthesis (both aliphatic and aromatic), action of dimethyl sulfate on alcohols/phenols, alkoxymercuration-demercuration of alkenes, heating silver oxide with alkyl halides – Reactions of ethers: Halogenation at α-carbon, hydrolysis, reaction with PCl_5, cleavage by HX (with mechanism) and electrophilic substitution reactions of aromatic ethers – Zeisel's method of estimation of ethoxy groups. Claisen rearrangement with mechanism

Preparation of epoxides: From vicinal halohydrins and epoxidation of alkenes – Reactions of epoxides: Ring opening in acid and base conditions (with mechanism).

Preparation of thiols: Heating alkyl halides with sodium hydrosulfide, using Grignard reagents, from alcohols and alkenes – Reactions of thiols: Reaction with aldehydes, ketones, acids and acid chlorides, oxidation of thiols using H_2O_2, I_2 and $KMnO_4$.

Preparation of thioethers: Reaction between alkyl halides and K_2S or mercaptide, conversion of ether to thioether using P_2S_5, conversion of thiols to thio ethers by thermal and catalytic method – Reactions of thio ethers: Reaction with alkyl halides, halogens, hydrolysis and oxidation – Preparation of

mustard gas.

Laboratory component: **60 hours**

1. Recrystallization of benzoic acid from hot water and determine the melting point
2. Preparation of aspirin
3. Preparation of β-naphthyl benzoate
4. Preparation of phenyl benzoate
5. Preparation of p-bromo acetanilide
6. Preparation of p-nitroacetanilide
7. Preparation of benzoic acid by hydrolysis method
8. Preparation of S-Benzylisothiouronium salt of benzoic acid
9. Preparation of hydrazone or semicarbazone derivative
10. Estimation of phenol
11. Estimation of aniline
12. Estimation of formaldehyde
13. Estimation of acetone

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. Paula Yurkanis Bruice, Organic Chemistry, 8th edition, Pearson Education, 2013.
2. Morrison Boyd and Bhattacharjee, Organic Chemistry, 7th edition, Pearson Education, 2010.
3. W Carruthers and Iain Coldham, Modern Methods of Organic Synthesis, 4th edition (South Asia Edition), Cambridge University Press, 2015.
4. Jonathan Clayden, Nick Greeves and Stuart Warren, Organic Chemistry: 2nd Edition, Oxford University Press, 2014.
5. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.
6. Francis A.Carey, Organic Chemistry, 8th edition, McGraw Hill Education, 2017.
7. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry: Part A: Structure and Mechanisms, 5th edition, Springer, 2008.
8. V. K. Ahluwalia and Renu Agarwal, Comprehensive Practical Organic Chemistry: Preparation and quantitative analysis, 1st edition, Universities Press, 2004.
9. Mann and Saunders, Practical Organic Chemistry, 4th edition, Pearson Education, 2009.
10. B.S. Furnis, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell,Vogel's Textbook of Practical Organic Chemistry, 5th edition, Pearson Education, 2003.

212CHY3310	Organic Chemistry – III	L	T	P	X	Hr	C
		3	0	3	0	6	4.5
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the preparation and important chemical reactions of esters and amides

CO2: Explain the preparation, reactions of aliphatic and aromatic amines

CO3: Illustrate the preparation and synthetic importance of diazonium compounds and nitrile

CO4: Analyse the reactions of nitro and diazoalkanes

CO5: Discuss the synthesis of important colouring agents (dyes)

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			L		L			S
CO2	S	M	S	M		M				M	L	
CO3	S	S	M	S		L		L		L		L
CO4	M	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		L		M

Unit-1: Derivatives of carboxylic acids **9 hours**

Preparation of acid anhydrides: Condensation of carboxylic acid (or its salt) with acid chloride – Reactions of acid anhydride: Reaction with water, alcohol, ammonia and Friedel craft reaction.

Preparation of esters: Fischer esterification, reaction of alcohols with acid chlorides and acid anhydrides, trans-esterification and reaction of carboxylic acid with diazomethane – Reactions of esters: Reduction with metal hydrides, reaction with Grignard reagent, Dieckmann reaction and Fries rearrangement with mechanism.

Preparation of amides: By the action of ammonia on acid chlorides and acid anhydrides and by heating ammonium salts of carboxylic acids. Beckmann rearrangement – Reactions of amides: Hydrolysis, reaction with nitrous acids, reduction with $LiAlH_4$, dehydration with P_2O_5.

Unit-2: Organic nitrogen containing compounds: Amines **9 hours**

Nomenclature, structure and basicity of aliphatic and aromatic amines – Preparation of aliphatic and aromatic amines: By substitution, reduction and reductive amination methods – Mechanistic study of Hofmann's degradation of amides and Curtius rearrangement – Methods to separate mixture of amines – Reactions of aliphatic and aromatic amines: alkylation and acylation, oxidation, electrophilic aromatic substitution, diazotisation, Hinsberg test and carbylamine reaction.

Unit-3: Organic nitrogen containing compounds: Diazonium salts and nitrile **9 hours**

Arenediazonium salts: Preparation and structure of benzene diazonium chloride – Reactions of diazonium salts: Reactions involving displacement of N_2X group and retainment of N atom – Synthetic uses of arenediazonium salts.

Nitrile and isonitrile: Preparation and structure of aliphatic and aromatic nitrile. Reactions of nitrile and isonitrile: Hydrolysis, alcoholysis, reduction and alkylation, Thorpe nitrile condensation.

Unit-4: Organic nitrogen containing compounds: Nitro and diazo compounds **9 hours**

Nitro compounds: Nomenclature, structure and preparation aliphatic and aromatic nitro compounds – Reactions: Reduction, halogenation, hydrolysis and electrophilic aromatic substitution – Test for nitro groups: Azo-dye test and Barker-Mulliken test – Preparation of alkyl nitrites.

Diazo compounds: Preparation of diazo alkanes and azides – Reactions of diazoalkanes and azides.

Unit-5: Organic dyes **9 hours**

Colour and constitution: Witts and modern theory of colour – Dyes: Classification based on structural composition: Definition and examples for nitro, azo, diphenylmethane, triphenylmethane, xanthene, phthaleins, anthraquinone, indigoid and thioindigoid dyes – Classification based on method of application: Definition and examples for direct, mordant, vat, ingrain, disperse dyes and food colours.

Preparation and uses of dyes: Aniline yellow, methyl orange, butter yellow, chrysoidine, congo red, bimarck brown, malachite green, pararosaniline, rosaniline, crystal violet, rhodamine b, fluorescein, indigo and alizarin.

Laboratory component: **45 hours**

1. Preparation fluorescein
2. Preparation of eosin
3. Preparation of methyl orange
4. Preparation of diazoaminobenzene
5. Preparation of picric acid
6. Separation of carboxylic acids from other organic compounds by solvent switch method
7. Separation of nitro compounds from other organic compounds by solvent switch method
8. Separation of amines from other organic compounds by solvent switch method
9. Separation of nitro phenols from other organic compounds by solvent switch method
10. Separation of amino phenols from other organic compounds by solvent switch method
11. Separation of esters from other organic compounds by solvent switch method
12. Chromatographic separation of dyes in black/blue ink

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. Paula Yurkanis Bruice, Organic Chemistry, 8th edition, Pearson Education, 2013.
2. Morrison Boyd and Bhattacharjee, Organic Chemistry, 7th edition, Pearson Education, 2010.
3. W Carruthers and Iain Coldham, Modern Methods of Organic Synthesis, 4th edition (South Asia Edition), Cambridge University Press, 2015.
4. Jonathan Clayden, Nick Greeves and Stuart Warren, Organic Chemistry: 2nd Edition, Oxford University Press, 2014.
5. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.
6. Francis A.Carey, Organic Chemistry, 8th edition, McGraw Hill Education, 2017.
7. Francis A. Carey and Richard J. Sundberg, Advanced Organic Chemistry: Part A: Structure and Mechanisms, 5th edition, Springer, 2008.

8. V. K. Ahluwalia and Renu Agarwal, Comprehensive Practical Organic Chemistry: Preparation and quantitative analysis, 1st edition, Universities Press, 2004.
9. Mann and Saunders, Practical Organic Chemistry, 4th edition, Pearson Education, 2009.
10. Zeba N. Siddiqui, Practical Industrial Chemistry, 1st edition, Anmol publications, 2002.

212CHY2303	Physical Chemistry-I	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand kinetics of gases and collision properties

CO2: Study the properties of liquid state and electrolytes

CO3: Understand the theories of electrolytic conductance

CO4: Understand the fundamentals of quantum chemistry

CO5: Study the basics of thermodynamics and thermochemistry

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			M
CO2	S	M	S	M		M				M	M	
CO3	S	S	M	M		L		L		L		S
CO4	S	M	S	S		M		L		L		M
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Gaseous state **12 hours**

Kinetic molecular gas model - Postulates and kinetic equation for gases (derivation not required)- Assumptions made to describe an ideal gas. Maxwell – Boltzmann distribution of molecular velocities – its graphical representation and salient features – effect of temperature – most probable, mean and root mean square velocities and their calculation – experimental verification of the distribution law.

Collision properties: collision diameter, collision frequency, collision number, mean free path (λ). Viscosity of gases: relation between η and λ. Principle of equipartition of energy – Average translational kinetic energy per degree of freedom. Behavior of real gases: Deviation from ideal behaviour – compressibility factor as a function of P - van der Waals equation.

Unit-2: Liquid state and ionic equilibria **12 hours**

Liquid state - Structural differences among solids, liquids and gases. Structure and physical properties of liquids: vapour pressure, surface tension, viscosity, and their dependence on temperature. Liquid crystals – Smectic, nematic and cholesteric liquid crystals – Swarm theory – applications of liquid crystals.

Electrolytes: Strong, moderate and weak electrolytes - degree of ionization - factors affecting degree of ionization - ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect, solubility and solubility product. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions: Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry.

Unit-3: Electrolytic conductance **12 hours**

Electrolytes, conductance, conductivity, specific conductance, equivalent conductance, molar conductance. Electrical conductance, cell constant and electrolytic conductivity - kappa and its

determination. Molar conductivity (λ) and its variation with concentration of strong electrolytes and Kohlrausch's empirical relation. Weak electrolytes – Arrhenius theory – degree of dissociation and its relation to λ. Kohlrausch law of independent migration of ions and Ostwald's dilution law and their applications – experimental verification of Ostwald's law. Drawbacks of Arrhenius theory.

Contribution of individual ions to λ^0 – transport number (t) and ionic mobility (u) – relation between them – determination of 't' by Hittorf method and by moving boundary method – Applications of t and u. Conductometric titrations - Applications of conductivity measurements.

Unit-4: Introduction to quantum chemistry **12 hours**

Inadequacy of classical mechanics - Blackbody radiation – Planck's equation - Photoelectric effect – Einstein mass-energy relation - The foundations of Quantum nature of electrons – Prince de Broglie concept and wavelength - Heisenberg uncertainty principle in different forms - Development of Schrodinger wave mechanics by analogy with wave theory of electromagnetic radiation – equation for a wave travelling in one direction – Eigen functions and Eigen values – Orthonormal wave functions - Quantum Mechanical postulates – linear operators, commuting operators, Hermitian operators.

Unit-5: Introduction to thermodynamics and thermochemistry **12 hours**

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.

Laboratory Component **60 hours**

1. Determination of surface tension using Stalagmometer
2. Determination of viscosity using viscometer
3. Study the variation of viscosity coefficient with concentration
4. Preparation of Buffer solution and measuring the pH of the solution
5. Conductometric titrations: Strong acid Vs strong base
6. Conductometric titrations: Weak acid Vs strong base
7. Conductometric titrations: Mixture of strong and weak acid Vs strong base
8. Determination cell constant of a conductivity cell
9. Determination of heat of solution-Oxalic acid in water
10. Determination of heat of solution-Ammonium oxalate in water
11. Determination of heat of solution- Potassium nitrate in water
12. Demonstration: Construction of interference pattern

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. G.W. Castellan, Physical Chemistry, 4th edition, Narosa, 2004.

2. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing House, 2020.
3. Ball, D. W., Physical Chemistry, Thomson Press, India 2007.
4. Barrow G. M., Physical Chemistry, 5th edition, McGraw Hill Education (India) Private Limited 2007.
5. V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu, Basic Principles of Practical Chemistry, 2nd edition, Sultan Chand & Sons, New Delhi, 2004.
6. Arthur M. Halpern, Experimental Physical Chemistry: A Laboratory Textbook, Prentice Hall, 1997.
7. Amita Dua and Navneet Manav, Practical Chemistry for Undergraduates, Ane Books Pvt. Ltd., 2014.
8. Shailendra K. Sinha, Physical Chemistry-A Laboratory Manual, Narosa publishing house, 2014.

212CHY2308	Physical Chemistry-II	L	T	P	X	Hr	C
		4	0	4	0	8	6
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand laws of thermodynamics and free energy functions

CO2: Apply the concept of phase equilibria in laboratories and other related fields

CO3: Understand the fundamentals and theories of chemical kinetics

CO4: Understand the behaviour of binary solutions

CO5: Apply the basics of group theory to explain the structure of molecule

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			M
CO2	S	M	S	M		M				M	M	
CO3	S	S	M	M		L		L		L		S
CO4	S	M	S	S		M		L		L		M
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Second and third laws of thermodynamics **12 hours**

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third law of thermodynamics: Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-2: Phase equilibria **12 hours**

Phase Equilibria: Concept of phases, components and degrees of freedom – Derivation of Gibbs phase rule for reactive and non-reactive systems. Phase diagram of one component (water, sulphur and carbon dioxide) and two-component (Ag-Pb, Bi-Cd and KI-H_2O) systems. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three component systems: water-chloroform-acetic acid system, triangular plots. Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria.

Unit-3: Chemical kinetics **12 hours**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudo unimolecular reactions, determination of the order.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit-4: Binary solutions **12 hours**

Binary solutions: Thermodynamics of ideal solutions - Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal) - Azeotropes, lever rule, - Distillation of immiscible liquids - Partial miscibility of liquids: UCST and LCST, Phenol-Water, Aniline-Hexane, Triethylamine-Water and Nicotine-Water system, miscible pairs, steam distillation.

Unit-5: Introduction to group theory **12 hours**

Symmetry elements and associated symmetry operations. Definitions and examples - Axis of rotation(C_n) – Plane of reflection (σ) – σ_v, σ_h and σ_d - Centre of inversion (i) - Rotation – reflection axis (S_n) – examples - Identity (E) - Successive C_n, **σ** and S_n operations.

Mathematical group – Characteristics of a group – construction of group multiplication table (GMT) for H_2O and NH_3 – Abelian and non-Abelian groups. Point groups.

Laboratory component: **60 hours**

1. Determination of the enthalpy of ionization of ethanoic acid.
2. Determination of integral enthalpy potassium dichromate in water.
3. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide
4. Construction of phase diagram: Urea-Benzoic acid
5. Construction of phase diagram: Naphthalene-Biphenyl
6. Construction of phase diagram: Urea-Resorcinol
7. Kinetics of ester hydrolysis
8. Kinetics of iodination of acetone
9. Kinetics of oxidation of iodide using persuphate
10. Comparing acid strengths: Kinetic method
11. Determination of critical solution temperature and composition of the phenol-water system
12. Effect of impurities in CST
13. Determination of transition temperature

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. G.W. Castellan, Physical Chemistry, 4th edition, Narosa, 2004.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing House, 2020.
3. Ball, D. W., Physical Chemistry, Thomson Press, India 2007.
4. Barrow G. M., Physical Chemistry, 5th edition, McGraw Hill Education (India) Private Limited 2007.
5. V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu, Basic Principles of Practical Chemistry, 2nd edition, Sultan Chand & Sons, New Delhi, 2004.

6. Arthur M. Halpern, Experimental Physical Chemistry: A Laboratory Textbook, Prentice Hall, 1997.
7. Amita Dua and Navneet Manav, Practical Chemistry for Undergraduates, Ane Books Pvt. Ltd., 2014.
8. Shailendra K. Sinha, Physical Chemistry-A Laboratory Manual, Narosa publishing house, 2014.

212CHY3312	PHYSICAL CHEMISTRY – III	L	T	P	X	Hr	C
		3	0	3	0	6	4.5
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the application of thermodynamics in partial molar quantities

CO2: Understand theories/thermodynamics of dilute solutions

CO3: Understand the basics of catalysis, mechanism of catalytic action, enzyme catalysis

CO4: Explain Langmuir, Freundlich, and multilayer adsorption isotherms

CO5: Apply the concepts of equilibrium in various industrial applications

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			M
CO2	S	M	S	M		M				M	M	
CO3	S	S	M	M		L		L		L		S
CO4	S	M	S	S		M		L		L		M
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Partial molar quantities **9 hours**

Systems of variable composition: Molarity and mole fraction, molality and mole fraction – Partial molar quantities: Chemical potential and Gibbs-Duhem equation – Change in thermodynamic functions in mixing of ideal gases – Variation of chemical potential with T and P – Determination of partial molar properties.

Concept of Fugacity and Activity – Determination of fugacity of gas – Fugacity of gas in gaseous mixtures – Fugacity of liquid component in liquid mixture – Activity of a substance and activity coefficient – Activity coefficient from solubility measurements.

Unit-2: Dilute solutions **9 hours**

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications.

Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Unit-3: Catalysis **9 hours**

General characteristics of catalytic reactions – Types of catalysis – Terminologies in catalysis: autocatalysis, activity, catalyst poison, negative catalysts, specificity and selectivity – Mechanism and kinetics of acid-base catalysis and enzyme catalysis - Michaelis-Menten mechanism: Derivation of Michaelis-Menten equation – Heterogeneous catalysis: Langmuir-Hinshelwood mechanism, Unimolecular and Bimolecular surface reactions – pH dependence of rate constants – Auto-catalysis - Effect of particle size and efficiency of nanoparticles as catalysts.

Unit-4: Surface chemistry **9 hours**

Adsorption: Physisorption and Chemisorption – Applications of adsorption – Factors influencing adsorption – Adsorption isotherms: Derivation of Langumuir and Freundlich adsorption isotherms, surface area determination. Concept of Temkin isotherm and BET theory of multilayer adsorption (no derivation). Adsorption in solution: Gibbs adsorption isotherm – Modern techniques for investigating surfaces: Concept and principle of EXAFS and STM.

Unit-5: Chemical equilibria **9 hours**

Spontaneity of a reaction – Standard free energy change – Chemical equilibrium: Thermodynamic derivation of Law of Mass Action – van't Hoff reaction isotherm: Derivation of integrated van't Hoff equation – Equilibrium constant: K_p, K_c and K_x and its relation – Homogeneous equilibria: Dissociation of dinitrogen tetroxide, phosphorous pentachloride, formation of sulphur trioxide from sulphur dioxide – Heterogeneous equilibria shown by $CaCO_3$ and NH_4Cl.

Le Chatelier's Principle: Thermodynamic derivation and its application on selected physical and chemical equilibria.

Thermodynamic derivation of Nernst distribution law, association of solute, dissociation of solute in solvents – Application of Nernst distribution law.

Laboratory component: **45 hours**

1. Determine the solubility of benzoic acid or salicylic acid at room temperature by volumetric method
2. Determine the solubility of benzoic acid or salicylic acid above room temperature by volumetric method
3. Determine the effect of addition of an electrolyte in the solubility of benzoic acid or salicylic acid at room temperature by volumetric method
4. Adsorption isotherm of oxalic acid in charcoal
5. Adsorption isotherm of acetic acid in charcoal
6. Solvent Extraction of metal ions (Ni and Fe) as a DMG complex
7. Partition Experiment -I
8. Partition Experiment -II
9. Partition Experiment -III
10. Preparation of ferric hydroxide sol
11. Preparation of Prussian blue sol
12. Determination of molecular weight-Rast method

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. G.W. Castellan, Physical Chemistry, 4th edition, Narosa, 2004.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing House, 2020.
3. Ball, D. W., Physical Chemistry, Thomson Press, India 2007.
4. Barrow G. M., Physical Chemistry, 5th edition, McGraw Hill Education (India) Private Limited 2007.

5. V. Venkateswaran, R. Veeraswamy and A.R. Kulandaivelu, Basic Principles of Practical Chemistry, 2nd edition, Sultan Chand & Sons, New Delhi, 2004.
6. Arthur M. Halpern, Experimental Physical Chemistry: A Laboratory Textbook, Prentice Hall, 1997.
7. Amita Dua and Navneet Manav, Practical Chemistry for Undergraduates, Ane Books Pvt. Ltd., 2014.
8. Shailendra K. Sinha, Physical Chemistry-A Laboratory Manual, Narosa publishing house, 2014.

212CHY2313	Heterocyclic Chemistry	L	T	P	X	Hr	C
		3	0	3	0	6	4.5
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand major classes of heterocyclic compounds and their chemical Properties

CO2: Familiar about the synthetic routes and reactivities of different classes of heterocycles

CO3: Analyze the general synthetic approaches to complex organic molecules containing heterocyclic motifs

CO4: Illustrate the major advances and current state-of-the art methods in heterocyclic chemistry

CO5: Understand the biological importance of heterocyclic compounds

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	M	M		S				M	M	
CO3	S	S	S	M		S		L		L		M
CO4	S	S	M	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Structure of heterocycles **9 hours**

Classification of heterocyclic compounds – Systematic Nomenclature: Hantzsch-Widman Nomenclature and Replacement Nomenclature – Aromaticity of heterocyclic Compounds – Structure and reactivity of heterocyclic compounds: Pyrrole, furan, thiophene, pyridine, quinoline and isoquinoline.

Unit-2: Five membered heterocycles **9 hours**

Synthesis and reactions of heterocyclic compounds: Pyrrole, furan, tetrahydrofuran, thiophene, furfural and indole – Synthesis of 3-hydroxyindole and isatin

Unit-3: Six membered heterocycles **9 hours**

Synthesis and reactions of heterocyclic compounds: Pyridine, piperidine, quinolinine and isoquinoline – Synthesis and reactions of diazines: Pyridazine, pyrimidine and pyrazine

Unit-4: Aromatic heterocycles with different heteroatoms **9 hours**

Structure, synthesis and reactions of 1,3-Azoles: Imidazoles, thiazoles and oxazoles – Structure, synthesis and reactions of 1,2-Azoles: Pyrazoles, isothiazoles, isoxazoles

Unit-5: Biologically important heterocyclic compounds **9 hours**

Synthesis and biochemical role of Vitamin B6 (Pyridoxine, pyridoxal and pyridoxamine): Harris-Folker synthesis, Kuhn's synthesis and Haris synthesis – Synthesis and biochemical role of niacin: From nicotin, 3-methylpyridine, quinoline and pyridine – Synthesis and biochemical role of riboflavin: Kuhn synthesis, Karrer synthesis and Tishler synthesis

Laboratory component: **45 hours**

1. Synthesis of coumarin derivatives
2. Synthesis of flavone derivatives
3. Synthesis of azalactone
4. Synthesis of acridone
5. Synthesis of benzotriazole from o-phenylenediamine.
6. Synthesis of 2-methylbenzimdazole from o-phenylenediamine.
7. Synthesis of 2-phenyl indole from acetophenone.
8. Estimation of urea by gravimetric method (using xanthhydrol)
9. Synthesis 2,4, thiazolidinedione
10. Synthesis of tetrahydrocarbazole
11. Purification of simple heterocyclic compounds using recrystallization and identify the products with mixed melting point method
12. Purification of simple heterocyclic compounds using chromatography and identify the products with mixed melting point method

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. J.A. Joule and K. Mills, Heterocyclic Chemistry, Wiley, 2010.
2. A. R. Parikh, H. Parikh and R. Khunt, The Essence of heterocyclic Chemistry, New Age Int. Publication, 2013.
3. L.A. Paquette and W.A. Benjamin, Principles of Modern Heterocyclic Chemistry, New York, 1968.
4. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.
5. A.R. Katritzky, Handbook of Heterocyclic Chemistry, Academic Press; 2nd edition, 2000.
6. van der Plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

212CHY2106	Organic Spectroscopy	L	T	P	X	Hr	C
		3	0	0	3	6	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type:** Theory with X component						

Course Outcome

On completion of the course, the students will be able to

CO1: Analyze the organic compounds using UV visible spectroscopic technique

CO2: Interpret the IR spectrum of organic molecules

CO3: Elucidate the structure of organic molecules using NMR spectroscopy

CO4: Utilize mass spectroscopy for deciding the molecular mass of an organic molecule

CO5: Analyze the working applications of fluorescence technique

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	M	M		L				M	M	
CO3	S	M	S	M		L		L		L		M
CO4	S	S	M	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: UV-Visible spectroscopy **9 hours**

Basis, principle and instrumentation – Sampling techniques – Transitions and transition probability – Shifts in band position – Woodward-Fieser rule for calculating λ_{max}

Unit-2: Infrared spectroscopy **9 hours**

Basis, principle and instrumentation – Sampling techniques – IR active vibrations – Regions of IR spectrum: Group region and finger print region – Major bands in the IR spectra of different classes of organic compounds

Unit-3: NMR spectroscopy **9 hours**

Basis, principle and instrumentation – Sampling techniques – Position and number of NMR signals – Chemical shift and factors affecting it – Coupling constant and deuterium labelling.

Unit-4: Mass spectrometry **9 hours**

Basis, principle and instrumentation – Sampling techniques – Nitrogen rule for parent ion – Fragmentation – Applications

Unit-5: Spectrometric identification of organic molecules **9 hours**

Application of above spectrometric tools collectively to identify the structure of given organic molecule

X-component: **45 hours**

1. Absorption studies of benzene, naphthalene and anthracene using UV-Visible Spectroscopy to understand bathochromic and hypsochromic shifts.

2. Absorption studies of benzene, phenol and aniline using UV-Visible Spectroscopy to understand auxochrome effect.
3. Effect of functional group on the IR spectra of simple organic compounds such as benzene, phenol and anisole.
4. Effect of functional group on the IR spectra of simple organic compounds such as benzoic acid, benzamide, methyl or ethyl benzoate, and acetophenone.
5. Identify the difference in the finger print region of the IR spectra of benzene, phenol, anisole or benzoic acid, benzamide, methyl or ethyl benzoate, and acetophenone.
6. Suggest a spectroscopic tool to monitor organic reaction - I
7. Suggest a spectroscopic tool to monitor organic reaction - II
8. Suggest a spectroscopic tool to identify geometrical isomers - I
9. Suggest a spectroscopic tool to identify geometrical isomers - II
10. Suggest a spectroscopic tool to identify tautomerism - I
11. Suggest a spectroscopic tool to identify tautomerism - II
12. Record and study the fluorescence spectra of benzene, naphthalene and anthracene using fluorescence spectrophotometer.
13. Calculate the PL quantum efficiency for benzene, naphthalene and anthracene

Reference books:

1. R.M. Silverstein, G.C. Bassler and T.C. Morrill, Spectroscopic Identification of Organic Compounds, John Wiley & Sons, 2014.
2. John R. Dyer, Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall India, 2012.
3. S.K. Deewan, Organic Spectroscopy (N.M.R., I.R., Mass and UV), CBS Publishers and Distributors Pvt. Ltd., 2010.
4. William Kemp. Organic Spectroscopy, Macmillan, 2019.
5. Ravi Sankar S., Text Book of Pharmaceutical Analysis, Rx Publications, 2001.
6. Joseph R. Lakowicz, Principles of Fluorescence Spectroscopy, 3rd edition, Springer, 2006.

212CHY2104	Synthetic Reagents and Green Chemistry	L	T	P	X	Hr	C
		4	0	0	0	4	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							

Course Category: Program Core **Course Type: Theory**

Course Outcome

On completion of the course, the students will be able to

CO1: Illustrate the chemical reactions and applications of organometallic compounds

CO2: Explain the reactions and applications of methylene compounds

CO3: Understand designing of chemical reactions using green chemistry principles

CO4: Utilize greener synthetic strategies for synthesizing industrially important compounds

CO5: Adopt the methods of green synthesis in the forthcoming years

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Synthetic applications of organometallic compounds **12 hours**

Organometallic compounds: Preparation of Grignard reagent using alkyl halides along with mechanism – Synthetic applications of Grignard reagent: Reaction of Grignard reagent with alkyl halides, water, alcohol, amines, epoxides, aldehydes, ketones, esters, acid chlorides, cyanides, carbon dioxide and sulphur – Preparation of organolithium compounds using alkyl halides – Synthetic applications of organolithium compounds: Reactions of RLi with water, acetic acid, ethanol, epoxides, aldehydes, ketones, esters and carbon dioxide.

Unit-2: Synthetic applications of active methylene compounds **12 hours**

Active methylene compounds: Keto-enol tautomerism – Preparation of Acetoacetic ester by Claisen condensation method (with mechanism) – Synthetic uses of AAE: Synthesis of alkylacetic acids, dialkylacetic acids, succinic acids, α,β-unsaturated acids, methyl ketones, 1,3-diketones, uracil and antipyrine – Preparation of diethyl malonate – Synthetic applications of diethyl malonate: Synthesis of alkylacetic acids, dialkylacetic acids, succinic acids, α,β-unsaturated acids, α–amino acids and barbituric acid. Michael addition and its mechanism.

Unit-3: Principles of green chemistry and designing a chemical synthesis **12 hours**

Basic introduction and explaining goals of green chemistry – Twelve principles of green chemistry: Explanations, examples – Designing a green synthesis using the principles: Prevention of waste/ byproducts, maximum incorporation of the materials used in the process into the final products, atom economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

Unit-4: Green synthetic reactions **12 hours**

Green synthesis of adipic acid, catechol, disodium iminodiacetate – Microwave assisted reactions:

Hofmann elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols, Diels-Alder reaction and decarboxylation reaction – Ultrasound assisted reactions: Sonochemical Simmons-Smith reaction – Adopting green synthetic strategies for aldol, benzoin and Knoevenagel condensation, Cannizaro and Michael reaction – Super critical or near critical conditions for organic transformations.

Unit-5: Future trends in green chemistry **12 hours**

Oxidation reagents and catalysts - Biomimetic, multifunctional reagents - Combinatorial green chemistry - Proliferation of solventless reactions - Co crystal controlled solid state synthesis (C_2S_3) - Green chemistry in sustainable development.

Reference books:

1. Paula Yurkanis Bruice, Organic Chemistry, 8th edition, Pearson, 2020.
2. Arun Bahl and B. S. Bahl, Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.
3. V.K. Ahluwalia and M.R. Kidwai, New Trends in Green Chemistry, Anamalaya Publishers, 2005.
4. M.A. Ryan and M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, 2002.
5. P.T. Anastas and J.K. Warner, Green Chemistry- Theory and Practical, Oxford University Press, 1998.
6. A.S. Matlack, Introduction to Green Chemistry, Marcel Dekker, 2001.
7. M.C. Cann and M.E. Connely, Real-World cases in Green Chemistry, American Chemical Society, 2000.
8. M. Lancaster, Green Chemistry: An Introductory Text RSC Publishing, 2nd edition, 2010.

212CHY2111	Materials Chemistry	L	T	P	X	Hr	C
		4	0	0	0	4	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type: Theory**						

Course Outcome

On completion of the course, the students will be able to

CO1: Understand basic parameters of crystalline solids, symmetry and crystal structures.

CO2: Analyze silica-based materials in applications

CO3: Illustrate technological importance of ionic liquids and preparation of materials

CO4: Understand self-assembled structures, nano-structured materials, carbon nanotubes, applications.

CO5: Explain composites and their industrial applications.

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Basics of crystalline solids **12 hours**

Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesive energy, Symmetry elements, operations , translational symmetries - point groups, space groups, equivalent positions, close packed structures, voids, crystal structures, Pauling rules, defects in crystals, polymorphism, twinning.

Unit-2: Silica based materials **12 hours**

Introduction to Zeolites, metallosilicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H_2 /CO_2 gas storage and catalytic applications.

Unit-3: Inorganic solids/ionic liquids of technological importance **12 hours**

Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydro-thermal method, Ion-exchange and Intercalation methods. Introduction to Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementary ideas).

Unit-4: Nanomaterials **12 hours**

Overview of nanostructures and nano-materials: Classification, preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nano-architecture-one dimensional control.

Carbon nanotubes and inorganic nanowires.

Unit-5: Composite materials **12 hours**

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Reference books:

1. P. Atkins, T. Overton, J. Rourke Weller, Armstrong F Shriver and Atkins, Inorganic Chemistry, 5th edition, Oxford University Press, 2012.
2. D.M. Adam, Inorganic Solids: An Introduction to Concepts in Solid-State Structural Chemistry, John Wiley,1974.
3. C.P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.
4. G.E. Rodger, Inorganic and Solid State Chemistry, Cengage Learning, 2002.
5. Ever J. Barbero Introduction to Composite Materials Design, 3rd edition, CRC Press, 2019.
6. A. Douhal and M. Anpo, Chemistry of Silica and Zeolite-Based Materials, Vol. 2, 1st edition, Elsevier, 2019.

212CHY2114	Nuclear and Radiation Chemistry	L	T	P	X	Hr	C
		4	0	0	0	4	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type:** Theory						

Course Outcome

On completion of the course, the students will be able to

CO1: Understand nuclear and radiochemical terminology, nomenclature, conventions and units.

CO2: Explain methods to measure radioactivity

CO3: Analyze the possible nuclear reactions and different types of nuclear reactors

CO4: The principles and procedures used in nuclear and radiochemical analysis and the characterization of nuclear and radiochemical compounds

CO5: The characteristics of the different methods of interactions of radiations with matter and the theories used to describe them. The principles and types of nuclear detection instruments

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Introduction to nuclear Chemistry **12 hours**

Introduction, Nucleus and its classification, nuclear forces, nuclear stability, nuclear models. Atomic nuclei, Radioactive Decay Processes (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half-life, mean life period), Equations of radioactive Decay and growth, Interaction of radiation with matter, Nuclear reactions, Nuclear binding energy, Mass defect and binding energy, The average binding energy per nucleon. Carbon dating and its usefulness.

Unit-2: Nuclear radioactivity **12 hours**

Radioactivity, Nuclear emissions, Nuclear transformations, The kinetics of radioactive decay, Units of radioactivity, Artificial isotopes, Bombardment of nuclei by high-energy a-particles and neutrons, Bombardment of nuclei by 'slow' neutrons. Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear acceletors, synchrontrons, Geiger-Muller detector, Scintillaton detectors.

Unit-3: Nuclear reactions **12 hours**

Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission, fission of uranium, the production of energy by nuclear fission, Nuclear reprocessing. Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

Unit-4: Separation and applications **12 hours**

Syntheses of transuranium elements, the separation of radioactive isotopes. Chemical separation, The

Szilard–Chalmers effect, nuclear fusion, Applications of isotopes, Infrared (IR) spectroscopy, Kinetic isotope effects, Radiocarbon dating, Analytical applications, Sources of 2H and 13C, Deuterium: electrolytic separation of isotopes.

Unit-5: Radiation detection and measurement **12 hours**

Radiation Detection and Measurement: Principles of Radiation Detection, Radiation Measuring & Monitoring Instruments, Radiation Protection Standards, Radiation Hazard Evaluation and Control, Disposal of Radioactive Waste, Transport of Radioactive Material. Diagnostic Radiology. diposal of nuclear waste, nuclear disaster and its management.

Reference books:

1. Alfred Nixon, Nuclear Chemistry, Apple Academic Press, Inc., 2010.
2. Walter D. Loveland, David J. Morrissey, Glenn T. Seaborg, Modern Nuclear Chemistry, Wiley, 2nd edition, 2017.
3. G. Friendlander, G. Kennedy and J.M. Miller, Nuclear and Radiochemistry, Wiley Interscience, 2013.
4. B.G. Harvey, Introduction to Nuclear Physics & Chemistry, Prentice – Hall, 2012.
5. Peter AC McPherson, Principles of Nuclear Chemistry, World Scientific, 2020.
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition. 2011.
7. P. Atkins, and P. Overton, P. Rourke, M. Weller, F. Armstrong and M. Hagerman, Inorganic Chemistry. 5th edition New York, NY: W.H. Freeman and Company, 2010.
8. A. Mozumder, Fundamentals of Radiation Chemistry, Academic press, 1999.

GENERIC ELECTIVE COURSES

213MAT1101	Mathematics I - Fundamentals of Calculus	L	T	P	X	H	C
		4	0	0	0	4	4

COURSE OBJECTIVE

To enable the students to acquire the basic knowledge of differentiation and complex variables

COURSE OUTCOMES

Upon successful completion of this course, the students will be able to

1. know about the differentiation and its applications.
2. understand the fundamental concepts of partial differentiation.
3. know about the idea on definite integrals and reduction formulae
4. apply the concept and consequences of differential equations
5. study about analytic functions and bilinear transformation

CO – PO MAPPING

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S										L
CO2	M		M									
CO3		M										
CO4	S											L
CO5		L										

*S – Strong; M – Medium; L – Low

UNIT-I: SIMPLE APPLICATIONS OF DIFFERENTIATION **(9 Hours)**

Radius of Curvature, Centre of curvature of Plane Curves - Involute and Evolute

UNIT-II: FUNDAMENTAL CONCEPTS OF PARTIAL DIFFERENTIATION **(9 Hours)**

Partial Differentiation -Homogeneous functions and Euler's Theorem**.**

UNIT-III: INTEGRATION **(9 Hours)**

Definite integrals, Reduction formulas for sinnx, cosnx, secnx, cotnx, cosecnx, and sinmx.cosnx and problems.

UNIT-IV: DIFFERENTIAL EQUATION **(9 Hours)**

Exact differential equations- second order equations- second order equations with right hand side in the forms x^n, e^{ax}, sin ax, cosax, e^{ax}sin bx, e^{ax}cosbx, $e^{ax}x^n$.

UNIT-V: COMPLEX VARIABLES **(9 Hours)**

Analytic function – C. R. Equations (without proof) – Bilinear Transformation, Cross Ratios.

TEXT BOOK(S)

1. S. Arumugam, Ancillary Mathematics, Paper I, New Gamma Publishing House, Reprint 2002.
2. S. Arumugam and Thangapandi, Issac, Ancillary Mathematics PaperIII, New Gamma Publications,2003.

- Unit 1: Chapter 3- Section 3.2.
- Unit 2: Chapter 3- Section 3.3,3.5
- Unit 3: Chapter 4- Section4.10,4.11.
- Unit 4: Chapter 3-Sections 3.1 to 3.6
- Unit 5: Chapter 10- Section 10.2,10.3, Chapter 9-Section 9.2,9.3.

REFERENCE BOOKS

1. Narayanan &ManickavasagamPillai, Differential Equations, S.V. Publication – Reprint, 2003.
2. P.DuraiPandian, Lakshmi DuraiPandian& D. Muhilan, Complex Analysis, Emerald Publishers, 1995.
3. S.Arumugam,A.TangapandiIsaac,A.Somasundaram.Mathematics for Engineers,Scitech Publications Pvt.Limited,Chennai2008.

213BIT1301	Biotechnology-I	L	T	P	C
		3	0	2	4

Objective(s) To understand the role of biochemistry and metabolism in living beings

Course Outcome(s)

CO1 Explain structure and classification of carbohydrate and its pathways

CO2 Describe different structures of proteins and amino acids and its metabolism

CO3 Explain the structure and biological functions of vitamins and its deficiency diseases

CO4 Describe various classifications and biological significance of lipids, fatty acids, nucleic acids and its metabolism

CO5 Describe the classification of enzymes and its kinetics

Mapping of Course Outcome(s):

CO/PO	PO				
	1	2	3	4	5
CO1		M	L	M	
CO2	M		S	M	S
CO3		S			L
CO4		L	M	S	
CO5	S		M		M

Unit I: Carbohydrates **9 Hours**

The foundations of biochemistry, Cellular and chemical foundations of life, Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides (glycogen, starch, cellulose, insulin, chitin and glycosaminoglycans) – Reactions and energy balance in Glycolysis, Gluconeogenesis and TCA cycle– Pentose phosphate. Outlines of glycoproteins, glycolipids and blood group substances.

Unit II: Amino Acids and Proteins **9 Hours**

Amino acid-classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups – Peptide bond – stability and formation, primary secondary, tertiary and quaternary structure of protein – Denaturation (pH, temperature, chaotropic agents) – Amino acids degraded to Pyruvate, Oxaloacetate – Amino acids degraded to Acetyl-CoA, Succinyl-CoA – Metabolism of branched chain amino acids – Glucose alanine cycle, urea cycle

Unit III Vitamins **9 Hours**

Vitamins: classification, structures and biological functions of fat soluble and water soluble vitamins and their deficiency.

Unit IV: Lipids and Nucleic acids **9 Hours**

Classification & biological significance of lipids & fatty acids – Simple, compound and derived lipids. Steroids and sterols: Cholesterol and bile acids. Fatty acids metabolism: Synthesis and β – oxidation, Ketone bodies. Biomembranes-formation of micelles, bilayers, vesicles, liposomes. Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes.

Unit V: Enzymes **9 Hours**

Nomenclature and classification of enzymes - Holoenzyme, apoenzyme, co-factors, co-enzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes - Thermodynamics of catalysis, Energy of activation, Relation of ΔG and K_{eq} – Enzyme activity and specific activity – catalytic activity of enzymes - Reversible and irreversible activation of enzymes (pro-enzymes, phosphorylation)

List of Experiments for Practical: **30 Hours**

1. Preparation of buffer solutions
2. Qualitative analysis of lipids
3. Qualitative analysis of carbohydrates
4. Qualitative analysis of amino acids
5. Determination of reducing sugars by DNS method
6. Quantitative estimation of aminoacids by ninhydrin method
7. Estimation of proteins (Biuret method)
8. Lowry's method of protein estimation
9. Estimation of Saponification value of fats/oils.
10. Extraction and quantitative estimation of total lipids from food samples

References:

1. David, L., Nelson and Michael, M., Cox., Lehninger's - Principles of Biochemistry, Macmillan worth Publisher, USA, 3rd Edition, 2000
2. Voet, D., Voet, G., Biochemistry, John Wiley and Sons, Singapore, 3rdEdition. 2016.
3. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied (P) Ltd., 2008.
4. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox

213MAT1102	**Mathematics II - Principles of Higher Calculus** for BSc (Physics & Chemistry)	**L**	**T**	**P**	**X**	**H**	**C**
		4	**0**	**0**	**0**	**4**	**4**

COURSE OBJECTIVE

To empower the students to understand the fundamental concepts of partial differential equations; double and triple integrals; vector calculus; Fourier Series and Laplace transform and apply them to solve real life problems.

COURSE OUTCOMES

Upon successful completion of this course, the students will be able to

1. construct partial differential equation and apply Lagrange's form for the given physical problems.
2. evaluate multiple integrals for regions in the plane and also to find area of the region bounded by curves and to find volume, surface area, Mass, C.G and M.I of solid geometric figures
3. understand the central concepts in multivariable analysis, directional derivative; gradient; multiple integrals; line and surface integrals; vector fields; divergence and curl
4. find the Fourier series representation of a function of one variable and to find half-range Fourier series for even/odd functions.
5. solve ordinary differential equations using Laplace transform.

CO – PO MAPPING

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M											L
CO2			S									
CO3	S											M
CO4		L										
CO5		M										

***S – Strong; M – Medium; L - Low

UNIT-I: PARTIAL DIFFERENTIAL EQUATIONS (9 Hours)

Partial differential equations – Formation of partial differential equations – Lagrange's equation – some standard forms.

UNIT-II: MULTIPLE INTEGRALS (9 Hours)

Double integration – Cartesian and polar coordinates – Change of order of integration – Change of variable between Cartesian and polar – Area as double integral – Triple integration in Cartesian, cylindrical and spherical polar coordinates – Volume as triple integral.

UNIT-III: VECTOR CALCULUS (9 Hours)

Vector differential operators, Gradient, Divergence, curl and their simple properties - Directional derivatives-Solenoidal -Irrotational vectors.

UNIT-IV: FOURIER SERIES (9 Hours)

Fourier series-Trigonometric Series – Even and odd functions – Half range Fourier series.

UNIT-V: LAPLACE TRANSFORM (9 Hours)

Laplace transform-Inverse Laplace Transformation-Solution of differential equations using Laplace Transforms

TEXT BOOK(S)

1. S. Arumugam, Ancillary Mathematics, Paper I, New GammaPublications,2002

2 S. Arumugam, Ancillary Mathematics, Paper II, New Gamma.Publications,2002.

3. S. Arumugam and Thangapandi, Issac, Ancillary Mathematics PaperIII, New Gamma Publications,2003.

- Unit 1: Chapter 6- Section 6.1, 6.2, 6.3, 6.4.
- Unit 2: Chapter1
- Unit2: Chapter7
- Unit 4: Chapter 4
- Unit 5: Chapter 5- Section 5.1, 5.2.

REFERENCE BOOK(S)

1. Narayanan &ManickavasagamPillai, Differential Equations, S.V. Publication – Reprint,2003.
2. P.DuraiPandian, Lakshmi DuraiPandian& D. Muhilan, Complex Analysis, Emerald publishers,1995.

213BIT1302	Biotechnology-II	L	T	P	C
		3	0	2	4

Objective(s) To know about the basics of cell biology

Course Outcome(s)

CO1 Understand the structure and classification of cell and its organelles
CO2 Explain structure and functions of different organelles in cells
CO3 Explain the role of nucleus and chromatin network
CO4 Describe cell reproduction and cell to cell communications
CO5 Describe the microscopic techniques

Mapping of Course Outcome(s):

CO/PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO 1	H			H						M		M
CO 2	H			H						M		M
CO 3	H		M	H	H	M				M		H
CO 4	H		M	H						M		
CO 5	H		M	H	H	M				M		H

Unit I - Cell and Cellular Processes **12 Hours**

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Compartmentalization of eukaryotic cells, Classification based on cellularity: Unicellular and Multicellular. Cell membrane: Chemical components of plasma membrane, organization and Fluid Mosaic Model, Membrane proteins and their functions; Carbohydrates in the membrane; Selective permeability of the membranes; Membrane transport.

Unit II - Cell Organelles and its functions **12 Hours**

Mitochondria; Structure, marker enzymes, composition; mitochondrial biogenesis; Proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast; Structure, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes; Structures and roles. Structural organization and function of intracellular organelles-cell wall. Signal peptide hypothesis, N-linkedglycosylation, Role of golgi in O-linked glycosylation. Peroxisomes and Glyoxisomes; Structures, composition, functions in animals and plants.

Unit III – Nucleus and chromosomes **12 Hours**

Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNApackaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome. Chromosome morphology, Chemical organization of nucleosome – nucleoproteins, Types of chromosomes based on centromere, karyotype and ideogram.

Unit IV – Cell division and cell cycle **12 Hours**

Cell division and cell cycle: mitosis; Meiosis; Cell cycle regulation, steps and control of cell cycle, Stem cells – sources and applications, Cell -cell interactions, interactions of cells with their environment, Cell signaling.

Unit V – Instrumentation techniques **12 Hours**

Principles of microscopy; Light Microscope; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Introduction to Electron microscopy (EM)- Scanning EM and transmission EM, sample analysis with examples.

Recommended books/References:

1. Campbell, N.A. and Reece, J. B. Biology (Eighth edition) Pearson Benjamin Cummings, SanFrancisco, (2008).

2. Hardin, J., Bertoni, G.P. Kleinsmith, L.J.–Becker's World of the Cell–Pearson Publ–2011 (8th Edition)

3. Raven, P.H *et al* Biology, Seventh edition Tata McGraw Hill, New Delhi (2006).

4. Sheeler, P and Bianchi, D.E. Cell and Molecular Biology (Third edition) John Wiley (2006)

Practical

1. Study of prokaryotic cells (bacteria), viruses, eukaryotic cells using microscope.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nervecell.
5. Preparation of temporary mounts of striated muscle fiber

6. To prepare temporary stained preparation of mitochondria from striated muscle cells/ cheekepithelial cells using vital stain Janus green.

213PHY1301	Physics-I	L	T	P	X	H	C
		3	0	2	0	5	4

Pre-requisite: Nil **Course Category:** Generic Elective

Applicable to B.Sc. Mathematics and B.Sc. Chemistry Course **Course Type**: Integrated

Objective(s):

This course focuses on the basic concepts of mechanics and their applications in solving various physical problems. In addition, it focuses on the analysis of the different properties of matter.

Course Outcome(s):

CO1: Acquire fundamental knowledge in Newtonian mechanics.
CO2: Gain the knowledge of gravitational force between bodies including planets
CO3: Analyze the elastic properties of materials
CO4: Analyze the viscous properties of materials
CO5: Understand the concepts of surface tension and its implications**.**

Unit I: Mechanics **9 Hours**

Newton's laws of motion – Force- Impulse of a force- law of conservation of linear, angular momentum – Collision – Elastic and inelastic collision Newton's law of impact – Impact of a smooth sphere on a fixed plane direct impact between two smooth spheres (derivation) - Moment of inertia – parallel & perpendicular axes theorem - Moment of inertia of a uniform rod, circular disc and solid sphere - Torsional pendulum.

Unit II: Gravitation **9 Hours**

Kepler's laws of motion (Statement only) – Newton's universal law of gravitation – Determination of G by Boy's method – Mass and density of earth- inertial mass & gravitational mass – variation of 'g' with altitude – latitude – depth and rotation of earth – Value of g at poles and equator – satellites – orbital velocity – escape velocity - Satellite in different orbitals and applications (Statements only)

Unit III: Elasticity **9 Hours**

Definition – stress – strain – Hooke's law - stress-strain diagram- three moduli of elasticity – units – dimensions – Poisson's ratio – definition –twisting couple on a cylindrical wire–limiting values – relation between q , n , k and σ - expression for bending moment – theory of uniform and non – uniform bending - Cantilever – expression for depression

Unit IV: Viscosity - Fluid motion **9 Hours**

Viscosity – Coefficient of viscosity – streamlined motion - turbulent motion – definition - critical velocity – Reynolds number and its significance – Poiseuille's equation – experimental determination of co-efficient of viscosity: Poiseuille's method, Stokes method –equation of continuity – Critical velocity – Bernoulli's theorem – Coefficient of Viscosity: Variation of viscosities with Temperature – Comparison of viscosities.

Unit V: Surface tension **9 Hours**

Surface tension – definition – Molecular forces – Explanation of surface tension on kinetic theory –surface energy – work done in increasing the area of a surface – Excess pressure inside a curved liquid surface – Excess pressure inside a liquid drop and soap bubble – angle of contact – capillarity – Surface Tension by drop weight method and Capillary rise method – Applications.

List of Experiments

1. Measurements of length using Vernier caliper, screw gauge and travelling microscope.
2. Torsional pendulum- Determination of Rigidity Modulus of a Wire.
3. Compound Pendulum -Determination of acceleration due to gravity.
4. Determination of young's modulus by uniform bending, pin and microscope method.
5. Determination of young's modulus by non-uniform bending – pin and microscope method.
6. Determination of young's modulus by cantilever method – scale and telescope method.
7. Uniform bending – Optic lever.
8. Determination of co-efficient of viscosity by Poiseuille's method.
9. Determination of surface tension by drop weight method.
10. Determination of surface tension by capillary rise method.
11. Determination of acceleration due to gravity by simple pendulum.
12. Stoke's Method - Experiment to determine coefficient of viscosity of low viscous liquid by Stoke's method.

Text Books:

1. Mechanics & Properties of matter, Brijlal, N. Subrahmanyan, S. Chand &Co., 2002.

Reference Books:

1. Mechanics, Berkeley Physics course, Charles Kittel, Tata McGraw-Hill, 2007
2. University Physics, Ronald Lane Reese, Thomson Brooks/Cole, 2003.
3. Mechanics, D.S. Mathur, S. Chand & Co., 2000.
4. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers.

213PHY1302	Physics-II	L	T	P	X	H	C
		3	0	2	0	5	4

Pre-requisite: Nil **Course Category:** Generic Elective

Applicable to B.Sc. Mathematics and B.Sc. Chemistry **Course Type**: Integrated Course

Objective: This course provides the fundamentals of light propagation, interaction and electrical properties with matter.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Acquire fundamental knowledge in optics.
CO2: Understand the basic concepts of laser and applications.
CO3: Gain the knowledge of fiber optics.
CO4: Analyze the importance electrostatics, magnetostatics and electromagnetic induction.
CO5: Understand the concepts of electronics and its consequences.

Unit I: Ray optics *9 Hours*

Dispersion by a prism – Refraction through a prism – Angular dispersion - Dispersive power Achromatic combination of prisms – deviation without dispersion - dispersion without deviation – Aberration - chromatic aberration in lenses -achromatic combination of lenses-spherical aberration-explanation-Eyepieces Huygen & Ramsden- differences.

Unit II: Wave Optics **9 Hours**

Interference, Young's double slit experiments, Fresnel's biprism, interference in thin films - Fresnel diffraction, Diffraction at a single slit and a circular aperture, Fraunhoffer diffraction at N slits, plane diffraction grating - Polarization: (Malu's law) Polarization by reflection and refraction, Brewster's law, double refraction in calcite crystal, Nicol prism, Production and analysis of elliptically and circularly polarized light.

Unit III: Laser **9 Hours**

Introduction - Interaction of light with matter – absorption – spontaneous emission – Stimulated emission - Einstein's Coefficients and their relations - population inversion - pumping schemes – Light amplification – Laser beam characteristics - Components of laser - Types of laser - He-Ne laser – Nd:YAG Laser – CO_2 Laser - Semiconductor Laser – Applications : Holography, Communication, Medical.

Unit IV: Electromagnetism **9 Hours**

Gauss law – Differential form of Gauss law – Applications of Gauss law: Electric field due to infinite plane sheet of charge, parallel sheets of charge, uniformly charged conducting sphere - Potential difference- equipotential surface - Biot Savart law - Magnetic field due to a current

- carrying conductor, Circular coil. Faraday's laws of electromagnetic induction – Lenz's law – Self-induction - L of solenoid - mutual induction – mutual inductance between two coils.

Unit V: Electronics **9 Hours**

PN Junction diode – V-I characteristics – Half wave - Full wave rectifier-Full wave Bridge rectifier-Filters-LC Filter- Zener Diode-Voltage regulation

Transistor – CE characteristics - Logic gates, AND, OR, NAND, NOR, XOR and NXOR. Boolean algebra (Boolean laws and simple expressions), binary adders, half adder, half subtractor, full adder and full subtractor

List of Experiments:

1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine Dispersive Power of the Material of a given Prism using Mercury Light.
3. To determine thickness of wire using Air wedge.
4. To determine wavelength of spectrum of Mercury light using plane diffraction Grating
5. To determine the wavelength of Laser light using Diffraction of Single Slit.
6. To determine the particle size by using LASER.
7. Ballistic Galvanometer
8. Virtual Lab - Magnetic Field Along The Axis of A Circular Coil Carrying Current
9. Transistor characteristics CE configuration
10. Logic gates verification of truth tables
11. Logic gates verification of truth tables
12. Zener diode characteristics
13. Zener voltage regulator
14. To determine wavelength of sodium light using Newton's Rings.

Text Books:

1. Optics, Brijlal & Subramaniam, S. Chand Publication, 2014.
2. Electricity and Magnetism R Murugesan, S. Chand & Co. 1995.
3. Basic Electronics: Solid State, B.L.Theraja, S.Chand& Co., 2001.

Reference Books:

1. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity and Magnetism, J.H. Fewkes& J. Yarwood. Vol. I, 1991, Oxford Univ.Press.
4. A Text Book of applied electronics, R.S. Sheda, S.Chand& Co., 2003.
5. A. P. Malvino, Electronic Principles, Glencoe, 1993.
6. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, AsiaPublishing House.
7. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4thEdition, reprinted 1985, Heinemann Educational Publishers
8. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition,2011, Kitab Mahal, New Delhi.

DISCIPLINE SPECIFIC ELECTIVE COURSES

213CHY2301	Organometallics and Bioinorganic Chemistry	L	T	P	X	Hr	C
		3	0	2	0	5	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective	**Course Type:** Integrated Course (IC)						

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the existence of variable oxidation states in d-bock elements

CO2: Explain the bonding and structure of organometallic compounds

CO3: Analyze the bonding and structure of metal carbonyls

CO4: Illustrate the catalytic activity of organometallic compounds

CO5: Discuss the concepts of bio-inorganic chemistry and the role of metal ions in biological processes

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Chemistry of 3d elements **9 hours**

Transition elements: Reason for variable oxidation states shown by 3d elements. Oxidation states displayed by the elements Cr, Fe, Ni, Co and Cu. Periodicity of properties in d-block elements – Preparation and properties of the following compounds: Peroxo compounds of chromium (CrO_5, $[CrO_8]^{3-}$ and CrO_4), potassium dichromate and potassium permanganate, sodium nitroprusside, hexamine cobalt (III) chloride and sodium cobatinitrite.

Unit-2: Organometallic compounds **9 hours**

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. General methods of preparation: Addition, oxidation and reduction methods – Organometallic compounds of alkali metals: Preparation and structure (methyl lithium) of alkyl lithium – Organometallic compounds of Be and Mg: Preparation and structure of dialkyl beryllium, dialkyl magnesium and Grignard reagent – Organometallic compounds of Al: Preparation and structure of trialkyl aluminium – Preparation and structure of metal-olefin complexes: Zeise's salt and evidences of synergic effect – Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity of ferrocene. Comparison of aromaticity and reactivity with that of benzene.

Unit-3: Organometallic compounds: Metal carbonyls **9 hours**

Definition of pi-acid ligands, complexes and metallic carbonyls – Classification: Based on number of metallic atoms present in the MCO and based on the structure of MCO – General methods of preparation: Direct synthesis, reduction of metals in the presence of CO, thermal and photochemical decomposition and decomposition of labile MCO – Reactions of metal carbonyls: Substitution, oxidative addition, insertion and reduction reactions. Formation of anionic carbonyl complexes, cationic carbonyl complexes, carbonyl halides and carbonyl hydrides – Study of some selective metal carbonyls: $Cr(CO)_6$, $Mn_2(CO)_{10}$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$, $Co_2(CO)_8$ and $Ni(CO)_4$ – Bonding in metal carbonyls: π-acceptor behavior of CO. Synergetic effects and explanation using VB and MO approach and IR spectral study – EAN and 18 electron rule.

Unit-4: Organometallic compounds: Reactivity and catalysis **9 hours**

Reactions of organometallic complexes: A detailed study on substitution, oxidative addition, insertion and reduction reactions.

Catalysis by organometallic compounds: Hydrogenation of alkenes using Wilkinson catalyst, synthesis gas production using Ru catalysts, hydroformylation reaction, Monsanto acetic acid process, Wacker process, Ficher-Tropsch process using Co or Fe supported over alumina and Ziegler Natta catalysis.

Unit-5: Bioinorganic chemistry **9 hours**

Essential and toxic elements in biology – Major or macronutrients (Na, K, Ca and P): Definition, source, functions and deficiency – Trace or micronutrients (Cu and I_2): Definition, source, functions and deficiency – Harmful effects of excess metal (Fe and Cu) ions in body – Role of metal ions present in biological systems: Na/K pump, magnesium in energy production (ATP) iron in hemoglobin, myoglobin, calcium in binding proteins, blood clotting.

Laboratory component: **30 hours**

1. Preparation of tetraamminecarbonatocobalt (III) nitrate and conductance measurement
2. Preparation of tetraamminecopper (II) sulphate and conductance measurement
3. Preparation of potassium trioxalatochromate (III) trihydrate and conductance measurement
4. Preparation of various Schiff base-metal complexes
5. Preparation of potassium trioxalatoferrate (III) trihydrate and conductance measurement
6. Preparation of Prussian blue
7. Preparation of tristhioureacuprous (II) choride
8. Chromatographic separation of any two cations (d-block elements)
9. Spectrophotometric estimation of any one micronutirient element
10. Estimation of Na/K in water sample by flame photometer
11. Estimation of antimony in tartar emetic using sodium thiosulphate
12. Spectrophotometric estimation of dichromate ions
13. Spectrophotometric estimation of permanganate ions

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th edition, Wiley, 1999.
2. J. E. Huheey, E. A. Keiter, R. L. Keiter & O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Pearson, 2006.
3. Ajai Kumar, Organometallic & Bioinorganic Chemistry, 4th edition, Aaryush Education, 2021.
4. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, 33rd edition, Milestone Publishers & Distributors/ Vishal Publishing Co. 2020.
5. P.L. Soni and Vandna Soni, The Chemistry of Coordination Complexes and Transition Metals, 1st edition, CRC press, 2021.
6. Ajai Kumar, Coordination Chemistry, 1st edition, Aaryush Pub., 2020.
7. R. Gopalan and V. Ramalingam, Concise Coordination Chemistry, 1st edition Vikas Publication House Pvt Ltd., 2008.
8. L. Rakesh Sharma, Practical Inorganic Chemistry, Evincepub Publishing, 2021.
9. Amita Dua and Navneet Manav, Practical Inorganic Chemistry, 1st edition, Manakin press, 2017.
10. Gurdeep Raj, Advanced Practical Inorganic Chemistry, 1st edition, Krishna Prakashan Media (P) Ltd., 2013

213CHY2302	Electrochemistry	L	T	P	X	Hr	C
		3	0	2	0	5	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective		**Course Type:** Integrated Course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand basic concepts of electrochemistry.

CO2: Construct electrochemical cells and apply the same for determining important parameters.

CO3: Evaluate the non-equilibrium electrochemical processes

CO4: Elaborate the conductivity of concentrated solutions.

CO5: Apply the potentiometric principles for performing redox and acid-base titration

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Electrode potential and electrodes **9 hours**

Single and standard electrode potentials. Reference electrodes: (i) Primary reference electrode: Standard hydrogen electrode (ii) Secondary reference electrode: Saturated calomel electrode. Determination of standard electrode potentials of zinc and copper electrodes. Calculation of cell EMF from single electrode potentials. Definition and applications of electromotive series.

Different types of electrodes (i) Metal-Metal ion electrodes (ii) Amalgam electrodes (iii) Gas electrodes (iv) Metal insoluble salt electrodes (v) Oxidation –reduction electrodes (definition and derivation of EMF for each electrode).

Electromotive force Definition. Measurement using potentiometer. Construction and working of Weston saturated and unsaturated standard cells Conventions regarding sign of EMF.

Unit-2: Thermodynamics and electrochemical reactions **9 hours**

Thermodynamics of electrochemical reactions Derivation of Nernst equation and its use in calculating EMF of cells at different activities of the individual electrodes. Relationship between EMF and (i) free energy changes (ii) enthalpies changes (iii) entropy changes occurring in electrochemical reactions. Equilibrium constants for electrochemical reactions.

Classification of electrochemical cells Chemical cells and concentration cells with and without transference. Definition and derivation of EMF for each cell-liquid junction potential.

Unit-3: Non-Equilibrium electrochemistry **9 hours**

Faraday's laws of electrolysis. Electrolysis of aqueous NaCl and $CuSO_4$ solutions using the corresponding metal or inert electrodes. Properties of electrolytes: Ionic strength of solutions. vant Hoff factor. Electrolytic conductance: Determination – variation of conductance with concentration. Equal conductance at infinite dilution. Transference and transference numbers: Absolute velocity of ions and ionic mobilities. Hittorf's rule, determination of transference numbers – Hittorf's method

and moving boundary method. Self-study Arrhenius theory of electrolytic dissociation. Evidences in favour of the theory. Limitations.

Unit-4: Ions in solution and conductometric titrations **9 hours**

Activities and activity coefficients of strong electrolytes. Determination. Debye-Huckel theory of activity coefficients. Mention of Debye-Huckel Onsager equation. Effect of concentration, solvent dielectric constant and temperature on conductance. Ionization Extent of ionization, relationship to conductance. Applications of conductance measurements – Determination of Ka and Ksp

Conductometric titrations: strong acid with strong base, strong acid with weak base, strong base with mixture of acids.

Unit-5: Potentiometric titration **9 hours**

Applications of EMF Calculation of (i) Valency of ions in doubtful cases (ii) free energy, enthalpy and entropy changes in electrochemical reactions, (iii)solubility product of sparingly soluble salt pH and its determination using hydrogen, quinhydrone and glass electrodes; Potentiometric acid-base, redox and precipitation titrations – Cyclic voltammetry: Principle

Laboratory component: **30 hours**

1. Determination of valency of a cation by constructing a concentration cell
2. Determination of solubility and solubility product by constructing a concentration cell
3. Determination of pH of a given solution using glass electrode
4. Determination of pH of a given solution using quinhydrone electrode
5. Determining emf of a cell
6. Potentiometric titration: Precipitation titration
7. Potentiometric titration: Acid vs base
8. Potentiometric titration: Redox titration (iron)
9. Potentiometric titration: Redox titration (cerium)
10. Determine emf of a given electrode by potentiometric method
11. Demonstrate emf measurement by Poggendorff compensation method
12. Exploration of corrosion prevention techniques in Domestic appliances

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. B.R. Puri, L.R. Sharma, Madan S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2020.
2. S.K. Dogra, Physical Chemistry through Problems, New age international, 2015.
3. RG. Mortimer, Physical Chemistry, 3rd edition., Elsevier 2009.
4. G. M.Barrow, Physical Chemistry, 5th edition., Tata McGraw Hill, 2006.
5. Engel, T. and Reid, P, Physical Chemistry, 3rd Ed., Prentice-Hall 2012.
6. Rogers, D.W. Concise Physical Chemistry, Wiley 2010
7. R.J. Silbey, R.A. Alberty, and M.G. Bawendi, Physical Chemistry, 4th edition, John Wiley & Sons, Inc. 2005.
8. Shailendra K. Sinha, Physical Chemistry-A Laboratory Manual, Narosa publishing house, 1st edition, 2014.

213CHY2303	Chemistry of Biomolecules and Natural Products	L	T	P	X	Hr	C
		3	0	2	0	5	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective		**Course Type:** Integrated course (IC)					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the metabolism, properties, stereochemical aspects and biological importance of carbohydrates.

CO2: Familiar about the structure, purification, sequencing analysis of proteins.

CO3: Know the structure, classification, properties, isolation and synthesis of terpenoids

CO4: Analyze the structural elucidation of alkaloids and their biosynthetic pathways.

CO5: Understand the process of isolation and synthesis of purines and pyrimidines.

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Carbohydrates **9 hours**

Classification of carbohydrates – Epimers, anomers, and diastereoisomers – Synthesis and interconversion of monosaccharides – Structure elucidation: Open and cyclic structure of glucose and fructose – Properties of monosaccharides (case glucose and fructose): Oxidation, reduction and condensation reactions, reaction with alkali. Disaccharides: Structure elucidation of sucrose and lactose – Polysaccharides: Structure, properties and uses of starch, cellulose – Qualitative test for carbohydrates: Molisch's tests, Anthrone test, Fehling's test, Bial's test, Seliwanoff's test and Barfoed's test.

Unit-2: Aminoacids, Peptides and Proteins **9 hours**

Preparation of α-aminoacids – Structure of aminoacids: Zwitter ion, isoelectric point and electrophoresis – Synthesis of peptides: Bergmann method, Sheehan method, solid phase synthesis. Proteins: Classification. Color reactions: Biuret test, Ninhydrin test, Xanthoproteic test, Millon's test, Hopkin's-Cole reaction. Structure analysis of proteins or peptides: N-terminal and C-terminal analysis: Sanger method, Edman degradation method, Dansyl method, Enzyme hydrolysis, hydrazinolysis – Structure of proteins: Primary, secondary and tertiary structure of proteins

Unit-3: Terpenoids **9 hours**

Structural Unit of terpenoids: Isoprene and isoprene rule – Classification – Isolation of terpenoids – Monoterpenoids: Synthesis, isomerism, properties and uses of citral and geraniol – Cyclic

monoterpenes: Synthesis chemical properties and uses of limonene, menthol and α-terpineol – Monocyclic sesquiterpenoids: Synthesis and uses of Zingiberene Bicyclic monoterpenes: Synthesis and uses of camphor – Tetraterpenes: Sources and isolation of ß-carotene, lycopene.

Unit-4: Alkaloids **9 hours**

Classification and general properties of alkaloids – Isolation/Extraction – Piperidine alkaloids: Occurrence, isolation, structure elucidation of piperidine and coniine – Pyridine alkaloid: Occurrence, isolation, structure elucidation of nicotine – Tropane alkaloids: Occurrence, isolation, structure elucidation of atropine – Quinoline alkaloid: Occurrence, isolation, structure elucidation of quinine.

Unit-5: Pyrimidines and Purines **9 hours**

Purines: Classification, occurrence and synthesis of purines and purine derivatives: Albert and Brown's method, Fischer's method, Traube's method and Saransin method. Isolation and synthesis of uric acid – Properties of Uric acid: Murexide, oxidation and reduction reaction – Isolation and synthesis of Xanthine, theophylline, theobromine, adenine, guanine and caffeine – Relation between uric acid and xanthine bases

Pyrimidines: Isolation and synthesis of pyrimidines, uracil, thymine, cytosine.

Laboratory component: **30 hours**

1. Quantitative estimation of protein using Lowry's method. Determine the concentration of the unknown sample.
2. Separation of amino acids by thin layer chromatography.
3. Qualitative analysis of monosaccharides.
4. Qualitative analysis of aminoacids & proteins.
5. Qualitative analysis of disaccharides.
6. Qualitative analysis of nucleic acids.
7. Determination of pKa of acetic acid and glycine.
8. Estimation of ascorbic acid.
9. Isoelectric pH of casein.
10. Ammonium sulphate fractionation of proteins
11. Estimation of urea
12. Quantitative analysis of aminoacids

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. S.V. Bhat, B.A. Nagasampagi and M. Sivakumar, Chemistry of Natural Products, 1st edition, Narosa Publishing House, 2008.
2. Paula Yurkanis Bruice, Organic Chemistry, 8th edition, Pearson Education, 2013.
3. Arun Bahl and B. S. Bahl, A Textbook of Organic Chemistry, 22nd edition, S Chand Publishing, 2019.

4. Gurdeep R. Chatwal, Organic Chemistry of Natural Products Vol I and II, 5th edition, Himalaya Publishing House, 2017.
5. V.K. Ahluwalia, Chemistry of Natural Products, Vishal Publishing House, 2018.
6. I.L. Finar, Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products, Pearson, 2002.
7. A.A. Siddiqui, Natural Products Chemistry Practical Manual, CBS publishers, 2019.

213CHY2104	Advanced Analytical Chemistry	L	T	P	X	Hr	C
		1	0	0	3	4	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective		**Course Type:** Theory with X-component					

Course Outcome

On completion of the course, the students will be able to

CO1: Analyze X-ray diffraction patterns of different samples

CO2: Detail the surface microstructure of materials

CO3: Analyze the surface smoothness

CO4: Evaluate the thermal stability of materials

CO5: Isolate compounds by chromatographic techniques

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: X-Ray Diffraction analysis **3 hours**

X-ray diffraction method: Principle, instrumentation, Bragg's law, powder diffraction pattern, Scherrer formula to calculate the crystallite size (concept only). Simple applications.

Unit-2: Scanning Electronic Microscopy (SEM) **3 hours**

Differences between optical microscope and electron microscope – Construction and working of SEM – Simple applications in surface topology and composition study.

Unit-3: Atomic Force Microscopy (AFM) **3 hours**

Construction and working of AFM – Contact Mode and Tapping mode analysis – Typical AFM image – Simple applications of AFM.

Unit-4: Thermal methods of analysis **3 hours**

Thermo analytical techniques – types-TGA principle-Instrumentation – TGA analysis of $CaC_2O_4.H_2O$. Differential thermal analysis-principle-DTA of $CaC_2O_4.H_2O$.-factors affecting TGA & DTA.

Unit-5: Chromatography **3 hours**

Chromatography Classification, principle and efficiency of the technique, column chromatography-thin layer chromatography, paper chromatography. Development of chromatograms: frontal, elution and displacement methods.

X-Component: **45 hours**

1. Practice of using graph plotting software
2. Compare the X-Ray diffraction pattern plotted using the graph plotting software with JCPDS

3. Compare the X-Ray diffraction pattern plotted using the graph plotting software with JCPDS
4. Collect various SEM images from research articles and identify the instrument details
5. Collect various SEM images from research articles and interpret them
6. Collect various AFM images from research articles and identify the instrument details
7. Collect various AFM images from research articles and interpret them
8. Develop a chromatogram for toner ink (black)
9. Develop a chromatogram for fountain pen ink (black)
10. Identify the thermal stability range for the given sample from its TGA trace – I
11. Identify the thermal stability range for the given sample from its TGA trace – II
12. Visit an instrumentation facility and prepare a report on sampling techniques (any 1 technique from this paper)

Reference books:

1. R. Gopalan, P.S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, 7th edition, Sultan Chand, 2015
2. Gurdeep R Chatwal, Sham K. Anand, Instrumental Methods of Chemical Analysis, Himalaya publishing house. 2005
3. Douglas A. Skoog, Donald M. West and F. J. Holler, Fundamentals of Analytical Chemistry, 7th edition, Harcourt College Publishers, 1995.
4. S.M. Khopkar, Basic Concepts of Analytical Chemistry, New Age International Publisher, 2008.
5. D.A Skoog, F.J. Holler, T.A. Nieman, Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd., 2005.

213CHY2305	Medicinal Chemistry	L	T	P	X	Hr	C
		3	0	2	0	5	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective **Course Type:** Integrated Course							

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the importance of clinical hygiene and identify various biochemical analysis methods

CO2: Explain the important terminologies used in pharmacology

CO3: Analyze the different types drugs and their synthetic methods

CO4: Understand physiological effects of different functional groups in drugs and drug formulation techniques.

CO5: Plan and execute the various pharmaceutical marketing strategies.

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Clinical hygiene and biochemical analysis **9 hours**

Definition of health. Role of WHO. Sterilization of surgical instruments. Disinfectants, antiseptics, sanitation. Treatment for specific poisons- acids, alkalis, arsenic and mercury compounds. Body Fluid Blood volume, blood groups, coagulation of blood. Plasma lipoproteins. Blood pressure. Arteriosclerosis, diseases affecting red cells: Hyperchromic and hypochromic anaemia. Blood transfusion. Coagulation, biochemical analysis of urine, serum and fecal matter, Methods of determination of blood sugar and diabetes.

Unit-2: Introduction to pharmaceutical chemistry **9 hours**

Important terminologies used-molecular pharmacology- Pharmacodynamics-Pharmacognosy, Pharmacophore, metabolites, Virus antimetabolites, bacteria, fungi, actinomycetes. Name of drugs, code number, chemical proprietary, trivial trade, Non-proprietary Names, synonyms (meaning only), dosage of drugs, storage of drugs, different temperature conditions. Assay- biological, chemical immunological- statement only, Metabolism of drugs and their effect on pharmacological activity.

Unit-3: Common drugs **9 hours**

Manufacture of drugs (quinine, reserpine, only structure for atopside and d–tubocurarine) from Indian medicinal plants. Testing of drugs: biological variation, screening and toxicity. Use of pharmacopeia and therapeutic index. Types of drugs and their modes of action: Depressant drugs (special reference to sedatives and hypnotics). Anticonvulsant drugs (sodium valproate). Narcotic analgesics (only morphine compounds). Antipyretic analgesics (p–aminophenol derivatives). Antibiotics (streptomycin, chloramphenicol). Cardiovascular drugs-nitrates, betablockers (propranolol and atenolol) and calcium channel blockers. Radiation therapy – chemotherapy.

Unit-4: Effects and formulation of drug **9 hours**

Physiological effects of different functional groups in drugs (any 2 functional groups). Testing of potential drugs and their side effect- Ethical clearance and clinical trials.

Need for conversion of drugs into medicine - additives and their role-classification of formulations- route wise and form wise: tablets, capsules, syrups, suspensions, powders, ointment, creams, gels, lotions, sprays suppositories, Injections.

Unit-5: Pharmaceutical marketing **9 hours**

Manufacture, packaging, distribution and stocking. Pharmaceutical Market, Pharmacy – Channels of distribution - Wholesaler & retailer - Departmental stores& chain stores -mail order business – Drug house management.

Laboratory component: **30 hours**

1. Preparation of methyl salicylate
2. Preparation of p–amino–phenol derivatives
3. Preparation of Magnesium bisilicate (antacid)
4. Preparation of Benzimidazole.
5. Preparation of 1,4 – dihydropyridine
6. Preparation of Acid/Basic Salts of Drugs and Evaluation of their Physicochemical Properties. (Benzilic Acid & Sodium Benzoate)
7. Purification of synthesized compounds by column chromatography
8. Computational modelling of drug design/use of software
9. Preparation of anthranilic Acid
10. Preparation of sulphanilamide
11. Preparation of sulphaguanidine
12. Preparation of phenacetin

Note: Any ten experiments with atleast two per unit will be covered.

Reference books:

1. J. Ghosh, A textbook of Pharmaceutical Chemistry, S. Chand and Co. Ltd, 3rd revised edition, 2014.
2. G L David Krupadanam, D Vijaya Prasad, K Varaprasad Rao, K L N Reddy and C Sudhakar, Drugs, Universities Press, Hyderabad, 2001.
3. Graham Patrick, Instant notes – Medicinal chemistry, PragatiPrakashan Viva books (Pvt.) Ltd, 2002.
4. Alka& Gupta, Medicinal chemistry, PragatiPrakashan, 2nd edition, 2008.
5. D.J. Abraham, D. P. Rotella, Burger's Medicinal Chemistry, Drug Discovery and Development, 7th edition., Vol- 8, Wiley Publications, New York, 2010.

213CHY2306	Polymer Chemistry	L	T	P	X	Hr	C
		3	0	2	0	5	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline specific elective		**Course Type:** Integrated Course					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the basic concepts of polymer chemistry

CO2: Predict the mechanism of polymerization

CO3: Analysing the degradation mechanism of various polymers

CO4: Evaluating the properties of industrial polymers

CO5: Formulate the polymer processing technology

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Introduction to polymers **9 hours**

Introduction: Background, Nomenclature, Classifications, Structure of polymers- Polydispersity index, Crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, van der Waals volume – Coefficient of linear thermal expansion and volumetric thermal expansion Pressure volume temperature (PVT) relationship.

Unit-2: Synthesis of polymers **9 hours**

Principles of Polymerization, Step-Growth Polymerization, Radical Chain Polymerization, Controlled Radical Polymerization, Chain Copolymerization, Emulsion Polymerization, Ionic Chain Polymerization, Ring-Opening Polymerization and Stereo-Regular Polymerization: Ziegler Natta polymers.

Unit-3: Characterization and degradation of polymers **9 hours**

Determination of Molecular mass of polymers: Number Average molecular mass (Mn) and Weight average molecular mass (Mw) of polymers and determination by (i) viscosity (ii) Light scattering method (iii) Gel Permeation Chromatography (iv) osmometry and ultracentrifuging. Spectroscopic techniques to determine chemical composition and molecular microstructure. Types of Polymer Degradation, Thermal degradation, mechanical degradation, photodegradation, Photo stabilizers.

Unit-4: Industrial polymers **9 hours**

Introduction to Thermoplastics and thermosetting plastics- Elastomers: natural and synthetic. Preparation, properties and applications of i) Thermoplastics:Polyethylene, Polypropylene, polystyrene, Polyacrylonitrile, Poly Vinyl Chloride, Poly tetrafluoro ethylene, nylon and polyester. ii) Thermosetting plastics: Phenol formaldehyde and expoxide resin .iii) Buna - N, Buna-S and neoprene Conducting Polymers: Elementary ideas; examples: poly sulphur nitriles, poly phenylene,

poly pyrrole and poly acetylene.

Unit-5: Introduction to polymer processing **9 hours**

Compounding: Polymer Additives: Fillers, Plasticizers antioxidants and thermal stabilizers fire retardants and colorants. Processing Techniques: Calendaring, die casting, compression moulding, injection moulding, blow moulding, extrusion moulding and reinforcing. Film casting, Foaming and Thermo foaming.

Lab component: **45 hours**

1. Determining the crystallinity of the polymer using differential scanning calorimetry.
2. Predicting the structure of a polymer using FTIR spectra
3. Synthesis polystyrene and to evaluate the mechanism of formation.
4. Synthesis of Nylon-66 and to validate the mechanism of formation
5. Determining the molecular weight of the synthesised polystyrene and Nylon-66
6. Subjecting the synthesised polystyrene and Nylon-66 to mechanical and thermal degradation and to analyse the molecular weight.
7. Synthesis of a conducting polymer.
8. Evaluate the conductivity of synthesised conducting polymer
9. Synthesis of polymer composite with natural filler in die casting/ compression moulding.
10. Synthesis of polymer composite film in foaming or thermo foaming.

Reference books:

1. Polymer Science, V.R. Gowariker, 3rd edition, New age international publisher,2019.
2. Introductory Polymer Chemistry, G.S. Misra, New Age International (Pvt) Limited, 1996.
3. Textbook of Polymer Science, F. N. Billmeyer, 3rd edition, Wiley, 2007.
4. Fundamentals and Polymer Science and Engineering, Anil Kumar, Rakesh K. Gupta, CRC Press, 2018.
5. Properties Of Polymer, D.W. Van Krevelen and P.J. Hoftyzen, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
6. Physical Properties of Polymers Hand Book, J.E. Mark, Springer; 2nd edition, 2007.
7. Reaction Engineering of Step Growth Polymerization S K Gupta and Anil Kumar, Springer US, 2012.
8. Polymers: Chemistry and Physics of Modern Materials, J.M.G. Cowie, Valeria Arrighi, CRC Press, 2007.
9. Introductory Polymer Chemistry, G.S. Misra, New Age International (Pvt) Limited, 1996.

213CHY2107	Nanochemistry	L	T	P	X	Hr	C
		4	0	0	0	4	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Program Core	**Course Type: Theory**						

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the basic concepts and classification of nanomaterials

CO2: Study the common properties and size dependent absorption behavior of nanomaterials

CO3: Acquire knowledge on synthesis of organic nanoparticles

CO4: Illustrate synthesis and properties of carbon nanotube

CO5: Apply nanomaterials in various fields including catalysis, photonics and medicine.

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Basics of nanochemistry **12 hours**

Basics of nanomaterials: Properties of nanomaterials, quantum confinement effect, surface to volume ratio, surface properties of nanoparticles. Classification of the nano materials – zero dimensional, one dimensional, two dimensional and three-dimensional nanostructures.

Unit-2: Properties of nanomaterials **12 hours**

Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra.

Unit-3: Organic nanoparticles **12 hours**

Introduction, definition, structure, types of NP, analytical methods (extraction and isolation, Separation, Characterization and Imaging), general method of preparation, properties, detection, and characterization of organic nanoparticles: hydrophobic drugs, protein, peptide, lipid, cyclodextrine, polysaccharides – Nanocochleates - Prospects and future challenges.

Unit-4: Carbon nanomaterials **12 hours**

Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, electronic, vibrational, mechanical and optical properties of CNT; applications of CNT and fullerenes. GO and RGO

Unit-5: Applications of nanomaterials **12 hours**

Catalysis on nanoparticles, semiconductors, sensors, and electronic devices, ferroelectric materials,

coatings, photochemistry and nanophotonics, nanomaterials in biology and medicine.

Reference books:

1. CNR Rao, The Chemistry of Nanomaterial: Synthesis, Properties and Applications, Vol. I and II, Springer, 2006.
2. S. Shanmugam, Nanotechnology, MJP Publishers, Chennai, 2010.
3. Znong Lin Wang, Characterization of Nanophase Materials" Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2000.
4. G. Schmidt, Nanoparticles: From theory to applications, Wiley Weinheim, 2004.
5. C.M. Hussain (editor) Handbook of Nanomaterials for Manufacturing Applications, 1st edition, Elsevier, 2020.

213CHY2108	Organic Photochemistry and Pericyclic Reactions	L	T	P	X	Hr	C
		4	0	0	0	4	4
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Discipline Specific Elective		**Course Type: Theory**					

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the mechanisms of energy transfer and electron transfer processes involved in photochemical reactions of organic compounds

CO2: Analyze the thermal and photochemical pathways of various pericyclic reactions

CO3: Study the classification, modes and stereochemical aspects of electrocyclic reactions

CO4: Acquire the knowledge of thermal and photochemical cycloaddition reactions and their stereochemical aspects.

CO5: Understand the mechanisms of sigma tropic rearrangements and chelotropic reactions

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Organic photochemistry **12 hours**

Introduction, definitions, importance. Electronic excitation and spin configurations – Jabolanski diagram. Energy transfer and electron transfer processes – quenching of excited states. Photochemistry of carbonyl compounds. Photochemistry of olefins, enones and dienones, photochemistry of aromatic molecules, molecular oxygen and organic photochemistry.

Unit-2: General aspects of pericyclic reactions **12 hours**

General introduction, activation of chemical reactions. Thermal and photochemical methods, molecular orbitals of conjugated polyenes and their symmetry properties. Definition and classification of pericyclic reactions. Methods of analyzing pericyclic reactions.

Unit-3: Electrocyclic reactions **12 hours**

Introduction, definition and classification, Woodward- Hoffmann rules for electrocyclic reactions. Stereochemical aspects and modes of electrocyclic reactions. Analysis of electrocyclic reactions by various methods. Examples of electrocyclic reactions.

Unit-4: Cycloaddition reactions **12 hours**

Woodward- Hoffmann rules for cycloaddition reactions. Stereochemical aspects and modes of cycloaddition reactions. Analysis of cycloaddition reactions by various methods. Examples of thermal and photochemical [2p+2p] cycloaddition reactions. Synthesis of cage type compounds using [2p+2p] cycloaddition reactions. Diels-Alder reaction, its variants and their synthetic utility. 1,3-

Dipolar cycloaddition reactions. Higher order cycloaddition reactions.

Unit-5: Sigmatropic rearrangements and chelotropic reactions **12 hours**

Woodward Hoffmann rules for sigmatropic rearrangements. Sigmatropic rearrangements – examples, Claisen and Cope rearrangements. [2,3]-sigmatropic rearrangements and higher order rearrangements. Chelotropic reactions - introduction, definition and classification. Ene reaction.

Reference books:

1. S. Sankararaman, Pericyclic Reactions - A textbook, Wiley-VCH, 2005.
2. I. Fleming, Pericyclic Reactions, Oxford University Press, 1999.
3. N.J. Turro, V. Ramamurthy and J. C. Scaiano, Modern Molecular Photochemistry of Organic Compounds, University Science Books, 2010.
4. Dinda and Biswanath, Essentials of Pericyclic and Photochemical Reactions, Springer, 2017.

SKILL ENHANCEMENT COURSES

214CHY1101	Biofertilizers	L	T	P	X	Hr	C
		1	0	0	3	4	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Skill Enhancement Course		**Course Type:** Theory					

Course Outcome

On completion of the course, the students will be able to

CO1: Acquire knowledge about biofertilizers

CO2: Understand the classification, characteristics and application of bioenzymes

CO3: Analyse the role of bioenzymes in biological cycle

CO4: Understand the types and taxonomy of mycorrhizal

CO5: Able to get knowledge about organic farming

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Need for biofertilizers **3hours**

Biofertilizers: Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production. A study of growth characteristics of various microbes used in biofertilizers production.

Unit-2: Microbial inoculant **3 hours**

Nitrogen cycle in Nature. Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen fixation – Rhizobium – isolation, identification, mass multiplication, carrier-based inoculants, Actinorhizal symbiosis. *Azospirillum:* isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit-3: Plant nutrient enhancement **3 hours**

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit-4: Integrated plant nutrient system **3 hours**

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit-5: Organic farming **3 hours**

Organic farming – Green manuring and organic fertilizers, Recycling of bio- degradable municipal, agricultural and Industrial wastes – bio compost making methods, types and method of vermi

composting – field Application.

X-factor activities: The activities listed below complement the lessons learned in the lecture/theory class. The activities are designed to correlate the theoretical concepts as applicable to real-world situations/settings. As part of the activities, field visit to the agriculture and horticulture fields attached to the KARE for hands-on experience on the use, advantages and challenges of using biofertilizers may be included.

X-Component **45 hours**

1. Enumeration of soil microbes by Plate culture method
2. Isolation of Microorganisms from soil sample – Bacteria, Fungi, Actinomycetes and Azotobacteria.
3. Isolation and cultivation of Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Actinomycetes, Mycorrhiza.
4. Biofertilizer production using Rhizobium
5. Biofertilizer production using Mycorrhiza
6. Quality control aspects in biofertilizer production
7. Strategies for biofertilizer field application
8. Commercialization and large-scale production techniques
9. Preparation of organic fertilizer from agriculture and food waste
10. Preparation of vermicomposting pit

Reference books:

1. NIIR Board. The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services , 2012.
2. Subba Rao, N.S. Biofertilizers in Agriculture and Forestry. 3rd Edition, Oxford and IBH. Publ. Co., New Delhi, 2019.
3. Giri, B., Prasad, R., Wu, Q.-S., Varma, A., Biofertilizers for Sustainable Agriculture and Environment, Springer Books, 2019.
4. Abdin, M.Z., Kiran, U., Kamaluddin, M., Ali, A. Plant Biotechnology: Principles and Applications, Springer Books, 2017
5. Dubey, R.C. A Text book of Biotechnology, 5th Edition, S.Chand & Co, New Delhi. 2014

214CHY1102	Fermentation Science and Technology	L	T	P	X	Hr	C
		1	0	0	3	15	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Skill Enhancement Course					**Course Type:** Theory		

Course Outcome

On completion of the course, the students will be able to

CO1: Acquire fundamental knowledge in preparation of microbial culture

CO2: Analyze the kinetics of microbial growth and product formation

CO3: Learn about the scope and opportunities of fermentation technology

CO4: Analyze the production of variety of material through fermentation technology

CO5: Study about the microbial production of enzymes

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Introduction to submersion fermentation techniques **3 hours**

Introduction to fermentation techniques, Preparation of microbial culture, Preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.

Unit-2: Fermentation techniques **3 hours**

Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

Unit-3: Batch fermentation **3 hours**

Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture.

Unit-4: Range of fermentation technology **3 hours**

Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).

Unit-5: Industrial fermentation process **3 hours**

Microbial production of enzymes: Amylase and Protease. Bioproduct recovery; Removal of Microbial cells – a) Foam Separation b) Precipitation; Filtration & Centrifugation

X-factor activities: The activities listed below complement the lessons learned in the lecture/theory class. The activities are designed to correlate the theoretical concepts as applicable to real-world situations/settings.

X-Component **45 hours**

1. Introduction to good microbiological laboratory practice
2. Understanding spillage management and aerosols
3. Understanding the chemical process during fermentation
4. Consolidate the industrial application of fermentation
5. Experiment to understand solid-state fermentation of kitchen waste
6. Studying the role of temperature on yeast fermentation of glucose
7. Understanding the fermentation process through production of alcohol
8. Understanding the fermentation process through production of amino acids
9. Comprehension of industrial fermentation process to produce enzymes
10. Comparison of different techniques for the separation of microbes and solid matter

Reference books:

1. Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton, Industrial Microbiology: An Introduction, Wiley, 2013.
2. L E J R Casida. Industrial Microbiology, New Age International (P) Limited Publishers, New Delhi, India. 2015
3. Prescott S.C., Dunn C.G. Industrial Microbiology, Jodhpur: Agrobios (India), 2011.
4. Pelczar M.J., Chan E.C.S. and Krieg N.R. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi. 2010.

214CHY1103	Herbal Science and Technology	L	T	P	X	Hr	C
		1	0	0	3	4	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Skill Enhancement Course					**Course Type:** Theory		

Course Outcome

On completion of the course, the students will be able to

CO1: Understand the methods of cultivation of herbal products

CO2: Develop the skills for cultivation and processing of herbal

CO3: Evaluate the quality of drugs through the biological testing

CO4: Formulate the value-added processing / storage for the better use of herbal medicine

CO5: Design a methodology of cultivation for various herbal plants

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Herbal technology **3 hours**

Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation - harvesting - processing - storage of herbs and herbal products.

Unit-2: Value added plant products **3 hours**

Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeticals and biopesticides, their Botanical names, plant parts used, major chemical constituents.

Unit-3: Pharmacognosy **3 hours**

Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus*, *Withania somnifera*, *Centella asiatica*, *Achyranthes aspera*, Kalmegh, Giloe (Tinospora), Saravar. Herbal foods, future of pharmacognosy.

Unit-4: Phytochemistry **3 hours**

Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs -Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit-5: Analytical pharmacognosy **3 hours**

Plant gene banks, Cultivation of Plants and their value-added processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation of some medicinal plants (*Withania somnifera*, neem and tulsi)

X-factor activities: The activities listed below complement the lessons learned in the lecture/theory class. The activities are designed to correlate the theoretical concepts as applicable to real-world situations/settings.

X-Component **45 hours**

1. Study the good agricultural and manufacturing practices in medicinal herbs
2. Studies on the geographical and seasonal variations in chemical compounds available in medical herbs
3. Identification of medicinal herbs used in commercially available cosmeceutical products
4. Identification of medicinal herbs used in commercially available nutraceutical products
5. Determination of alcohol-soluble extractive value of ginger
6. Determination of water-soluble extractive value of ginger
7. Chemical screening tests for secondary metabolites - alkaloids
8. Chemical screening tests for secondary metabolites - terpenoids
9. Determination of ash content in crude herbal formulations
10. Determination of moisture content in herbal formulation

Reference materials:

1. Current scenario of Herbal Technology worldwide: An overview. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. Int J Pharm Sci Res; 4(11): 4105-17. 2013.
2. AYUSH website. About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India (https://main.ayush.gov.in).
3. Plant Food Residues as a Source of Nutraceuticals and Functional Foods Varzakas, T., Zakynthinos, G, and Francis Verpoort, Foods 5: 88. (2016).
4. Plants Used in Cosmetics, Aburjai, T. and Natsheh, F.M. Phytotherapy Research 17:987-1000. 2003.

Reference books/Textbooks:

1. Agnes Arber, Herbal Plants and Drugs: Their Origin and Evolution, Mangal Deep Publications, Jaipur, 2000.
2. Patri, G. and Silano,V. Plants in cosmetics: Vol. 1: Plants and plant preparations used as ingredients for cosmetic products, Stationery Office Books, 2002.
3. Evans W.C., Trease and Evans Pharmacognosy, 16th Edition, SAUNDERS/ Elsevier, 2009
4. Sivarajan, V.V. and Indira Balachandrani, Ayurvedic Drugs and Their Plant Sources, CBS Publishers & Distributors Pvt Ltd, India, 2017.
5. Miller, L. and Miller, B, Ayurveda and Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing, Motilal Banarsidass, 4th Edition 2017.
6. Kokate, C.K., Practical Pharmacognosy, Vallabh Prakashan, Pune, 18th Edition, 2017

214CHY1104	Fuel Chemistry	L	T	P	X	Hr	C
		1	0	0	3	4	2
Pre-requisite: Basic knowledge of Chemistry at the higher secondary course level							
Course Category: Skill Enhancement Course	**Course Type: Theory**						

Course Outcome

On completion of the course, the students will be able to

CO1: Know the chemistry of fuels

CO2: Understand the role of coal as a fuel

CO3: Explain the petroleum products and industry

CO4: Understand the petrochemical sources for suitable applications

CO5: Analyze the principles of lubrication process and lubricants

Mapping of Course Outcome(s):

CO/PO	Programme Outcome (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	S	S	S	S			M		L			S
CO2	S	S	S	M		M				M	M	
CO3	S	S	S	M		M		L		M		S
CO4	S	S	S	S		M		L		M		S
CO5	S	S	S	M	M	S		M		M		M

Unit-1: Fuels and their classification **6 hours**

Review of energy sources - Renewable and Non-renewable resources (Wood, geothermal, biofuels, coal and nuclear fuels) - Characteristics of a good fuel - Classification of fuels: Solid, liquid and gaseous fuels - comparison - advantages of gaseous fuels.

Calorific value of fuels: Definition - Types. Theoretical calculation of calorific value.

Unit-2: Coal processing **6 hours**

Uses of coal (fuel and non-fuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas - composition and uses - Rrequisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification).

Unit-3: Petroleum and non-petroleum fuels **6 hours**

Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming - Petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Unit-4: Petrochemicals **6 hours**

Synthesis, properties and industrial uses of the following chemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives - Xylene.

Unit-5: Lubricants **6 hours**

Classification of lubricants, lubricating oils (conducting and non-conducting) - Solid (Graphite and

molybdenum disulphide) and semisolid lubricants (Greases), synthetic lubricants - Silicone oils. Properties of lubricants: Viscosity index, cloud point, pour point and their determination.

Reference books:

1. Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd., UK (1990).
2. Jain, P.C. & Jain, M. *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi (2008).
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
4. James G. Speight, Handbook of Petrochemical Processes, 1st edition, CRC Press. 2019.
5. G. Totten, R. Shah and D. Forester, Fuels and Lubricants Handbook: Technology, Properties, Performance and Testing, 2nd edition, Portland State University, 2019.

EXPERIENTIAL ELECTIVE COURSE

215CHY4201	Project	L	T	P	X	H	C
		0	0	12	3	12	6
Prerequisite: Nil		**Course Category:** Experiential Elective **Course Type**: Practical					

Objectives: To develop the students' knowledge towards solving, analysing and/or exploring the real time difficult problems.

Course Outcomes:

Upon successful completion of this course, students will be able to

CO1: Demonstrate the fundamental chemistry concepts

CO2: Undertake the problem identification, formulation and solution

CO3: Demonstrate knowledge of contemporary issues in their chosen field of research.

CO4: Design the new solution/product

Mapping of COs and POs

CO/PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	1					1			2	3	1	2
CO2	3	3	2	2	2	1	1	1				1	3	1	2
CO3	3	3	3	3	3	2		2	2	2	1	1	3	3	3
CO4	3	3	3	3	3	3		2	1	2	2	2	3	3	3

3 - Strong Correlation; 2- Medium Correlation; 1- Low Correlation

This course will be conducted largely as an individual or small group project under the direct supervision of a member of academic staff. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. The following few fields are listed below.

- Synthetic organic chemistry
- Nanomaterials and applications
- Supramolecular chemistry
- Polymer chemistry
- Surfactants
- Photochemistry
- Computer simulation towards chemistry problems
- Materials synthesis and characterizations
- Electrochemistry
- Catalysis (Inorganic / organic/ physical)
- Energy chemistry
- Bioorganic chemistry

Those who want to select the project fields which are not listed above, they are also permitted to do the project on their own interest with the permission of supervisor and department.

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