PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

KOZHIKODE, KERALA



Syllabus

Four Year Under Graduate Programme

BSc CHEMISTRY HONOURS

(Major, Minor and General foundation Courses)

w.e.f. 2024-25 Admissions

BOARD OF STUDIES IN CHEMISTRY

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS), KOZHIKODE, KERALA

Sl. No.	Name & Designation	Institution
1	Dr. (Sr.) Asha Thomas, Asst. Professor,	
1	Chairman, Head of the Department	
2.	Dr. Deepthi Jose, Asst. Professor, Member	
3.	Dr. Anu Jose, Asst. Professor, Member	Department of Chamistay, Providence Wamen's
4.	Dr. Sareena C, Asst. Professor, Member	Department of Chemistry, Providence Women's College (Autonomous), Kozhikode
5.	Dr. Reshma C, Asst. Professor, Member	
6.	Dr. Ann Jasmine Jose, Asst. Professor, Member	
7.	Dr. Anjitha Theres Benny, Asst. Professor, Member	
	Dr. G. Unnikrishnan, Professor	Department of Chemistry, National Institute of
8.	Subject expert from outside the parent university	Technology Calicut (NITC), Calicut 9846764238, unnig@nitc.ac.in
0	Dr. Pradeepan Periyat, Associate Professor	Department of Environmental Science, Kannur
9.	Subject expert from outside the parent university	University, Mangattuparamba Campus Kerala, pperiyat@kannuruniv.ac.in
	Dr. Rajeev S Menon, Professor	Professor & Head, Department of Chemistry,
10.	Expert recommended by the principal and nominated by the VC	University of Calicut, rajeev@uoc.ac.in
11.	Dr. Sheeba Velathur	Managing Director, Core Valley Herbal
11.	Representative from industry	Technologies Pvt. Ltd.
12.	Dr. Sheeba. P. S., Associate Professor Post graduate meritorious alumnus	Department of Chemistry, Malabar Christian College, Calicut 673001 sheebapvs@gmail.com

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS), KOZHIKODE

B.Sc. CHEMISTRY HONOURS (MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(FYUGP Regulations 2024)

B.Sc. CHEMISTRY HONOURS (MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

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PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Providence Women's College (Autonomous), a student would:

	Knowledge Acquisition:
PO1	Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
	Communication, Collaboration, Inclusiveness, and Leadership:
PO2	Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
	Professional Skills:
PO3	Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
	Digital Intelligence:
PO4	Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
	Scientific Awareness and Critical Thinking:
PO5	Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
	Human Values, Professional Ethics, and Societal and Environmental Responsibility:
PO6	Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication
	to the well-being of society and the environment.
	Research, Innovation, and Entrepreneurship:
PO7	Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc Chemistry Honours programme at Providence Women's College (Autonomous), a student would:

PSO1	Understand theoretical concepts and applications across major chemistry subfields,
	including inorganic, organic, physical, analytical chemistry, and quantum mechanics.

PSO2	Evaluate complex chemical phenomena and real-world problems by applying principles of theoretical chemistry and computational chemistry.
PSO3	Develop practical skills in handling chemicals safely, preparing solutions, conducting experiments, and analyzing chemical species in the lab.
PSO4	Design and execute a project to solve real-world problems following the needs of
	society and academic research within a stipulated time frame.
PSO5	Acquire foundational knowledge of chemistry essential for advanced studies in
	interdisciplinary fields such as Physics, Mathematics, Botany, Zoology, Geology, and
	other related disciplines.
PSO6	Apply chemistry knowledge to various industries including pharmaceuticals, materials
	science, energy, polymer, and environmental monitoring.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN FYUGP

Sl.	Academic	Major	Minor/	Foundation	Intern	Total	Example
No ·	Pathway		Other Disciplines	Courses AEC: 4 MDC: 3	-ship	Credit s	
			ourse has redits	SEC: 3 VAC: 3			
				Each course has 3 credits			
1	Single Major (A)	68	24	39	2	133	Major: Chemistry +
		(17 courses)	(6 courses)	(13 courses)			six courses in different disciplines in different combinations
2	Major (A) with Multiple Disciplines	68	12 + 12	39	2	133	Major: Chemistry +
	(B, C)	(17 courses)	(3 + 3 = 6 courses)	(13 courses)			Mathematics and Physics
3	Major (A) with	68	24	39	2	133	Major: Chemistry,

	Minor (B)	(17 courses)	(6 courses)	(13 courses)			Minor: Physics
4	Major (A) with Vocational Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Chemistry, Minor: Vocational Chemistry
5	Double Major (A, B)	A: 48 (12 courses) B: 44 (11 courses)	are distribut Majors. 2 MDC, 2 Internship structured to the structure of	its in the Minor ted between SEC, 2 VAC hould be in Major A sin M	and the Major A. hould be	133	Chemistry and Physics double major

Exit with UG Degree / Proceed to Fourth Year with 133 Credits

B.Sc. CHEMISTRY HONOURS PROGRAMME COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major

2. Major with Multiple Disciplines

3. Major with Minor

4. Major with Vocational Minor

Se mes ter	Course	Course Title	Total	Hours/	Credi	Marks			
	Code		Hours	Week	ts	Inte rnal	Exte rnal	Total	
1	CHE1CJ 101/ CHE1M N100	CORE COURSE 1 IN MAJOR – INORGANIC CHEMISTRY I	75	5	4	30	70	100	
		MINOR COURSE 1	60/75	4/5	4	30	70	100	
		MINOR COURSE 2	60/75	4/5	4	30	70	100	

	ENG1F A	ABILITY ENHANCEMENT COURSE 1– ENGLISH	60	4	3	25	50	75
	101(2)	ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
		MULTI-DISCIPLINARY COURSE 1 – OTHER THAN MAJOR	45	3	3	25	50	75
		TOTAL		23/25	21			525
	CHE2CJ 101/ CHE2M N100	CORE COURSE 2 IN MAJOR– PHYSICAL CHEMISTRY –I: STATES OF MATTER	75	5	4	30	70	100
		MINOR COURSE 3	60/75	4/5	4	30	70	100
		MINOR COURSE 4	60/75	4/5	4	30	70	100
2	ENG2F A 103(2)	ABILITY ENHANCEMENT COURSE 3– ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
		MULTI-DISCIPLINARY COURSE 2 - OTHER THAN MAJOR	45	3	3	25	50	75
		TOTAL		23/25	21			525
	CHE3CJ 201	CORE COURSE 3 IN MAJOR – THEORETICAL CHEMISTRY I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100
	CHE3CJ 202/ CHE3M N200	CORE COURSE 4 IN MAJOR – ORGANIC CHEMISTRY 1	75	5	4	30	70	100
		MINOR COURSE 5	60/75	4/5	4	30	70	100
3		MINOR COURSE 6	60/75	4/5	4	30	70	100
		MULTI-DISCIPLINARY COURSE 3 - KERALA KNOWLEDGE SYSTEM	45	3	3	25	50	75
	ENG3F V 108(2)	VALUE-ADDED COURSE 1 – ENGLISH	45	3	3	25	50	75
		TOTAL		23/25	22			550

	CHE4CJ	CORE COURSE 5 IN MAJOR –				20	70	100
	203	INORGANIC CHEMISTRY-II	75	5	4	30	70	100
	CHE4CJ	CORE COURSE 6 IN MAJOR –	75	5	4	30	70	100
	204	ORGANIC CHEMISTRY-II	75	3	4	30	70	100
		CORE COURSE 7 IN MAJOR –				30	70	100
	CHE4CJ	PHYSICAL CHEMISTRY –II:						
	205	CHEMICAL THERMODYNAMICS,	75	5	4			
		KINETICS & SURFACE						
4	ENG4F	CHEMISTRY						
	V	VALUE-ADDED COURSE 2 –	45	3	3	25	50	75
	109(2)	ENGLISH	43	3	3			
	105(2)	VALUE-ADDED COURSE 3 –			_	25	50	7.5
		ADDITIONAL LANGUAGE	45	3	3	25	50	75
	ENG4F	SKILL ENHANCEMENT COURSE				25	50	75
	S	1 – ENGLISH	60	4	3			, -
	111(2)	1 ENGLISH						
		TOTAL		25	21			525
		CORE COURSE 8 IN MAJOR –				30	70	100
	CHE5CJ	THEORETICAL CHEMISTRY II:	60	4	4			
	301	GROUP THEORY AND		•				
	CTTT - CT	MOLECULAR SPECTROSCOPY						
	CHE5CJ	CORE COURSE 9 IN MAJOR –	75	5	4	30	70	100
_	302	INORGANIC CHEMISTRY-III						
5	CHE5CJ	CORE COURSE 10 IN MAJOR –	75	5	4	30	70	100
	303	ORGANIC CHEMISTRY - III ELECTIVE COURSE 1 IN MAJOR	60	4	4	30	70	100
		ELECTIVE COURSE 2 IN MAJOR	60	4	4	30	70	100
		SKILL ENHANCEMENT COURSE				25	50	75
		2	45	3	3	23	30	75
		TOTAL		25	23			575
	CHE6CJ							
	304/	CORE COURSE 11 IN MAJOR –	60	4	1	30	70	100
	CHE8M	INORGANIC CHEMISTRY-IV	00	4	4		, 0	100
6	N304							
	CHE6CJ							
	305/	CORE COURSE 12 IN MAJOR-	75	5	4	30	70	100
	CHE8M	ORGANIC CHEMISTRY - IV						
	N305							

	ı	T	1		1		I	
		CORE COURSE 13 IN MAJOR –						
	CHE6CJ	PHYSICAL CHEMISTRY – III:				30	70	100
	306/	CHEMICAL AND PHASE	75	5	4			
	CHE8M	EQUILIBRIA,	13	3	7			
	N306	ELECTROCHEMISTRY AND						
		PHOTOCHEMISTRY						
		ELECTIVE COURSE 3 IN MAJOR	60	4	4	30	70	100
		ELECTIVE COURSE 4 IN MAJOR	60	4	4	30	70	100
		SKILL ENHANCEMENT COURSE	4.5	2	2	25	50	75
		3	45	3	3	23	30	73
		INTERNSHIP IN MAJOR (CREDIT				50		50
	CHE6CJ	FOR INTERNSHIP TO BE				30	-	30
	349	AWARDED ONLY AT THE END	60		2			
		OF SEMESTER 6)						
		TOTAL		25	25			625
	1	TOTAL CREDITS FOR THREE YEAD	RS		133			3325
	CHE7CJ	CORE COURSE 14 IN MAJOR –				30	70	100
	401	THEORETICAL CHEMISTRY III:		_	4	30	70	100
		ADVANCED QUANTUM	75	5	4			
		CHEMISTRY						
	CHE7CJ	CORE COURSE 15 IN MAJOR –				20	7.0	100
	402	INORGANIC CHEMISTRY-V	75	5	4	30	70	100
	CHE7CJ	CORE COURSE 16 IN MAJOR –				20	70	100
	403	ORGANIC CHEMISTRY V	75	5	4	30	70	100
7	CHE7CJ	CORE COURSE 17 IN MAJOR –				20	70	100
	404	PHYSICAL CHEMISTRY IV:				30	70	100
	101	STATISTICAL	75	5	4			
		THERMODYNAMICS						
	CHE7CJ	CORE COURSE 18 IN MAJOR –				20	5 0	400
	405	INSTRUMENTAL METHODS OF	75	5	4	30	70	100
	105	ANALYSIS	, ,					
		TOTAL		25	20			500
	CHE8CJ	CORE COURSE 19 IN MAJOR –						- 30
	406/	INORGANIC CHEMISTRY-VI						
	CHE8M	INOROZINIC CILIVIIOTICI - VI	60	4	4	30	70	100
	N406							
8	CHE8CJ	CORE COURSE 20 IN MAJOR –						
	407/	ORGANIC CHEMISTRY- VI						
	CHE8M	OROMNIC CHEWISTRI- VI	75	5	4	30	70	100
	N407							
	1140/							

60					
60	1				100
1 00	4	4	30	70	100
	-				
COURSES 1	19- 21 IN	MAJOR	₹)		
260*	1.2*	12	90	210	300
360	13	12	90	210	300
			90	210	300
360*	13*	12	70	210	300
60	4	1	30	70	100
00	4	4	30	/0	100
60	1	1	30	70	100
00	4	4	30	70	100
60	4	4	30	70	100
	'	'			
•		CASE OF	F HON	OURS V	WITH
PROGRAM	IME)				Γ
60	Δ	4	30	70	100
		-			
	25	24			600
	360* 360* 60 60 MAJOR, I	360* 13* 360* 13* 60 4 60 4 60 4 MAJOR, IN THE CPROGRAMME) 60 4	360* 13* 12 360* 13* 12 60 4 4 60 4 4 MAJOR, IN THE CASE OF PROGRAMME) 60 4 4	360* 13* 12 90 60 4 4 30 60 4 4 30 60 4 4 30 MAJOR, IN THE CASE OF HONO PROGRAMME) 60 4 4 30	360* 13* 12 90 210 360* 13* 12 90 210 60 4 4 30 70 60 4 4 30 70 MAJOR, IN THE CASE OF HONOURS OPROGRAMME) 60 4 4 30 70

^{*} The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTIONFOR PATHWAYS 1 – 4

1. Single Major

2. Major with Multiple Disciplines

3. Major with Minor

4. Major with Vocational Minor

Semester	Major Courses	Minor Foundat Courses Course		Internship/ Project	Total
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22

4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for					
Three	68	24	39	2	133
Years					
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
	* in	stead of thre	ee Major course	es	
Total for					
Four	88 + 12 = 100	36	39	2	177
Years					

DISTRIBUTION OF MAJOR COURSES IN CHEMISTRY FOR PATHWAYS 1 – 4

1. Single Major

2. Major with Multiple Disciplines

3. Major with Minor

4. Major with Vocational Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	CHE1CJ 101 / CHE1MN 100	CORE COURSE 1 IN MAJOR – INORGANIC CHEMISTRY - I	5	4
2	CHE2CJ 101 / CHE2MN 100	CORE COURSE 2 IN MAJOR –PHYSICAL CHEMISTRY – I: STATES OF MATTER	5	4
3	CHE3CJ 201	CORE COURSE 3 IN MAJOR –THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	4	4
3	CHE3CJ 202 / CHE3MN 200	CORE COURSE 4 IN MAJOR – ORGANIC CHEMISTRY - I	5	4
_	CHE4CJ 203	CORE COURSE 5 IN MAJOR – INORGANIC CHEMISTRY-II	5	4
4	CHE4CJ 204	CORE COURSE 6 IN MAJOR – ORGANIC CHEMISTRY-II	5	4

	CHE4CJ 205	CORE COURSE 7 IN MAJOR – PHYSICAL CHEMISTRY-II: CHEMICAL THERMODYNAMICS KINETICS AND SURFACECHEMISTRY	5	4
	CHE5CJ 301	CORE COURSE 8 IN MAJOR – THEORETICAL CHEMISTRY – II: GROUP THEORY AND MOLECULAR SPECTROSCOPY	4	4
5	CHE5CJ 302	CORE COURSE 9 IN MAJOR – INORGANIC CHEMISTRY - III	5	4
	CHE5CJ 303	CORE COURSE 10 IN MAJOR – ORGANIC CHEMISTRY - III	5	4
		ELECTIVE COURSE 1 IN MAJOR	4	4
		ELECTIVE COURSE 2 IN MAJOR	4	4
	CHE6CJ 304 / CHE8MN 304	CORE COURSE 11 IN MAJOR – INORGANIC CHEMISTRY - IV	4	4
	CHE6CJ 305 / CHE8MN 305	305 / CORE COURSE 12 IN MAJOR–ORGANIC CHE8MN CHEMISTRY - IV		4
6	CHE6CJ 306 / CHE8MN 306	CORE COURSE 13 IN MAJOR – PHYSICAL CHEMISTRY – III: CHEMICAL AND PHASE EQUILIBRIA, ELECTROCHEMISTRY AND PHOTOCHEMISTRY	5	4
		ELECTIVE COURSE 3 IN MAJOR	4	4
		ELECTIVE COURSE 4 IN MAJOR	4	4
	CHE6CJ 349	INTERNSHIP IN MAJOR	-	2
	ТОТ	AL FOR THE THREE YEARS		70
	CHE7CJ 401	CORE COURSE 14 IN MAJOR – THEORETICAL CHEMISTRY III: ADVANCED QUANTUM CHEMISTRY	5	4
7	CHE7CJ 402	CORE COURSE 15 IN MAJOR – INORGANIC CHEMISTRY-V	5	4
	CHE7CJ 403	CORE COURSE 16 IN MAJOR – ORGANIC CHEMISTRY V	5	4

	CHE7CJ 404	CORE COURSE 17 IN MAJOR – PHYSICAL CHEMISTRY IV: STATISTICAL THERMODYNAMICS	5	4
	CHE7CJ 405	CORE COURSE 18 IN MAJOR – INSTRUMENTAL METHODS OF ANALYSIS	5	4
	CHE8CJ 406 / CHE8MN 406	CORE COURSE 19 IN MAJOR – INORGANIC CHEMISTRY -VI	4	4
	CHE8CJ 407 / CHE8MN 407	CORE COURSE 20 IN MAJOR – ORGANIC CHEMISTRY- VI	5	4
	CHE8CJ 408 / CHE8MN 408	CORE COURSE 21 IN MAJOR – PHYSICAL CHEMISTRY V: ADVANCED TOPICS IN SOLID STATE AND ELECTROCHEMISTRY	4	4
8		OR (INSTEAD OF CORE COURSES 19 - 21 IN M	AJOR)	
	CHE8CJ 449	PROJECT (IN HONOURS PROGRAMME)	13	12
	CHE8CJ 499	RESEARCH PROJECT (IN HONOURS WITH RESEARCH PROGRAMME)	13	12
		ELECTIVE COURSE 5 IN MAJOR	4	4
		ELECTIVE COURSE 6 IN MAJOR	4	4
		ELECTIVE COURSE 7 IN MAJOR	4	4
	OR (INS	ΓΕΑD OF ELECTIVE COURSE 7 IN MAJOR, IN H RESEARCH PROGRAMME)	ONOURS	WITH
	CHE8CJ 489	RESEARCH METHODOLOGY IN CHEMISTRY	4	4
	TO	ΓAL FOR THE FOUR YEARS		114

ELECTIVE COURSES IN CHEMISTRY

Sl.	Course	Title	Seme	Total	Hrs/	Cre		Marks			
No.	Code		ster	Hrs	Week	dits	Inte rnal	Exte rnal	Total		
1	CHE5EJ	GREEN CHEMISTRY	5	60	4	4	30	70	100		
	301										
2	CHE5EJ	NANOSCIENCE AND	5	60	4	4	30	70	100		
	302	NANOTECHNOLOGY									
3	CHE5EJ	BIO CO-ORDINATION	5	60	4	4	30	70	100		
	303	CHEMISTRY									
4	CHE5EJ	FOOD CHEMISTRY	5	60	4	4	30	70	100		
	304	TOOD CHEMISTRY									
	1	Among the four elective cour	ses two c	an be se	lected in	the fif	th seme	ester			
5	СНЕ6ЕЈ	POLYMER	6	60	4	4	30	70	100		
	311	CHEMISTRY									
6	СНЕ6ЕЈ	INDUSTRIAL	6	60	4	4	30	70	100		
	312	CHEMISTRY									
7	CHE6EJ	ADVANCED ENERGY	6	60	4	4	30	70	100		
0	313	MATERIALS	6	60	1	1	20	70	100		
8	CHE6EJ	MATERIAL SCIENCE	6	60	4	4	30	70	100		
	314	mong the four Elective Cour	gag two g	on ha sa	looted in	tha Cir	yth com	agtar			
		iniong the four Elective Cour									
9	CHE8EJ	INDUSTRIAL	8	60	4	4	30	70	100		
	409	CATALYSIS									
10	CHE8EJ	ADVANCED ORGANIC	8	60	4	4	30	70	100		
	410	CHEMISTRY									
11	CHE8EJ	MODERN ORGANIC	8	60	4	4	30	70	100		
	411	SYNTHESIS									

12	CHE8EJ	COMPUTATIONAL	8	60	4	4	30	70	100
	412	CHEMISTRY							
13	CHE8EJ	PETROCHEMICALS	8	60	4	4	30	70	100
	413	AND COSMETICS							
14	CHE8EJ	ADVANCED TOPICS IN	8	60	4	4	30	70	100
	414	INORGANIC CHEMISTRY							
	Ar	mong the Six Elective Course	s three c	an be sel	ected in	the Eig	ghth sen	nester	

GROUPING OF MINOR COURSES IN CHEMISTRY

(Title of the Minor: INTRODUCTORY CHEMISTRY)

The minor courses given below should not be offered to students who have taken chemistry as the major discipline. They should be offered to students from other major discipline only

Group	Sl.	Course	Title	Seme	Total	Hrs/	Cre		Marks	S
No.	No.	Code		ster	Hrs	Week	dits	Inte	Exte	Total
								rnal	rnal	10
									1 Hai	
1			GENERAL AND T	HEORI	ETICAL	CHEM	ISTR	Y		
			(Preferab	le for Ph	-					
	1	CHE1MN	BASIC INORGANIC	1	75	5	4	30	70	100
		101	AND NANO							
		101	CHEMISTRY							
	2	CHE2MN	QUANTUM	2	75	5	4	30	70	100
			MECHANICS, SOLID							
		101	STATES AND							
			GASEOUS STATES							
	2	CHEO OI	Diala obalina	2	7.5		4	20	70	100
	3	CHE3MN	BASIC ORGANIC	3	75	5	4	30	70	100
		201	CHEMISTRY							
2			GENERAL CHEM	ISTRY	AND BI	OMOLI	ECULI	ES		
		(Preferabl	e for Zoology, Botany, Micro	obiology	, Biotech	nology a	and Pla	nt Scie	nce stud	lents)
	1	CHE1MN	BASIC INORGANIC	1	75	5	4	30	70	100
		102	AND BIO-INORGANIC							
		102	CHEMISTRY							

	2	CHE2MN 102	LIQUID STATE, GASEOUS STATE AND ELECTROCHEMISTRY	2	75	5	4	30	70	100
	3	CHE3MN 202	BIOORGANIC CHEMISTRY	3	75	5	4	30	70	100
3			FUNDAMENTALS OF CH					EMIST	RY	
	1	CHE1MN	(Preferable for I	Botany a	nd Zoold 75	ogy stude	ents)	30	70	100
	1	103	AND GREEN CHEMISTRY	1	75	3	7	30	70	100
	2	CHE2MN 103	PHYSICAL PROPERTIES OF SOLUTIONS, GASES AND COLLOIDS	2	75	5	4	30	70	100
	3	CHE3MN 203	ORGANIC AND PHYTOCHEMISTRY	3	75	5	4	30	70	100
4			FUNDAMENTAL ((Preferable for (LS		
	1	CHE1MN 104	BASIC INORGANIC CHEMISTRY AND METALLURGY	1	75	5	4	30	70	100
	2	CHE2MN 104	STATES OF MATTER AND NUCLEAR CHEMISTRY	2	75	5	4	30	70	100
	3	CHE3MN 204	ORGANIC CHEMISTRY IN DAILY LIFE	3	75	5	4	30	70	100
5			BASIC CHEMISTI	RY AND	POLY	MER SO	CIENC	CE CE		
			(Preferable for Environ						T	
	1	CHE1MN 105	BASIC INORGANIC AND NUCLEAR CHEMISTRY	1	75	5	4	30	70	100

	1	1	T	1	1	1		1	1	
	2	CHE2MN	SOLUTIONS AND	2	75	5	4	30	70	100
		105	SURFACE CHEMISTRY							
		103								
	3	CHE3MN	ORGANIC CHEMISTRY	3	75	5	4	30	70	100
			AND POLYMERS							
		205								
6			FUNDAMEN	TALS (OF CHE	EMISTR	\mathbf{Y}			
			(Preferable for Physics, E	Botany, Z	Zoology,	and Geol	logy st	udents)		
	1	CHE1MN		1	75	5	4	30	70	100
		100/	INORGANIC							
		CHE1CJ								
			CHEMISTRY – I							
		101								
	2	CHE2MN		2	75	5	4	30	70	100
	2	100 /	PHYSICAL	2	13	3	"	30	70	100
			CHEMISTRY – I:							
		CHE2CJ	STATES OF MATTER							
		101	STATES OF WARTIER							
				_						
	3	CHE3MN		3	75	5	4	30	70	100
		200/	ORGANIC CHEMISTRY							
		CHE3CJ	- I							
		202								
		202								
		l	BASIC AND	A DDI TI	ED CHE	MICTO	V			
								(-)		
			(Preferable for Physic	ics, Z001	ogy and	Botany	studen	is)		
_										
7	1	CHE1MN	COORDINATION	1	75	5	4	30	70	100
			CHEMISTRY							
		106								
	2	CHE2MN	FUNDAMENTALS OF	2	75	5	4	30	70	100
		CIILZIVIIN	PHYSICAL		'3				, ,	100
		106								
			CHEMISTRY							
	3	CHE3MN	APPLIED ORGANIC	3	75	5	4	30	70	100
		20.5	CHEMISTRY							
		206								
		1		l		l		1		

^{(*}Students who are opting for a single minor pathway can choose any two set of minors from groups 1-7)

GROUPING OF VOCATIONAL MINOR COURSES IN CHEMISTRY

(Title of the Vocational Minor: **CHEMISTRY IN TECHNOLOGY**)

The minor courses given below should not be offered to students who have taken chemistry as the major discipline. They should be offered to students from other major discipline only

Group	Sl.	Course	Title	Seme	Total	Hrs/	Cre		Marks			
No.	No.	Code		ster	Hrs	Week	dits	Inte rnal	Exte rnal	Total		
1			INDUST	RIAL C	HEMIS	TRY						
	1	CHE1VN 101	INTRODUCTION TO INDUSTRIAL CHEMISTRY	1	75	5	4	30	70	100		
	2	CHE2VN 101	PERSPECTIVES OF INDUSTRIAL CHEMISTRY	2	75	5	4	30	70	100		
	3	CHE3VN 201	INDUSTRIAL POLLUTION AND CONTROL	3	75	5	4	30	70	100		
	4	CHE8VN 301	INDUSTRIAL QUALITY MANAGEMENT	8	60	4	4	30	70	100		
2			POLY	MER CI	HEMIST	ΓRY						
	1	CHE1VN 102	INTRODUCTION TO POLYMER CHEMISTRY	1	75	5	4	30	70	100		
	2	CHE2VN 102	COMMERCIAL POLYMERS	2	75	5	4	30	70	100		
	3	CHE3VN 202	PLASTICS AND FIBER TECHNOLOGY	3	75	5	4	30	70	100		
	4	CHE8VN 302	POLYMERS IN I NDUSTRY	8	60	4	4	30	70	100		

⁽i). Students in Single Major pathway can choose course/courses from any of the Minor/Vocational Minor groups offered by a discipline other than their Major discipline.

- (ii). Students in Major with Multiple Disciplines pathway can choose all the three courses from any one of the Minor/Vocational Minor groups offered by any discipline, other than his Major discipline as one of the multiple disciplines.
- (iii). Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline. Students in Major with Vocational Minorpathway can choose all the courses from any two Vocational Minor groups offered by any discipline. If the students choose any two Vocational Minor groups in Chemistry as givenabove, then the title of the Vocational Minor will be Chemistry in Technology

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN CHEMISTRY

Sem	Course		Total	Hours/			Marks	
ester	Code	Course Title	Hours	Week	Credits	Inter nal	Exter nal	Total
1	CHE1FM 105	MULTI-DISCIPLINARY COURSE 1 – ENVIRONMENTAL CHEMISTRY	45	3	3	25	50	75
2	CHE2FM 106	MULTI-DISCIPLINARY COURSE 2 – CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
3	CHE3FV 108	VALUE-ADDED COURSE 1 - CHEMISTRY OF CONSUMER PRODUCTS	45	3	3	25	50	75
4	CHE4FV 110	VALUE-ADDED COURSE 2 - SOLID WASTE MANAGEMENT	45	3	3	25	50	75
		SKILL ENHANCEMENT COU	RSE 2*					
5	CHE5FS 112	CHEMISTRY IN EVERYDAY LIFE	45	3	3	25	50	75
	CHE5FS 113	CHEMISTRY OF COSMETICS	45	3	3	25	50	75

*Among the two Skill Enhancement Courses, one course can be selected in the Fifth semester									
		SKILL ENHANCEMENT COU	SKILL ENHANCEMENT COURSE 3*						
6	CHE6FS 114	ANALYTICAL TECHNIQUES IN WATER QUALITY ASSESMENT	45	3	3	25	50	75	
	CHE6FS 115	SCIENTIFIC COMMUNICATION, PUBLIC OUTREACH AND ENTREPRENEURIAL SKILLS	45	3	3	25	50	75	

^{*}Among the two Skill Enhancement Courses, one course can be selected in the Sixth semester

COURSE STRUCTURE FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Chemistry (Major A)

B1: 68 credits in Major B

A2: 53 credits in Chemistry (Major A)

B2: 53 credits in Major B

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

SE			ТОТА	HOU			MARKS		
ME ST ER	CUE1CI	COURSE TITLE	L HOU RS	WEE TS ER	INT ER NA L	EXT ERN AL	TOTAL		
	CHE1CJ 101/CH E1MN1 00	CORE COURSE 1 IN MAJOR CHEMISTRY-INORGANIC CHEMISTRY - I	75	5	4	30	70	100	
1	BBB1CJ 101	CORE COURSE 1 IN MAJOR B -	60/75	4/5	4	30	70	100	
1	CHE1CJ 102/CH E2CJ10 2/ CHE2M N106	CORE COURSE 2 IN MAJOR CHEMISTRY- FUNDAMENTALS OF PHYSICAL CHEMISTRY (FOR BATCH A1 ONLY)	75	5	4	30	70	100	

	1		1	1			1	
	ENG1F A 101(2)	ABILITY ENHANCEMENT COURSE 1 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE1F M105	MULTI-DISCIPLINARY COURSE 1 IN CHEMISTRY- ENVIRONMENTAL CHEMISTRY (FOR BATCH A1 ONLY)	45	3	3	25	50	75
		TOTAL		24/ 25	21			525
	CHE2CJ 101/ CHE2M N 100	CORE COURSE 3 IN MAJOR CHEMISTRY-PHYSICAL CHEMISTRY – I: STATES OF MATTER	75	5	4	30	70	100
	BBB2CJ 101	CORE COURSE 2 IN MAJOR B	60/75	4/ 5	4	30	70	100
	BBB2CJ 102 / BBB1CJ 102	CORE COURSE 3 IN MAJOR B - (FOR BATCH B2 ONLY)	60/75	4/ 5	4	30	70	100
2	ENG2F A 103(2)	ABILITY ENHANCEMENT COURSE 3 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE2F M106/C HE3FM 106	MULTI-DISCIPLINARY COURSE 2 IN CHEMISTRY- CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
		TOTAL		23 - 25	21			525
3	CHE3CJ 201	CORE COURSE 4 IN MAJOR CHEMISTRY-THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100

	CHE3CJ 202 / CHE3M N 200	CORE COURSE 5 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB3CJ 201	CORE COURSE 4 IN MAJOR B	60/75	4/ 5	4	30	70	100
	BBB3CJ 202	CORE COURSE 5 IN MAJOR B	60/75	4/ 5	4	30	70	100
	BBB3F M 106 / BBB2F M 106	MULTI-DISCIPLINARY COURSE 1 IN B	45	3	3	25	50	75
	CHE3F V 108	VALUE-ADDED COURSE 1 IN CHEMISTRY-CHEMISTRY OF CONSUMER PRODUCTS (FOR BATCH A1 ONLY)	45	3	3	25	50	75
		TOTAL		23 - 25	22			550
	CHE4CJ 203	CORE COURSE 6 IN MAJOR CHEMISTRY - INORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 6 IN MAJOR B	60/75	4/ 5	4	30	70	100
	CHE4CJ 204	CORE COURSE 7 IN MAJOR CHEMISTRY- ORGANIC CHEMISTRY - II (FOR BATCH A1 ONLY)	75	5	4	30	70	100
4	CHE4F V 110	VALUE-ADDED COURSE 2 IN CHEMISTRY- SOLID WASTE MANAGEMENT	45	3	3	25	50	75
	BBB4F V 110	VALUE-ADDED COURSE 1 IN B	45	3	3	25	50	75
	CHE4F S 113/CH E5FS11 3	SKILL ENHANCEMENT COURSE 1 IN CHEMISTRY- CHEMISTRY OF COSMETICS	45	3	3	25	50	75
		TOTAL		23/ 24	21			525

	CHE5CJ 302/ CHE6CJ 308	CORE COURSE 8 IN MAJOR CHEMISTRY INORGANIC CHEMISTRY - III	75	5	4	30	70	100
		CORE COURSE 7 IN MAJOR B	60/75	4/ 5	4	30	70	100
	CHE5CJ 301/CH E6CJ30 7	CORE COURSE 9 IN MAJOR CHEMISTRY THEORETICAL CHEMISTRY - II- GROUP THEORY AND MOLECULAR SPECTROSCOPY (FOR BATCH A1 ONLY)	60	4	4	30	70	100
5		ELECTIVECOURSE 1 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR B *	60	4	4	30	70	100
	BBB5F S 112 / BBB4F S 112	SKILL ENHANCEMENT COURSE 1 IN B	45	3	3	25	50	75
		TOTAL		24/ 25	23			575
	CHE6CJ 309/CH E5CJ30 3	CORE COURSE 10 IN MAJOR CHEMISTRY- ORGANIC CHEMISTRY – III	75	5	4	30	70	100
	309/CH E5CJ30	CHEMISTRY- ORGANIC	75 60/ 75		4	30	70	100
	309/CH E5CJ30	CHEMISTRY- ORGANIC CHEMISTRY – III		5				
6	309/CH E5CJ30 3 BBB6CJ	CHEMISTRY - ORGANIC CHEMISTRY - III CORE COURSE 8 IN MAJOR B CORE COURSE 9 IN MAJOR B -	60/75	5 4/5	4	30	70	100
6	309/CH E5CJ30 3 BBB6CJ	CHEMISTRY - ORGANIC CHEMISTRY - III CORE COURSE 8 IN MAJOR B CORE COURSE 9 IN MAJOR B (FOR BATCH B2 ONLY) ELECTIVECOURSE 2 IN	60/75	5 4/5	4	30	70	100

CHECCI	INTERNSHIP IN MAJOR CHEMISTRY				50	-	50
CHE6CJ 349	(CREDIT FOR INTERNSHIP TO BE AWARDED ONLY AT THE	60		2			
	END OF SEMESTER 6)						
	TOTAL		24/ 25	25			625
TOTAL CREDITS FOR THREE YEARS				133			3325

FOR BATCH A1(B2), THE COURSE STRUCTURE IN SEMESTERS 7 AND 8 IS THE SAME AS FOR PATHWAYS 1-4, EXCEPT THAT THE NUMBER OF THE CORE AND ELECTIVE COURSES IS IN CONTINUATION OF THE NUMBER OF COURSES IN THE TWO CATEGORIES COMPLETED AT THE END OF SEMESTER 6.

CREDIT DISTRIBUTION FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

Semester 1 2 3	Major Courses in Chemistry 4 + 4 4 4 + 4	General Foundation Courses in Chemistry 3 3 3	Internship/ Project in Chemistry	Major Courses in B 4 4+4 4+4	General Foundation Courses in B 3	3+3 3+3	Total 21 21 22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for	48	18	2	44	9	12	133
Three Years		68		5	53	12	133
						T	
	Major	Minor					
	Courses in Chemistry	Courses					
7	4 + 4 + 4 + 4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
		* In	stead of three	Major courses		•	
Total for Four Years	88 + 12 = 100	12					177

^{*} Choose any one elective course each in Major Chemistry from the course basket of four elective courses in Chemistry in semester 5 and four elective courses in Chemistry in semester 6, as listed above in the two tables of elective courses. Choose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.

COURSE STRUCTURE FOR BATCH B1(A2) IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Chemistry (Major A)

B1: 68 credits in Major B B2: 53 credits in Major B

A2: 53 credits in Chemistry (Major A)

The combinations available to the students: (A1 & B2), (B1 & A2) Note: Unless the batch is specified, the course is for all the students of the class

SE			ТО	HOU			MAR	KS
ME ST ER	E CODE	COURSE TITLE	TAL HO URS	RS/ WEE K	CRE DITS	INT ER NA L	EX TE RN AL	TOTA L
	CHE1CJ 101/ CHE1M N 100	CORE COURSE 1 IN MAJOR CHEMISTRY- INORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB1CJ 101	CORE COURSE 1 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	CORE COURSE 2 IN MAJOR B – (FOR BATCH B1 ONLY)	60/ 75	4/ 5	4	30	70	100
1	ENG1F A 101(2)	ABILITY ENHANCEMENT COURSE 1 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 2 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	BBB1F M 105	MULTI-DISCIPLINARY COURSE 1 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
		TOTAL		23 – 25	21			525
2	CHE2CJ 101/CH E2MN1 00	CORE COURSE 2 IN MAJOR CHEMISTRY- PHYSICAL CHEMISTRY – I: STATES OF MATTER	75	5	4	30	70	100
	BBB2CJ 101	CORE COURSE 3 IN MAJOR B	60/ 75	4/ 5	4	30	70	100

	CHE2CJ 102/CH E1CJ10 2/CHE2 MN 106	CORE COURSE 3 IN MAJOR CHEMISTRY- FUNDAMENTALS OF PHYSICAL CHEMISTRY (FOR BATCH A2 ONLY)	75	5	4	30	70	100
	ENG2F A 103(2)	ABILITY ENHANCEMENT COURSE 3 – ENGLISH	60	4	3	25	50	75
		ABILITY ENHANCEMENT COURSE 4 – ADDITIONAL LANGUAGE	45	3	3	25	50	75
	CHE2F M106/C HE3FM 106	MULTI-DISCIPLINARY COURSE 2 IN CHEMISTRY- CHEMISTRY IN DAILY LIFE	45	3	3	25	50	75
		TOTAL		24/ 25	21			525
	CHE3CJ 201	CORE COURSE 4 IN MAJOR CHEMISTRY- THEORETICAL CHEMISTRY – I: BASIC QUANTUM CHEMISTRY	60	4	4	30	70	100
	CHE3CJ 202/ CHE3M N 200	CORE COURSE 5 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - I	75	5	4	30	70	100
	BBB3CJ 201	CORE COURSE 4 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
3	BBB3CJ 202	CORE COURSE 5 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
	BBB3F M 106 / BBB2F M 106	MULTI-DISCIPLINARY COURSE 2 IN B –	45	3	3	25	50	75
	BBB3F V 108	VALUE-ADDED COURSE 1 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
		TOTAL		23 – 25	22			550

	CHE4CJ 203	CORE COURSE 6 IN MAJOR CHEMISTRY -INORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 6 IN MAJOR B	60/ 75	4/ 5	4	30	70	100
		CORE COURSE 7 IN MAJOR B – (FOR BATCH B1 ONLY)	60/ 75	4/ 5	4	30	70	100
4	CHE4F V110	VALUE-ADDED COURSE 1 IN CHEMISTRY-SOLID WASTE MANAGEMENT	45	3	3	25	50	75
	BBB4F V 110	VALUE-ADDED COURSE 2 IN B –	45	3	3	25	50	75
	CHE4F S 113/CH E5FS11 3	SKILL ENHANCEMENT COURSE 1 IN CHEMISTRY- CHEMISTRY OF COSMETICS	45	3	3	25	50	75
		TOTAL		22 – 24	21			525
	CHE5CJ 304/CH E4CJ20 4	CORE COURSE 7 IN MAJOR CHEMISTRY-ORGANIC CHEMISTRY - II	75	5	4	30	70	100
		CORE COURSE 8 IN MAJOR B –	60/ 75	4/ 5	4	30	70	100
		CORE COURSE 9 IN MAJOR B – (FOR BATCH B1 ONLY)	60	4	4	30	70	100
5		ELECTIVECOURSE 1 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 1 IN MAJOR B *	60	4	4	30	70	100
	BBB5F S 112 / BBB4F S 112	SKILL ENHANCEMENT COURSE 1 IN B	45	3	3	25	50	75
		TOTAL	_	24/ 25	23			575

	CHE6CJ 308/CH E5CJ30 2	CORE COURSE 8 IN MAJOR CHEMISTRY- INORGANIC CHEMISTRY - III	75	5	4	30	70	100
		CORE COURSE 10 IN MAJOR B –	60/ 75	4/5	4	30	70	100
	CHE6CJ 307/CH E5CJ30 1	CORE COURSE 9 IN MAJOR CHEMISTRY- THEORETICAL CHEMISTRY – II GROUP THEORY AND MOLECULAR SPECTROSCOPY (FOR BATCH A2 ONLY)	60	4	4	30	70	100
6		SPECTROSCOPY AND GROUP THEORY (FOR BATCH A2 ONLY)						
		ELECTIVECOURSE 2 IN MAJOR CHEMISTRY*	60	4	4	30	70	100
		ELECTIVECOURSE 2 IN MAJOR B*	60	4	4	30	70	100
	BBB6F S 113	SKILL ENHANCEMENT COURSE 2 IN B – (FOR BATCH B1 ONLY)	45	3	3	25	50	75
	BBB6CJ 349	INTERNSHIP IN MAJOR B (CREDIT FOR INTERNSHIP TO BE AWARDED ONLY AT THE END OF SEMESTER 6)	60		2	50	-	50
		TOTAL		24/ 25	25			625
	TOTA	AL CREDITS FOR THREE YE	ARS		133			3325

TO CONTINUE TO STUDY CHEMISTRY IN SEMESTERS 7 AND 8, BATCH B1(A2) NEEDS TO EARN ADDITIONAL 15 CREDITS IN CHEMISTRY TO MAKE THE TOTAL CREDITS OF 68. SUPPOSE THIS CONDITION IS ACHIEVED, AND THE STUDENT OF BATCH B1(A2) PROCEEDS TO THE NEXT SEMESTERS TO STUDY CHEMISTRY. THE COURSE STRUCTURE IN SEMESTERS 7 AND 8 IS THE SAME AS FOR PATHWAYS 1 – 4, EXCEPT THAT THE NUMBER OF THE CORE AND ELECTIVE COURSES IS IN CONTINUATION OF THE NUMBER OF COURSES IN THE TWO CATEGORIES COMPLETED AT THE END OF SEMESTER 6, TAKING INTO ACCOUNT THE NUMBER OF COURSES IN CHEMISTRY TAKEN ONLINE TO EARN THE ADDITIONAL 15 CREDITS.

CREDIT DISTRIBUTION FOR BATCH B1(A2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Chemistry	General Foundation Courses in Chemistry	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for	48	18	2	44	9	12	133
Three Years		68		5	53	12	133
	Major	Minor					
	Courses in	Courses					
	В						
7	4 + 4 + 4 +	-			-	-	20
-	4 + 4						20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
		* Ir	stead of three	Major courses			
Total for Four Years	88 + 12 = 100	12					177

^{*}Choose any one elective course each in Major Chemistry from the course basket of four elective courses in Chemistry in semester 5 and four elective courses in Chemistry in semester 6, as listed above in the two tables of elective courses. Choose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.

EVALUATION SCHEME

- 1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
- **2.** The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
 - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
 - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
- **3.** All the 3-credit courses (General Foundational Courses) in chemistry are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam	Total Marks
			Open-ended module / Practical	On the other 4 modules	on 4 modules (Marks)	
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
	Course	Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
		20	10	10	20*
Total		30		30	

^{*} Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- Combining the rough and fair records into a single record for lab experiments is sufficient; there's no need to maintain them separately. The consolidated record can be submitted for evaluation at the end of the semester.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who have done 75% of the experiments alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exerciseperformed in practical classes by the students. (Performance in the lab - 7 Marks, Attendance in the lab - 3 Marks)	10	50%
2	Evaluation of the Practical records submitted for the end semester viva—voce examination by the teacher-in-charge and additional examiner	3	15%
3	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Туре	Total No. of Questions	No. of	Marks for	Ceiling
			Questions to be	Each	of
			Answered	Question	Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

2. INTERNSHIP

 All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.

- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

- 1. Internship can be in Chemistry or allied disciplines.
- 2. There should be minimum 60 hrs. of engagement from the student in the Internship.
- 3. Summer vacations and other holidays can be used for completing the Internship.
- 4. In BSc. Chemistry Honours programme, institute/ industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.
- 5. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
- 6. The log book and the typed report must be submitted at the end of the Internship.
- 7. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship	Marks for Internship	Weightage
		2 Credits	
1	Continuous evaluation of Acquisition of skill set internship through interim	10	40%
2	presentations and reports by the committee internally Interim Presentation and Viva-voce	5	
3	constituted by the Department Council Punctuality and Log Book	5	
4	Report of Institute Visit/ Study Tour	5	10%
5	End-semester viva-voce Quality of the work examination to be	6	35%
6	conducted by the Presentation of the work	5	
7	committee internally Viva-voce constituted by the Department Council	6	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva—voce examination before the committee internally constituted by the Department Council	8	15%
	Total Marks	50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution / any other higher educational institution (HEI) / research centre/ training centre.
- The project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ST/OBC (non-creamy layer)/ Differently- Abled/Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three core courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty member with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME

AND HONOURS WITH RESEARCH PROGRAMME

- 1. Project can be in Chemistry or allied disciplines.
- 2. Project should be done individually.
- 3. Project work can be of experimental/ theoretical/ computational in nature.
- 4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as Honours with Research programme

- 5. There should be minimum 13 hrs./ week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme
- 6. The various steps in project works are the following:
 - ➤ Wide review of a topic.
 - > Investigation on a problem in systematic way using appropriate techniques.
 - > Systematic recording of the work.
 - > Reporting the results with interpretation in a standard documented form.
 - Presenting the results before the examiners.
- 7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
- 8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
- 9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
- 10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
- 11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The Project in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the college.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the	Weightag
	Project	e
	(Honours/	
	Honours with	
	Research)	
Continuous evaluation of project work through	90	30%
interim presentations and reports by the		
committee internally constituted by the		
Department Council		
End-semester viva-voce examination to be	150	50%
conducted by the external examiner appointed by		
the college		
Evaluation of the day-to-day records and project	60	20%
report submitted for the end-semester viva-voce		
examination conducted by the external examiner		
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

		Marks for the Project
		(Honours / Honours
Sl. No	Components of Evaluation of Project	with Research
		programme)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours / Honours with Research programme)
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

• All the General Foundation Courses (3-credits) in Chemistry are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal	Internal Marks of a General Foundation		
	Evaluation of a General	Course of 3-credits in Chemistry		
	Foundation Course in Chemistry	4 Theory Modules	Open-ended Module	
1	Test paper/ Mid-semester Exam	10	2	
2	Seminar/ Viva/ Quiz	6	2	
3	Assignment	4	1	
		20	5	
	Total		25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the college based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration		Total No. of	No. of	Marks for	Ceiling
	Type		Questions to be	Each	of
		Questions	Answered	Question	Marks
	Short Answer	10	8 – 10	2	16
1.5 Hours	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
Total Marks					

5.LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.

 Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl.	Percentage of Marks	Descriptio	Letter	Grad	Range of	Class
No.	(Internal & External	n	Grad	e	Grade	
	Put Together)		e	Point	Points	
1	95% and above	Outstandin	О	10	9.50 - 10	First Class
		g				with
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9.	Distinction
	7100ve 65 % and below 95 %	LACCHOIL	2 1			
					49	
3	75% to below 85%	Very Good	A	8	7.50 –	
					8.49	
4	65% to below 75%	Good	B+	7	6.50 –	
					7.49	First Class
5	55% to below 65%	Above	В	6	5.50 -	
		Average			6.49	
6	45% to below 55%	Average	С	5	4.50 –	Second
					5.49	Class
7	35% to below 45% aggregate	Pass	P	4	3.50 -	Third Class
	(internal and external put				4.49	
	together) with a minimum of					
	30% in external valuation					
8	Below an aggregate of 35%	Fail	F	0	0 - 3.49	Fail
	or below 30% in external					
	evaluation	A 1				D 11
9	Not attending the	Absent	Ab	0	0	Fail
	examination					

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

 The following method shall be used to compute the Semester Grade Point Average (SGPA):

The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

i.e. SGPA (Si) =
$$\Sigma i$$
 (Ci x Gi) / Σi (Ci)

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$SGPA = \frac{Sum \ of \ the \ credit \ points \ of \ all \ the \ courses \ in \ a \ semester}{Total \ credits \ in \ that \ semester}$$

ILLUSTRATION - COMPUTATION OF SGPA

Semester	Course	Credit	Letter	Grade	Credit Point
			Grade	point	(Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	$4 \times 7 = 28$
I	Course 3	3	В	6	3 x 6 = 18
I	Course 4	3	0	10	3 x 10 = 30
I	Course 5	3	С	5	3 x 5 = 15
I	Course 6	4	В	6	4 x 6 = 24
	Total	20			139
		SGF	139/20 = 6.950		

• The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

CGPA for the three-year programme in FYUGP shall be calculated by the following formula.

$$CGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ six\ semesters}{Total\ credits\ in\ six\ semesters\ (133)}$$

CGPA for the four-year programme in FYUGP shall be calculated by the following formula.

$$CGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ eight\ semesters}{Total\ credits\ in\ eight\ semesters\ (177)}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the college shall issue the transcript for each semester and a consolidated transcript indicating the performance inall semesters.

CORE COURSES IN MAJOR

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	INORGANIC CHE	INORGANIC CHEMISTRY I				
Type of Course	MAJOR/MINOR					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
Pre-requisites	Scope of chemistry, Interdisciplinary areas involving chemistry. Fundamentals of periodic properties of elements, Atoms and molecules, Need for chemical bonding and its types, Awareness on nature of experiments and health risk, hazard associated with chemicals, Mole concept					
Course Summary	This course explores the importance of chemistry as a central discipline of science. It introduces the periodic properties of elements, concept of chemical bonding and explanation of inorganic molecular structure using hybridization and MO theory. A few basic topics of the emerging area of Nanochemistry are also introduced in this course. The basic laboratory safety, concepts in volumetric analysis and related practical experiments are also covered.					

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools used
		Level*	Category#	
CO1	Understand the role of chemistry in science and scientific research with emphasis on analytical data evaluation	U	С	Instructor- created exams/ Quizzes/Assignments
CO2	Conceptualize and predict chemical bonding, molecular structures using	An	Р	Instructor- created exams/ Quizzes/assignments

	dipole moment, hybridisation, and MO Theory			
CO3	Develop a basic understanding of the extraordinary properties of nanomaterials and its applications.	U	С	Instructor- created exams/ Quizzes/Assignments
CO4	Apply the concepts of lab safety measurements and volumetric analysis	Ap	M	Instructor- created exams/ Assignments/problem solving
CO5	Enable students to develop analytical skills in inorganic quantitative volumetric analysis.	Ap	Р	Group work /Viva Voce// Observation of practical skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
			(45+30)	
I	Cl	HEMISTRY AS A SCIENCE DISCIPLINE &	8	17
		SCIENTIFIC ANALYSIS		
	1	Science- Chemistry as a branch of science, History of	1	
		chemistry, Involvement of chemistry in daily life		
		(Mention only)		
	2	Introduction to analytical chemistry, Classification of	1	
		analytical methods: Qualitative and Quantitative		
		analysis (Mention with examples)		
	3	Treatment of analytical data - Significant figures -	3	
		Accuracy - Precision - Methods of representing		
		Accuracy, Absolute error, Relative error, Types of		
		errors, Constant errors, Proportional errors, Correction		
		of determinate errors		
	4	Methods of representing Precision –Mean, Average	3	
		deviation, Standard deviation, Relative standard		
		deviation, Coefficient of variation, Variance,		
		Rejection of a result: Q test, Methods of least squares		
II	C	HEMICAL BONDING AND MOLECULAR	17	38
		STRUCTURE		
	5	Periodic Properties and their Periodic Trends: (a)	2	
		Atomic and Ionic radius (include isoelectronic species		
		in discussion) (b) Ionisation energy: (c) Electron		

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		affinity (d) Electronegativity (Pauling, Mulliken		
		Allred & Rochow scales).		
	6	Classification of bonds: Ionic bond - Definition,	1	
		Factors affecting the formation of ionic bond.		
		Characteristics of ionic compounds. Lattice energy		
	7	Born Haber cycle - Born Lande equation (derivation	2	
		not needed) - Covalent –(Mention polar and non polar		
		compounds) and Coordinate bond		
	8	Dipole moment and its applications: (Prediction of	2	
		linearity and symmetry of polyatomic molecules,		
		Prediction of position of substituents in aromatic		
		compounds, Measurement of bond angle)		
	9	Covalent Bond, Lewis concept of covalent bond,	2	
		Atomic orbital overlap, Concept of covalency,		
		Variable covalency and Maximum covalency		
	10	Prediction of Covalent character in ionic bond using	1	
		Fajans rule. Prediction of Ionic character in Covalent		
		bond using Hannary Smidth equation.		
	11	Structure of molecules by the concept of	3	
		Hybridisation: NO ₃ -, CO ₃ ² -, SO ₄ ² - ,IF ₇ , XeO ₃ , XeO ₄ ,		
		XeF ₂ , XeF ₄ , XeF ₆ , ClF ₃ , BrF ₅ , SF ₄		
	12	Introductory MO Theory: Homoatomic molecules in	4	
		N_2 and O_2 and their ions (comparison of bond order,		
		bond length and stability), MO Theory: Heteroatomic		
		molecules like NO, CO, HCl, HF, LiF.		
III		INTRODUCTION TO NANOMATERIALS	10	21
	13	Definition of Nanomaterials, Historical revolution of	2	
		Nanochemistry, Nanochemistry and		
		Nanotechnology, Classification of nanostructures		
		based on electron confinement (0D, 1D and 2D)		
	14	Synthesis of Nanomaterials: Bottom Up and Top	1	
		down approaches (Elementary idea with examples)		
	15	Metal nanoparticles (gold and silver nanoparticles),	2	
		Semiconductor nanoparticles (CdS and CdSe		
		nanoparticles), Metal oxide nanoparticles (zinc oxide,		
		iron oxide, silica and titania nanoparticles),		
		Nanocomposites, Nanoceramics (Definition with		
		examples), Carbon Based Nanomaterials: Graphene,		
		Carbon Nanotubes, Fullerenes, Carbon dots		
	1.6	(elementary idea only) Characteristics of Nanomaterials: Surface area to	3	
	16		3	
		volume ratio and its significance, Novel properties of		
		Nanomaterials, Size dependent optical (surface		

		plasmon resonance), Electronic, Mechanical,		
		magnetic and catalytic properties (No deep discussion		
		is needed)		
	17	Applications of nanomaterials: Electronics (Batteries,	2	
		Solar cell), Biomedical (Drug Delivery) and		
		Environmental based applications (Water Purification, Dye Removal) (General idea only)		
IV	FUNI	DAMENTALS OF ANALYTICAL CHEMISTRY	10	22
_,	18	Lab safety measurements: Awareness of material	2	
		safety data sheet (MSDS), Safe storage and handling		
		of hazardous chemicals, Simple first aids; Electric		
		shocks, fire, Cut by glass and inhalation of poisonous		
		gas.		
	19	Accidents due to acids and alkalis, Burns due to	1	
		phenol and bromine, Disposal of waste chemicals,		
		Disposal of sodium and broken mercury thermometer,		
		-R and S phrases (elementary idea only), Personal		
	20	protective Equipment (PPE) Mole concept - Equivalent mass - Methods of	2	
	20	expressing concentration: Weight percentage,	2	
		molality, molarity, normality, mole fraction, ppm and		
		millimoles - Numerical Problems related to basic		
		concepts.		
	21	Volumetric Analysis: Introduction - Primary and	3	
		secondary standards – Standard solutions – Theory of		
		titrations involving acids and bases,		
		Permanganometry, Dichrometry, Iodometry,		
		Iodimetry Precipitation and Complexometric		
	22	titrations.	2	
	22	Indicators: Theory of acid-base, redox, adsorption and	2	
		complexometric indicators. Double burette method of titration: Principle and advantages.		
V	INORG	ANIC CHEMISTRY PRACTICAL I-	30	
,	21,02101	VOLUMETRIC ANALYSIS		
	1	General Instructions: Use a safety coat, gloves,		
		shoes and goggles in the laboratory. For weighing		
		electronic balance must be used. Double burette		
		titration method may be used for titrations. Standard		
		solution must be prepared by the student. A minimum		
		of 7 experiments must be done from Section B and C.		
	1	1		

Section D is open-ended and the experiments can be selected by the teacher

SECTION A

Importance of lab safety – Burns, Eye accidents, Cuts, Gas poisoning, Electric shocks, Treatment of fires, Precautions and Preventive measures.

Weighing using electronic balance, Preparation of standard solutions.

SECTION B

Neutralization Titrations

- Acidimetry and Alkalimetry: Strong acid Vs Strong base
- Acidimetry and Alkalimetry: Strong acid Vs Weak base

SECTION C

Redox Titrations

- 1. Permanganometry: Estimation of Fe²⁺/FeSO₄. 7H2O/Mohr's salt
- 2. Permanganometry: Estimation of Oxalic acid
- 3. Permanganometry: Estimation of Calcium using std KMnO4
- 4. Dichrometry: Estimation of Fe²⁺/ FeSO₄. 7H2O /Mohr's salt
- 5. Dichrometry: Estimation of Ferric iron
- 6. Iodometry and Iodimetry: Estimation of Copper
- 7. Iodometry and Iodimetry: Estimation of Iodine

SECTION D

Open Ended (Any two experiments are to be conducted, may be selected from the below list or the teacher can select related experiments)

1. Determination of acetic acid content in vinegar by titration with NaOH.

2. Determination of alkali content in antacid tablets	
by titration with HCl.	
3. Determination of available chlorine in bleaching	
Powder.	
4. Estimation of Cu in Brass	

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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO1	3			2	1	1	3				3	1	1
CO2	2	2					2				2		1
CO3	2		1	2	2	3	2			1	2	1	2
CO4			3		2	2	2		1		1	1	1
CO5			3		2	3	3		1		2	1	2

Correlation Levels:

Level	Correlation
ı	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/ Viva/ Seminar	Practical skill evaluation	End Semester Examinations
CO 1	√	✓		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√	√	

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	PHYSICAL CHEMISTRY – I: STATES OF MATTER							
Type of Course	MAJOR/MINOR							
Semester	II							
Academic Level	100-199	100-199						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	4	3	-	2	75			
Pre-requisites	NCERT or equivalent https://onlinecourses		•					
Course Summary	Atoms and molecules form the matter that is recognisable for us in the real world, as gases, liquids and solids. Why would they exist as they are? And why would they behave as they do? This course is designed to introduce first year UG students, the physical chemistry of matter in different states of its existence through theory and laboratory experiments. The course explains the various types of interactions between atoms and molecules and their important role in physical and chemical characteristics of the different states of matter. The course introduces the theory and experimental methods that are commonly used to study the various states of matter.							

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic nature of real gases and understand interactions at molecular levels	U	С	Assignments/Quiz designed by the instructor
CO2	To recognise the significance of various interactions in condensed matter	U	С	Assignments/Quiz designed by the instructor

CO3	To analyse the physical properties of liquids through theory and practical experiments	An	Р	Seminars and exams
CO4	To explain the regular, periodic arrangement of atoms in solids and appreciate the concept of unit cells	An	Р	Seminars/ exams
CO 5	To evaluate and understand the importance of the X-ray diffraction technique for characterisation of crystalline solids	Ар	Р	Lab/Discussion/Ass ignments
CO 6	To execute experiments to determine and tune the various colligative properties of dilute solutions	С	Р	Lab/Viva voce exams

^{* -} Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
			(45+30)	
I		GASEOUS STATE	15	33
	1	Kinetic theory of gasses: derivation	1	
	2	Maxwell-Boltzmann distribution of molecular velocities — Average velocity, RMS velocity and most probable velocity (derivations not required)	2	
	3	Collision theory – Collision diameter- Collision number-Collision frequency - Mean free path – Molecular beams (Mention only)	2	
	4	Real gas- Deviation from ideal behavior-Compressibility factor – Virial equation and Virial coefficients- van der Waals equation of state (derivation required)-features of van der Waals equation - Expression of van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gasses – Andrews' experiments - Continuity of states - Isotherm of van der Waals equation	6	

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Solid State Solid State Critical phenomena - Critical constants - 4					
Barrel B		5	Relationship between critical constants and van der Waals constants - Experimental determination of critical constants - Supercritical carbon dioxide	4	
6 Discussion of different types (with suitable examples) of molecular interactions- dipole-dipole, dipole-induced dipole, induced dipole-induced dipole, induced dipole-induced dipole interactions, Lennard-Jones 6-12 potential. 7 Properties of liquids- Vapour pressure, Refractive index, Surface tension- Interfacial tension and viscosity - Poiseuille's equation – Explanation of these properties on the basis of intermolecular forces. 8 Hydrogen bonding in water and other polar molecules, its relevance in biological systems. 9 Liquids on solid surfaces- Hydrophobic and Hydrophilic, Superhydrophilic and Superhydrophobic surfaces-simple explanationby using the water drop contact angles on surfaces III SOLID STATE 15 10 Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals. 11 Crystalline Materials – Periodicity- Types of Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and	II		**	8	17
index, Surface tension- Interfacial tension and viscosity - Poiseuille's equation – Explanation of these properties on the basis of intermolecular forces. 8 Hydrogen bonding in water and other polar molecules, its relevance in biological systems. 9 Liquids on solid surfaces- Hydrophobic and Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanationby using the water drop contact angles on surfaces III SOLID STATE 15 10 Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals. 11 Crystalline Materials – Periodicity- Types of Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₁ - anatase, rutile and 1	n	6	Discussion of different types (with suitable examples) of molecular interactions- dipoledipole, dipole-induced dipole, induced dipole-induced dipole interactions, Lennard-Jones 6-12		
molecules, its relevance in biological systems. 9 Liquids on solid surfaces- Hydrophobic and Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanationby using the water drop contact angles on surfaces 10 SOLID STATE 10 Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals. 11 Crystalline Materials – Periodicity- Types of Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and			index, Surface tension- Interfacial tension and viscosity - Poiseuille's equation – Explanation of these properties on the basis of intermolecular forces.		
Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanationby using the water drop contact angles on surfaces 10 SOLID STATE 15		8	molecules, its relevance in biological systems.	2	
10 Crystalline and amorphous solids- atomic and molecular solids- nucleation and growth of crystals. 11 Crystalline Materials – Periodicity- Types of Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and		9	Hydrophilic, Superhydrophilic and Superhydrophobic surfaces- simple explanationby	1	
molecular solids- nucleation and growth of crystals. 11 Crystalline Materials – Periodicity- Types of Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and	III		SOLID STATE	15	33
Close packing and packing fraction. 12 Space Lattice - Unit cell (use models)- Lattice planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and		10	molecular solids- nucleation and growth of	2	
planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use of software like Crystal viewer is recommended). 13 X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, 14 Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and		11		1	
X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure factor, Systematic absences for simple, face centered, and body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. Structural transitions in TiO ₂ - anatase, rutile and 1		12	planes and Miller indices (use models) - 7 crystal systems- 14 Bravais lattices- Types of cubic crystals and their planes- Distance formula for cubic systems- Calculation of crystal density (Use	4	
body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of electron and neutron diffraction. 15 Structural transitions in TiO ₂ - anatase, rutile and 1		13	X-ray diffraction- Bragg's law (derivation)- Powder and single crystal X-ray diffraction methods, Atomic scattering factor, Structure	3	
		14	body centered cubic crystals, Analysis of XRD patterns of NaCl, KCl and CsCl. Basic idea of	3	
randa randa		15	Structural transitions in TiO ₂ - anatase, rutile and brookite phases	1	
Concepts of melting point/boiling point and molecular/atomic/ionic interactions, Examples: CO ₂ , N ₂ , H ₂ O, NH ₃ , NaCl, TiO ₂		16	molecular/atomic/ionic interactions, Examples: CO ₂ , N ₂ , H ₂ O, NH ₃ , NaCl, TiO ₂	_	
IV SOLUTIONS 7	IV		SOLUTIONS	7	15

17	Solubility of gases in liquids – Henry's law and its applications	1	
18		1	
19		1	
20		1	
21		1	
22	Solid Solutions: Substitutional and interstitial solid solutions, Differences between Alloys, Mixtures and Composites. Colloids: Dispersed phase and dispersing medium, Sol, Emulsion, Foam, and Aerosol, Tyndall effect, Nephelometry	2	
V	PHYSICAL CHEMISTRY PRACTICALS	30	
	A minimum of 5 practical experiments out of which ONE EACH from sections 1, 2 and THREE from section 3 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-typed printed form.		
	 Section 1 1. Determination of cryoscopic constant (K_t) of solid solvent using a solute of known molecular mass. (Solvent: Naphthalene, biphenyl Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) 	3	
	2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (K _t). (Solvent: Naphthalene, biphenyl Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine)	3	
	Section 2		
	 Determination of molal transition point depression constant (K₁) of salt hydrate using solute of known molecular mass. (Salt hydrates: Na₂S₂O₃.5H₂O, CH₃COONa.3H₂O. Solutes: Urea, Glucose) 	3	
	 4. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (K₁). (Salt hydrates: Na₂S₂O₃.5H₂O, CH₃COONa.3H₂O. Solutes: Urea, Glucose) 	3	

Section 3		
5. Determination of viscosity of various liquids using Ostwald's viscometer.	3	
 6. Study of glycerine-water system and determination of percentage of glycerine using viscometer [plot composition (c) <i>versus</i> time of flow x density of the solution (td)]. 7. Determination of the surface tension of a liquid or a dilute solution (NaCl / surfactant) using a stalagmometer (drop number method). 	3	
8. Determination of composition of glycerine-water mixture by refractive index method.	3	
9. Determination of refractive indices of KCl solutions of different concentrations and unknown concentration of KCl solution.	3	
10. Indexing powder XRD patterns and determination of unit cell parameters of simple and/or bcc and/or fcc systems (Instructors must provide the powder XRD patterns and ask students to index it and calculate unit cell parameters)	3	
	3	
References:		
Module I o IV		
 Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) Solid State Chemistry and its Applications, 2nd Edition, A R West, (Wiley, 2014) 		
Module V 4. Findlay's Practical Physical Chemistry, Ninth Edition, Revised and Edited by B P Levitt, (Longman, London, 1973) 5. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008 6. R. C. Das, B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill, New Delhi, 1983.		

Further reading	
7. 1. B. R. Puri, L. R. Sharm	na, M. S. Pathania,
Principles of Physical Chemistry,	46th Edn., Vishal
Publishing Company, New Delhi, 201	13.
8. G. M. Barrow, Physical Chem	nistry, 5th Edn., Tata
McGraw Hill Education, New Delhi,	2006.
9. F. Daniels, R. A. Alberty, Phy	rsical Chemistry, 5th
Edn., John Wiley and Sons, Canada, 1	980.
10. D. P. Shoemaker, C. W. Garla	and, Experiments in
Physical Chemistry, McGraw-Hill Bo	ook Company, New
York, 1962.	
11. W. G. Palmer, Experimental 1	Physical Chemistry,
Cambridge University Press, Cambrid	dge, 2009

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O 5	PS O 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	3	2	3	2	2	-	2	-	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	2	-	-	3	3	3	2	1	-	1	-	1
CO 5	3	2	2	1	3	3	3	2	1	-	3	-	1
CO 6	2	-	3	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

Level	Correlation
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		√		√
CO 2		\		✓
CO 3	√			✓
CO 4	√			√
CO 5	√	√		√
CO 6	√	√	✓	✓

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS) FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	THEORETICAL CHEMISTRY I – BASIC QUANTUM CHEMISTRY								
Type of Course	MAJOR	MAJOR							
Semester	III								
Academic Level	200 – 299								
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours				
	4	4	-	-	60				
Pre-requisites	experiment and disgold foil experiment model of the atom, Mathematical prerepartial differentiatical cartesian and spherospherical discontinuous cartesian and spherospherical discontinuous cartesian and spherospherical discontinuous cartesian and spherospherical cartesian and cartesian and cartesian and	 Early atom models – John Dalton's atomic theory, the discharge tube experiment and discovery of electrons, the plum-pudding model, the gold foil experiment and the invention of the nucleus, the nuclear model of the atom, failures of the nuclear model. Mathematical prerequisites - basic understanding of differentiation, partial differentiation, integration, technique of separation of variables. Cartesian and spherical polar coordinate systems. 							
Course Summary	 VSEPR theory, postulates and applications Properties of bulk matter can be examined from the viewpoint of thermodynamics. But it is essential to know how these properties stem from the behaviour of individual atoms and molecules. The laws of quantum mechanics decide the properties of the micro-world. The course introduces the basic principles of quantum mechanics and explains how quantum mechanics has revolutionised our understanding of atomic structure and chemical bonding. 								

Course Outcomes (CO):

CC	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used

CO1	recognize the importance and the impact of quantum revolution in science.	R	F	Assignment
CO2	<i>identify</i> the wave functions of hydrogen atom as atomic orbitals.	U	С	Class tests/Viva
CO3	apply the concept of atomic orbitals in chemical bonding (the mixing of wave functions of the two combining atoms).	Ap	С	Seminar/ Class tests
CO4	relate the concept of hybridization as linear combination of atomic orbitals of the same atom.	An	P	Class tests/Assignment
CO5	instill an atomic/molecular level philosophy in the minds of the students.	С	M	Viva

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
			(45 +30)	
I	Th	e Quantum revolution and its early impact in atomic structure	8	21
	1	Experiments which led to the development and generalisation of quantum theory – black body radiation, Planck's quantum hypothesis, photoelectric effect, Einstein's generalisation of quantum theory	3	
	2	Atomic model partly based on quantum theory – Bohr's theory of the atom, calculation of Bohr radius, velocity and energy of an electron.	3	
	3	Atomic spectra of hydrogen and explanation using Bohr's theory; Limitations of Bohr's theory; Louis de Broglie's matter waves – wave-particle duality; Davisson and Germer experiment.	2	
	Section	ons from References: Section A		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

II	I	ntroductory Quantum Chemistry and the Quantum Mechanical Model of the Atom	22	42
	4	Heisenberg's uncertainty principle and the need of quantum mechanics for the micro world; <i>Postulates of quantum mechanics</i> - <i>Wave function postulate</i> , Physical significance of the wave function, The Born interpretation of the wave function and probability density. Well behaved functions, orthonormal functions	2	
	5	Time-dependent Schrodinger equation postulate – Deduction of Time independent Schrödinger wave equation for conservative systems. Laplacian and Hamiltonian operators.	2	
	6	Operator postulate - linear and Hermitian operators, eigenfunctions and eigenvalues of an operator. Eigenvalue postulate. Hermitian operators have real eigenvalues.	2	
		Average value or expectation value postulate		
	7	Applications of time independent Schrödinger wave equation	4	
		Particle in a one dimensional box with infinite potential energy walls – derivation of wave functions and energy, normalization of wave function, plots of wave functions and probability densities, average value of position, average value of momentum, calculation of energy levels and absorption band in butadiene using the particle in a box model.		
	8	Particle in a one dimensional box with finite potential energy walls (derivation not required) – Introduction to tunnelling, Principle of Scanning Tunnelling Microscopy (STM)	1	
	9	Particles in a three dimensional box – separation of variables and derivation of wave functions and energy, degeneracy of states in a cubic box.	2	
	10	Hydrogen atom - Hamiltonian operator of H-like systems, separation of nuclear and electronic motions - The Born-Oppenheimer approximation, The Schrodinger equation in spherical polar coordinates, separation of variables	3	
	11	Wave functions or atomic orbitals, radial and angular parts of atomic orbitals. Quantum numbers (n, l, m). Radial functions and their plots, Radial distribution functions and	3	

		their plots, Angular functions and their plots (1s, 2s and 2p _z only).		
	12	The Stern - Gerlach experiment and the concept of electron spin, spin quantum number, spin orbitals (elementary idea only). Antisymmetric wave functions and Pauli's exclusion principle.	2	
	13	Exact solution of the Schrodinger equation is impossible for multi-electron atoms - Need for approximation methods.	1	
	Section	ons from References: Section A		
III		Bonding in Diatomic Molecules	12	21
	14	Hamiltonian operator of H ₂ molecule - Born-Oppenheimer approximation, approximate theories of chemical bonding – (ways of mixing of wave functions of different atoms).	1	
	15	Valence bond theory of H_2 molecule - trial wave function, improvements by including delocalisation of electrons, mutual screening and partial ionic character. Potential energy profile of H_2 molecule formation - equilibrium geometry, Comparison of theoretical and experimental energy profiles.	3	
	16	Molecular orbital theory of H ₂ molecule —linear combination of atomic orbitals (LCAO), bonding and antibonding molecular orbitals, wave function as product of one electron functions, electron distribution in bonding and antibonding molecular orbitals, overlap integral, normalisation of bonding and antibonding molecular orbitals.	3	
	17	MO diagrams of homonuclear diatomic molecules – He ₂ , Li ₂ , Be ₂ , B ₂ , C ₂ , N ₂ , O ₂ , F ₂ ; Bond order, stability and magnetic properties of these molecules.	2	
	18	MO diagrams of heteronuclear diatomic molecules - CO and NO; Bond order.	2	
	19	Comparison of VB and MO theories.	1	
	Section	ons from References: Section B		
IV		Bonding in Polyatomic Molecules	6	14
	20	Concept of Hybridization: Need of hybridization, Definition (mixing of wave functions of the same atom)	1	

	21	LCAO of the central atom – coefficients of atomic orbitals in the linear combination of sp (BeH ₂), sp ² (BH ₃) and sp ³ (CH ₄) hybridization (derivation not required)	4	
	22	Other examples of hybridization – Geometry of molecules like PCl ₅ , SF ₆ and IF ₇ .	1	
	Section	ons from References: Section B		
V	Oper	Ended Module: Learning through problem solving and plots	12	
	1	 Plots of wave functions of particle in a box using excel or other software Plots of angular parts of atomic orbitals using any freeware Problem solving sections Connections with inorganic chemistry topics 		
	Section	ons from References: Section A & Section B		

Books and References:

Section A

- 1. D. A. McQuarrie, J. D. Simon, Physical Chemistry A Molecular Approach, Viva, 2001.
- 2. I. N. Levine, Quantum Chemistry, 6th Edn., Pearson Education Inc., 2009.
- 3. R.K. Prasad, Quantum Chemistry, 3rd Edition, New Age International, 2006.

Section B

- 1. James E. Huheey, Ellan A. Keiter, Richard L. Keiter, *Inorganic Chemistry Principles of Structure and Reactivity*, 4th Edn., Harper Collins, 1993.
- 2. D. A. McQuarrie, J. D. Simon, *Physical Chemistry A Molecular Approach*, Viva, 2001.

Further reading

- 1. F.L. Pilar, Elementary Quantum Chemistry 2 ND 2nd Edn., Dover, 1990.
- 2. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 4th Edn., Oxford University Press, 2005

3. Donald, A. McQuarrie, *Quantum Chemistry*, University Science Books, 1983 (first Indian edition, Viva books, 2003)

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	ı	ı	ı	2	2	3			1	2		2
CO 2	2	3	-	-	2	2	3				1		2
CO 3	-	-	1	-	2	2	3			1	3		2
CO 4	-	-	2	3	3	3	2				2		2
CO 5	-	1	-	-	3	3	3		2	2	2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/viva	Practical skill Evaluation	End Semester Examinations
CO 1		√		✓
CO 2		✓		√
CO 3	√			✓
CO 4	✓	√		✓
CO 5		✓		

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	ORGANIC CHEMISTRY 1								
Type of Course	MAJOR /MINOR	MAJOR /MINOR							
Semester	III								
Academic Level	200 - 299								
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours				
	4	3	-	2	75				
Pre-requisites	Basics of organic chemistry-Functional groups, Homologous series, Nomenclature and isomerism								
Course Summary	This course explores basics of organic chemistry reaction mechanism, Reactions and mechanism of important functional groups and stereochemistry								

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	To understand the basics of	U	С	Test /Seminar
	Organic chemistry			
CO2	To understand the basic concepts	U	p	Discussion/
	of reaction mechanisms			Assignment
CO3	To recognize the various types	An	P	Quizzes/Test
	of organic reactions and reaction			
	intermediates			
CO4	To realise the importance of	Ap	P	Discussion/Seminar
	stereoisomerism, optical activity			/Assignment
	and chirality			_
CO5	To enable the students to	Ap	P	Assignment/Test
	improvise Molecular models	_		

	CO6	To empower students in various	Ap	P	Lab work/Viva				
		separation and purification							
		techniques							
ſ	* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)								
	# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive								
	Knowledge (M)								

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		12	26	
	1	IUPAC Nomenclature of multifunctional acyclic and cyclic compounds. Structural isomerism.	2	
	2	Hybridization and bonding in organic compounds (methane, ethane, ethylene and acetylene	2	
	3	Localised and delocalised bonding. Hydrogen bonding, effect of hydrogen bonding on physical and chemical properties of compounds	1	
	4	Organic acids and bases	2	
	5	Basics of MO theory as applied to organic molecules -Ethylene and Buta-1,3-diene.	3	
	6	Aromaticity-Huckel's rule for aromaticity (Benzenoid compounds)	2	
II		12	26	
	7	Types of bond fission-Homolytic and Heterolytic fission	1	
	8	Arrow formalism used in reaction schemes.	1	
	9	Electrophiles and Nucleophiles	1	
	10	Electron displacement Effects: Inductive effect and Field effect, Steric effect- Acidity and basicity of organic compounds based on Field effect and steric effect.	2	
	11	Electromeric effect, Mesomeric effect	2	
	12	Hyperconjugation- Stability of alkenes.	1	
	13	Reactive intermediates: Structure, formation and stability of carbocations, carbanions, free radicals, carbenes and nitrenes.	3	
	14	Pericyclic reactions and its classifications	1	

III		14	30			
	15	Stereoisomerism: Conformational isomerism and configurational isomerism. Representation of stereostructures of organic molecules using Flying wedge, Fischer, Sawhorse and Newmann projections.	3			
	16	Inter conversion of different projections of L-tartaric acid and 3-chloro-2-butanol.	3			
	17	Conformational Isomerism – Conformational analysis of Ethane, n- butane and cyclohexane with PE diagram.	3			
	18	Conformation of mono substituted cyclohexanes. Relative stability of conformations.	2			
	19	Configurational isomerism: Geometrical isomerism in alkenes, cycloalkanes and oximes. Cis-trans, Syn-Anti and E-Z notations, sequence rule.	3			
IV		7	16			
	20 Distillation- Simple, fractional, steam and vacuum distillations					
	21	Recrystallisation, sublimation, solvent extraction.	2			
	22	Chromatography, stationary phase, mobile phase, Rf values, - TLC, Column chromatography, HPLC and GC (basic concepts only).	3			
V		30				
	1.	Introduction to organic lab	4			
	2	 Distillation of Aniline, Distillation of Limonene (from orange peels) Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol Sublimation of a dicarboxylic acid/Naphthalene Molecular model construction and conformation of ethane Molecular model construction of Ethylene or Acetylene Molecular model construction of acetaldehyde and Cyclohexane. 	20			
	3 Open ended					

References

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- 3. Kalsi, P. S., Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015
- 4. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
- 5. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 7. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 8. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.
- 9 . Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2^{nd} Edn., Pearson Education, Noida, 2013
- 10. An Improved Method for the Extraction and Thin-Layer W Chromatography of Chlorophyll a and b from Spinach Hao T. Quach, Robert L. Steeper, and G. William Griffin, J Chem Edn, 2004, 81, 385
- 11. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and sons, Ltd.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3				1	1	1
CO 2	2						2				2		1
CO 3	3						2				2		1
CO 4				2	2		2				2		1
CO 5	2						2		1	1	1	1	1
CO 6			3			2	2		1		2	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignm ent/viva/s eminar	Practical skill Evaluation	End Semester Examinations
CO 1	√	✓		\
CO 2		√		✓
CO 3	✓			√
CO 4		✓		✓
CO 5	√	√		✓
CO 6		√	✓	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry						
Course Title	INORGANIC CHE	INORGANIC CHEMISTRY-II					
Type of Course	MAJOR						
Semester	4						
Academic Level	200-299						
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours		
	4	3	-	2	75		
Pre-requisites	Classification of elements to different blocks, Comparative study of s and p block elements based on electronic configuration and atomic size, General idea about transition and inner transition elements, Concept of coordinate bond, Differences between double salts and complexes, Ligands, Coordination number. Concept of catenation and polymerization. Theoretical and practical knowledge about volumetric analysis.						
Course Summary	an insight into various application of inorgan	knowledge about volumetric analysis. This course explains characteristics of s, p, d and f block elements. It also gives an insight into various theories in coordination compounds. It explores the application of inorganic chemistry in daily life. It covers practical application of complex formation in quantitative analysis.					

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	To Elucidate the trends in physical and chemical properties of s and p block elements	U	С	Instructor- created exams/ Quizzes/assignments
CO2	To Evaluate the general characteristics of Transition and Inner Transition elements, their comparison and applications	U	С	Instructor- created exams/ Quizzes/assignments

CO3	To demonstrate knowledge of coordination chemistry, isomerism and theories of bonding in	U	M	Instructor- created exams/ Quizzes/assignments
	coordination compounds			
CO4	To analyze different types of inorganic polymers their structures, properties and applications	An	С	Instructor- created exams/ Quizzes/assignments
CO5	To Appreciate the utility of inorganic compounds in day to day life	Ap	М	Instructor- created exams/ Quizzes/assignments
CO6	To Apply the knowledge of complex formation and gain hands on experience in in quantitative analysis with some day to day application	Ap	P	Group work /Viva Voce// Observation of practical skill

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I		15	33	
	1	s block General properties: Ionization Energy, Flame coloration, Photoelectric effect, Metallic character, Hydration energy.	2	
	2	p block elements: Comparative study- Halides, Sulfates, Carbonates and bicarbonates (solubility and thermal stability)	1	
	3	Oxidation number and inert pair effect, Comparison of Lewis acidity of boron halides.	2	
	4	Preparation, Properties, Structure and uses of Diborane, Boric acid, Borazine and Boron nitride, Structure of AlCl ₃	3	
	5	Structure and bonding of oxides of N (N ₂ O, NO, N ₂ O ₃ ,NO ₂ ,N ₂ O ₄ ,N ₂ O ₅) and S (SO ₂ and SO ₃)	2	
	6 Oxo acids of P (H ₃ PO ₂ , H ₃ PO ₃ , H ₃ PO ₄) and Cl (HOCl, HOCl ₂ , HOCl ₃ ,HOCl ₄) (Structure and Acid strength), Colour and Bond Dissociation energy of halogens.		1	
	7	Interhalogen compounds: Preparation, Properties, Uses and Structure (One example each for AB,AB ₃ ,AB ₅ and AB ₇ types), Electropositive character of iodine, Pseudo	3	

		halogen: Comparison of Pseudo halogen (Cyanogen as example) and halogens and structure of Poly halide ions.		
	8	Noble gases: Isolation of noble gases: Dewar's method- Separation by charcoal adsorption method, Uses of He, and Ne	1	
II		TRANSITION AND INNER TRANSITION ELEMENTS	8hr	17
	9	Electronic configuration and General characteristics, Ionization energy, Colour, Magnetic properties, Reducing properties, Catalytic properties.	2	
	10	Non-stoichiometric compounds, Complex formation and Alloy formation. Comparison of 3d, 4d and 5d transition series. Important application of transition metals. Isopoly and heteropoly anions of W and Mo.	2	
	11	Lanthanides and Actinides- Electronic configuration and General properties. Isolation of Lanthanides from monazite sand, Separation by ion exchange method.	2	
	12	Magnetic properties. Lanthanide contraction, causes and consequences. Industrial importance of Lanthanides. Comparison of Actinides & Lanthanides [Mention only].	2	
Ш		COORDINATION CHEMISTRY	15 hr	33
	13	IUPAC Nomenclature of complexes, Types of ligands: (mono, bi, tri, tetra, hexa, ambidentate, chelate and macrocyclic ligands), Isomerism-Structural and Stereoisomerism,	2	
	14	Review of Werner's theory and Sidwick concept of coordination-EAN rule,	1	
	15	Factors affecting stability of complexes, Application of coordination complexes in quantitative and qualitative analysis.	2	
	16	Theories of bonding, VBT (valence bond theory), Geometry of coordination numbers 4 & 6, Limitation of VBT.	2	
	17	Crystal field Theory: CFT-splitting of d orbitals in Octahedral and Tetrahedral complexes. CFSE of low spin and high spin octahedral complexes- Normal and inverse	3	

		spinel compounds, Factors affecting crystal field splitting, Spectrochemical series.		
	18	CFT-splitting of d orbitals in Tetragonal and Square planar Complexes. Magnetism (spin only magnetic moment) and Colour (d-d transition), Distorted octahedral complexes-Jhan-Teller theorem, CFSE calculation and its applications, Merits and demerits of CFT.	5	
IV		INDUSTRIALLY IMPORTANT INORGANIC COMPOUNDS AND THEIR APPLICATION IN DAILY LIFE	7 hr	15
	19	Inorganic Polymers: Homochain Polymers and Heterochain Polymers.	1	
	20	Structure and Applications of Silicones, Silicates, Zeolites, Phosphazenes, Preparation, Properties and Structure of di and tri phosphonitrilic chlorides, SN compounds: Preparation Methods, Properties and Structure of S_2N_2 , S_4N_4 and $(SN)_x$,	3	
	21	Refractory materials: Borides and Carbides, Inorganic fertilizers: Essential Nutrients to plants- Nitrogenous, Phosphate and Potash fertilizers-Examples with formula, Rocket Propellants: Classification with examples.	2	
	22	Cement: Ingredients, Setting of cement, Role of gypsum Glass: Varieties of glass.	1	
v		INORGANIC CHEMISTRY PRACTICAL II: COMPLEXOMETRIC TITRATIONS AND INORGANIC PREPARATIONS	30 hr	
		From Section A Minimum of 3 experiments must be done and from Section B Minimum 3 experiments must be done Section A		
		Complexometry		
		 Estimation of magnesium Estimation of Zinc Determination of hardness of water Determination of COD of water samples Section B 		
		Inorganic preparations:		
		(a) Ferric alum,		

(b)Nickel (II) dimethylglyoximate,	
(c)Tetraammine copper (II) sulfate,	
(d)Potash alum	
Open Ended: Any two experiments related to complexometry can be selected by the teacher	

References:

- 1. B.R. Puri L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2010.
- 2. S. Prakash, G. D. Tuli, S. K. Basu, R. D.Madan, Advanced Inorganic Chemistry,5th Edn.,Vol.I,S Chand,2012.
- 3. J.D. Lee, Concise Inorganic Chemistry,5th Edn., Wiley India Pvt.Ltd.,2008.
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- 10. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 11. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

- 1. W.U.Malik, G.D.Tuli, R.D. Madan, selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 2010(Reprint)
- 2. F.A.Cotton,G.Wilkinson,Advanced Inorganic Chemistry,6TH Edn.,Wiley India Pvt.Ltd., New Delhi,2009.
- 3. James E. House, Inorganic Chemistry, academic press, 2008.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3			-	2	2	3				2		1
CO 2	3		-	-	2	2	3				1	1	2
CO 3	3	-		-	-	-	2		1		1		2
CO 4	3	-			3	3	3		2	1	2		2
CO5	2		-	-	3	2	2		1	1	2	2	2
CO6	2	-	2		3	3	2		2	1	3	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/viva/seminar	Practical evaluation	skill	End Examinations	Semester
CO 1	✓	✓			✓	
CO 2	√	√			✓	
CO 3	√	√			√	
CO 4	√	√			√	
CO 5	√	√			✓	
CO 6		√	√			

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	ORGANIC CHEMI	ORGANIC CHEMISTRY-II					
Type of Course	MAJOR						
Semester	IV						
Academic Level	200 - 299						
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	3	-	2	75		
Pre-requisites	 Concept of is isomerism (c) Basic idea ab elimination re 	hain, position out organic a	and function ddition react	nal) ions, substitut	ion and		
Course Summary	The concepts of chirality, Optical isomerism, Relative and absolute configuration and racemic mixture and its separation are included in the first module. The course is designed to provide a comprehensive understanding of addition, substitution and elimination reactions of organic chemistry. The practical component of the course helps to acquire skills in organic synthesis and Column chromatographic techniques.						

Course Outcomes (CO):

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the concepts of chirality, optical isomerism and relative and absolute configuration.	U	Ĉ	Seminar presentation /Assignment
CO2	To provide a comprehensive understanding of addition reactions in organic chemistry, To understand the mechanisms and stereochemistry of addition reactions.	Ap	P	Class test /Quiz /Assignment

CO3	Understanding the mechanism and stereochemical aspects of substitution reaction at sp3 carbon.	An	Р	Seminar Presentation / Instructor created exam
CO4	To provide a comprehensive understanding of elimination reactions.	U	С	Instructor- created exams / Home Assignments
CO5	Examine the mechanisms and factors influencing aromatic substitution reactions.	Ap	Р	Assignment /Seminar presentation /Class test
CO6	Execute practical lab techniques in organic synthesis. Acquire skills in conducting column Chromatography for the separation mixtures. Chromatography for the separation mixtures.	Ap	P	Lab work /Viva Voce

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hours	Marks
I	Stereo	chemistry II	13	29
	1	Optical Isomerism: Optical activity – Concept of chirality – Chirality in organic molecules.	2	
	2	Enantiomers, Diastereomers and Meso compounds.	2	
	3	Optical isomerism in glyceraldehyde, lactic acid and tartaric acid.	1	
	4	Relative and absolute configuration - DL system, RS system of nomenclature for acyclic optical isomers with one and two asymmetric carbon (Amino acids ,Tartaric acids)— sequence rules. Erythro and threo representations (basic idea only)	4	
	5	Racemic mixture – Resolution methods (Chemical and biochemicals methods)	2	
	6	Enantiomeric excess, Optical purity. Common approaches in asymmetric synthesis. (mention only)	2	
II	Additio	on reactions	12	27

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	7	Addition reactions to carbon-carbon multiple bonds: Origin of reactivity, regioselectivity (Markownikov's and anti-Markownikov's additions) and stereoselectivity of addition reactions	2	
	8	Examples of addition reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration-demercuration,	2	
	9	hydroboration-oxidation, epoxidation, dihydroxylation, ozonolysis.	1	
	10	Addition to C=C: Mechanism, reactivity, regioselectivity (Markownikov's and anti-Markownikov's additions) and stereoselectivity	3	
	11	Reactions: Complete hydrogenation, Partial hydrogenation, Electrophilic addition of halogens and hydrogen halides, Ozonolysis	2	
	12	Acidity of alkynes – test for terminal alkynes – Oxidation– (Ozonolysis and reaction with alkaline KMnO ₄). Chemistry of the tests for unsaturation: Bromine water and Baeyer's reagent test.	2	
III	Substi	itution and Elimination Reactions	10	21
	13	Nucleophilic substitution reactions: Substitution at sp ³ centre (systems: alkyl halides and alcohols)- Origin of reactivity, SN1, SN2 with stereochemical aspects, types of leaving groups (Oxygen-based and halogen-based).	3	
	14	Effects of substrate structure, solvent, nucleophile, and leaving group on Nucleophilic aliphatic substitution reactions.	3	
	15	Elimination reactions: E1, E2 & E1CB mechanisms. formation of alkenes and alkynes; mechanisms (with evidence), reactivity, regioselectivity (Saytzeff/Hofmann), and stereoselectivity;	3	
	16	competition between substitution and elimination reactions. Syn elimination	1	
IV	Arom	atic Substitution Reactions	10	21
	17	Aromatic Electrophilic Substitution: Mechanism of nitration, halogenation, sulphonation, Friedel-Crafts alkylation, and acylation	3	

	18	Synthesis of Aspirin. Ring activating and deactivating groups- Orientating effect of common substituents in aromatic electrophilic substitution.	2	
	19	Electrophilic substitution reactions of Phenols (bromination, nitration and sulphonation)	2	
	20	Preparation of phenolphthalein and Fluorescein	1	
	21	Aromatic nucleophilic substitution: Bimolecular displacement mechanism	1	
	22	Elimination-addition (benzyne intermediate) mechanism.	1	
V			30	
		PRACTICALS		
	I	 Separation of binary mixture using solvent extraction (strong acid neutral, basic+neutral and weak acid+neutral compound combinations) Bromination of Cinnamic acid (Green method-Bromide -Bromate mixture) Preparation of dibenzal acetone Nitration of acetanilide Reduction of ethyl acetoacetate by yeast and measurement of optical rotation. Drawing structures using software. Visualization of SN2 reaction using software 	24	
		Open Ended: 1.Making models of enantiomers and diastereomers	6	

References:

- 1. R. T. Morrison, R. N. Boyd, Organic Chemistry, Pearson Education, New Delhi.
- 2. I. L. Finar, Organic Chemistry, Vol. I, Pearson Education, New Delhi.
- 3. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Company Co.
- 4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, Vikas Publishing House.
- 5. P. Y. Bruice, Essential Organic Chemistry, 3rd Edn., Pearson Education, 2015.

- 6. John McMurry, Organic Chemistry, 5th Edn., Thomson Asia Pvt. Ltd.
- 7. C. N. Pillai, Organic Chemistry, Universities Press.
- 8. Vogel's practical organic chemistry.
- 9. John McMurry, Eric Simanek, Fundamentals of organic chemistry, 6th Edn., Thomson India Edition.
- 10. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and sons, Ltd.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	-	-	2		2		2		1
CO 2	2	2	1	1	2	ı	3		1		2		1
CO 3	2	-		-	-	2	2		1		2		1
CO 4	2	-		1	-	-	3		1		2		1
CO 5	3		-	-	-	-	2		1		2		1
CO 6	-	-	3		-	-	3		3		2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

Quiz / Assignment/ Quiz/ Discussion / Seminar

Midterm Exam

Programming Assignments (20%)

Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/viva/seminar	Practical skill Evaluation	End Semester Examinations
CO 1		√		✓
CO 2	√	✓		✓
CO 3	√	√		✓
CO 4	√	√		√
CO 5	√	✓		✓
CO 6		√	✓	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	PHYSICAL CHEMISTRY –II: CHEMICAL THERMODYNAMICS, KINETICS AND SURFACE CHEMISTRY					
Type of Course	MAJOR					
Semester	IV					
Academic Level	200-299					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
Pre-requisites	[Prerequisites: NCEI https://onlinecourses Fundamentals of Cifunction - Thermody Types of systems]	.swayam2.ac	.in/nce24_sc0	07/preview s. Path funct	tion and state	
Course Summary	We witness, feel and create physical and/or chemical change(s) everyday. What drives these changes? This course deals with the principles of chemical thermodynamics and chemical kinetics to answer these questions. The subject matter covered will enable the student to understand the relation between heat, work, temperature, and energy. Here, the various tools to evaluate chemical systems in equilibrium and rates of chemical reactions are also introduced. Further, the concept of catalysis and its importance in industrial processes is also included in this course.					

Course Outcomes (CO):

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To Understand the fundamental concepts of	U	F	Assignments/Quiz/Se minars

	thermodynamics and identify it with the real world			
CO2	To apply thermochemical principles to chemical reactions	Ap	С	Work out problems/assignment s/Test
CO3	To apply the concept of kinetics and catalysis to various chemical and physical processes	Ap	С	Work out problems/assignment s/Test
CO4	To interpret kinetic data using graphical representations and evaluate the rate of a reaction	An	Р	Quiz/Discussion
CO5	To evaluate the surface area of catalysts using various adsorption isotherms	Ap	Р	Quiz/Discussion
CO6	To apply the theories of kinetics and adsorption through laboratory experiments	С	Р	Lab work/Viva voce exams

^{* -} Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C)

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs (45+30)	Marks
I		FIRST LAW OF THERMODYNAMICS AND THERMOCHEMISTRY	15	33
	1	Intensive and extensive properties - Steady state and equilibrium state. Concept of thermal equilibrium	1	
	Zeroth law of thermodynamics. Intensive, extensive and state variables (state functions), Introduction to partial derivatives and line integrals, Euler theorem, Exact and Inexact		3	

		differential, Illustration of exact differential using molar volume of ideal gas.		
	3	First law of thermodynamics – Concept of heat (q), work, internal energy(U) and enthalpy (H) - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas under isothermal and adiabatic conditions - Work done in reversible isothermal and adiabatic expansion.	4	
	4	$\label{eq:Joule-Thomson} \begin{array}{cccccccccccccccccccccccccccccccccccc$	3	
	5	Thermochemistry: Heat changes during physical and chemical changes. Hess's Law.	2	
	6	Temperature dependence of reaction enthalpies- Kirchoff's law. Bond dissociation energies. Resonance energy from thermochemical data.	2	
II	S	ECOND & THIRD LAWS OF THERMODYNAMICS	10	21
	7	Limitations of first law and Need for the second law – Kelvin and Clausius statements. Carnot's theorem and Heat engine and its efficiency.	2	
	8	Concept of Entropy. Calculation of entropy change for reversible and irreversible processes. Statement of first law in terms of entropy. Entropy change during the isothermal mixing of ideal gasses.	2	
	9	Energy functions (Gibbs free energy (G) and Helmholtz energy (A)) and their variation with T and P.	2	
	10	Maxwell's relations. Gibbs-Helmholtz equation - Criteria for spontaneity and equilibrium - Significance of Clausius inequality.	2	
	11	Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation.	1	
	12	Third law of thermodynamics - Nernst heat theorem - Statement of third law.	1	
III		CHEMICAL KINETICS	15	33
	13	Rate of a reaction - Factors influencing the rate of a reaction- Concentration, Temperature, Surface area and Catalyst - Rate law - Order and molecularity -	2	
	14	Derivation of rate constants for first, second (with same and different reactants), third (with same reactants only) and zero	4	

		A minimum of 5 practical experiments out of which TWO EACH from sections 1 and 2 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-typed printed form. Section 1 1. Determination of rate constant of the Acid Hydrolysis of ethyl acetate 2. Determination of effect of temperature on the rate of acid hydrolysis of ethyl acetate 3. Determination of order of the reaction between crystal violet dye and NaOH (or Fuchsin and NaOH) by using	3 3	
V		PHYSICAL CHEMISTRY- PRACTICALS-2	30	
	22	Enzyme catalysis - Michaelis-Menten equation (derivation not required). Application of enzyme technology for environmental, medical, agricultural, and industrial benefits.	1	
	21	Homogeneous and heterogeneous catalysis - Theories of homogenous and heterogeneous catalysis with examples	1	
	20	Physisorption, Chemisorption. Adsorption isotherms – Langmuir, Freundlich and BET (No derivation required). Determination of Surface area, Particle size and surface area, Activated charcoal and its uses	2	
	19	Solid surfaces, microstructure and elementary idea about microscopic techniques for studying the surface of solids (SEM, TEM, STM, AFM)	1	
IV	SUR	FACE CHEMISTRY, ADSORPTION AND CATALYSIS	5	11
	18	Unimolecular reactions - Lindemann mechanism.	2	
	17	Theories of reaction rates - Collision theory - Derivation of rate equation for bimolecular reactions using collision theory - Transition state theory - Expression for rate constant based on equilibrium constant and thermodynamic aspects – Eyring equation (derivation not required)	5	
	16	Effect of temperature on reaction rates - Arrhenius equation - Determination and significance of Arrhenius parameters	1	
	15	Half-life period (derivation for first and n th order reactions) - Methods to determine the order of a reaction.	1	
		order reactions with examples. Data interpretation including graphical representations		

a colorimeter/spectrophotometer 4. Kinetics studies of reaction between KMnO ₄ and Oxalic acid 5. Open ended Section 2	3	
6. Adsorption of oxalic acid on activated charcoal and thereby determining the adsorption isotherm.	3	
7. Observation of decolourisation of a suitable dye on activated charcoal or filter paper via visual or colorimetry/spectrophotometry	3	
8. Verification of Hess's law by using Mg, MgO and HCl reactions.	3	
9. Effect of Mn2+ catalyst on reaction kinetics of KMnO ₄ vs Oxalic acid 10. Open ended	3	
References		
Module I and II		
 Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013. 		
Module III and IV		
 5. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) 6. K. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004. Module V 		
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- 8. Advanced Physical Chemistry: Practical Guide, C. Arora and S. Bhattacharya, Bentham Books, UAE, 2022
- 9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008...
- 10. R. C. Das, B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill, New Delhi, 1983

Further reading

- 11. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn., John Wiley and Sons, Canada, 1980.
- 12. 1. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 13. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 14. F. Daniels, R. A. Alberty, Physical Chemistry, 5th Edn., John Wiley and Sons, Canada, 1980.
- 15. D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill Book Company, New York, 1962.
- 16. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, Cambridge, 2009

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	3	2	3	2	2	1	2	1	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	2	-	-	3	3	3	2	1	-	1	-	1

CO 5	3	2	ı	1	3	3	3	2	1	1	3	1	1
CO 6	3	-	2	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		√		√
CO 2		√		✓
CO 3	√			✓
CO 4	√			✓

CO 5	√	√		✓
CO 6	√	<	√	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	Programme B. Sc. Chemistry						
Course Title	THEORETICAL CHEMISTRY II - GROUP THEORY AND MOLECULAR SPECTROSCOPY						
Type of Course	MAJOR						
Semester	V						
Academic Level	300 – 399						
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours		
	4	4	-	-	60		
Pre-requisites Course Summary	Elementary as including trans Basic underst quantised ene Review the concept content of the course introduce theoretical chemistry. Group theory and Modern of the course introduce theoretical chemistry. Group theory and Modern of the course introduce theoretical chemistry. Group theory and Modern of the course introduce theoretical chemistry. Group theory is a top (whatever be their national obey certain conditional used for systematizing symmetry. This can molecules that we concept of the course of th	islation, rotate anding of quargy levels. Oncept of election of the relation of the relation of the relation of the theoretics. It is the theoretic which find olecular Specific of mathemature) can be used. The course of the study of the study of the symmetry of the symm	ion and vibra antum chemi etron spin intenship between ical aspects of a wide rang troscopy. atics which segrouped into se brings to lift of structures grouping the to only a few etry operation	stry and the corroduced in the en structure of two fundame of practical suggests that	ets of elements l groups if they based on their nd millions of l groups called by them. Such		

Molecular Spectroscopy: The interaction of electromagnetic radiation with matter forms the basis for the different spectroscopic techniques used for the structural elucidation of molecules. The course brings to light the underlying principles involved in each of these spectroscopic techniques. The allowed energy states of molecules and the transitions between them are unique and are decided by the laws of quantum mechanics. Radiations having different frequencies (and hence different energy) interact with molecules and bring about characteristic transitions which help to identify the exact structure of molecules.

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	understand the principles of constructing mathematical groups	U	F	Assignment
CO 2	realise point groups as collections of symmetry operations of molecules	Ap	С	Class tests/Viva
CO 3	identify each spectroscopic method as the interaction of molecules with a characteristic radiation of the electromagnetic spectrum	An	Р	Seminar/ Class tests
CO 4	apply various spectroscopic techniques for the structural elucidation of molecules.	Ap	Р	Class tests/Assignment
CO 5	justify spectroscopic methods as unique tools for identifying molecules.	Е	M	Viva

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	nit Content Content		Marks
			(45 +30)	
I		Mathematical Preliminaries of Group Theory	6	12
	1	Conditions for sets of elements to form mathematical groups - closure rule, associativity, existence of identity and inverse elements.	2	

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	2	Order of a group, Definitions of finite, infinite, Abelian and cyclic groups.	1	
	3	Binary combination of elements of a group - the group multiplication table and its features - general group multiplication tables of groups up to order 4.	2	
	4	Sub groups, similarity transformation and classes.	1	
	Section	ons from References: Section A		
II	Gro	oup Theory as a Means for the Systematic Study of Molecular Symmetry	12	25
	4	Tools for studying molecular symmetry – symmetry elements, symmetry operations and their classification.	2	
	5	Mathematical groups of symmetry operations - the point groups, nomenclature of point groups - Schoenflies notations.	2	
	6	Assigning point groups to molecules based on their symmetry elements.	2	
	7	Binary combinations of symmetry operations - the group multiplication tables of C_{2v} , C_{3v} and D_{2h} point groups.	3	
	8	Identifying classes of symmetry operations in point groups (C_{2v} and C_{3v} as examples)	2	
	9	Matrix representation of symmetry operations. Matrices for the symmetry operations of C_{2v} , C_{3v} and D_{2h} .	1	
	Section	ons from References: Section A		
III		Molecular Spectroscopy-I	18	36
	14	Energy levels in molecules – Born-Oppenheimer approximation. Electromagnetic spectrum - wavelength, frequency, wavenumber.	2	
	15	Interaction of electromagnetic radiation with matter - factors affecting line width and intensity of signal.	2	
	16	Rotational Spectroscopy: Introduction – Rigid rotor – Expression for energy – Selection rules – Intensities of spectral lines – Determination of bond lengths of diatomic molecules.	3	
	17	Vibrational Spectroscopy: Simple harmonic oscillator – Energy levels – Force constant – Selection rules - Anharmonicity – Fundamental frequencies – Overtones – Fingerprint region – Group frequency concept – Degree of freedom for polyatomic molecules – Modes of vibrations of CO ₂ and H ₂ O.	4	

	Raman Spectroscopy: Basic principles – Rayleigh scattering – Raman scattering-Stokes & anti-stokes lines and their intensity difference - classical theory of Raman effect: polarizability – quantum theory of Raman scattering, selection rules for Raman spectra- Qualitative treatment of rotational Raman effect – Vibrational Raman spectra — Selection rules – Mutual exclusion principle. Resonance Raman scattering, Raman and IR spectroscopy,	-	
	19 Electronic Spectroscopy: Basic principles – Frank-Condon principle – Electronic transitions – Beer Lambert's law - Dissociation energy of diatomic molecules – Chromophore and auxochrome – Bathochromic and hypsochromic shifts.		
137	Sections from References: Section B	12	25
IV	Molecular Spectroscopy-II	12	25
	Proton NMR spectroscopy – nuclei in a static magnetic field - basic principle of NMR spectroscopy - resonance; spectral parameters - chemical shift - nuclear shielding - spin-spin coupling - origin of coupling - coupling constants - NMR spectra of simple molecules.		
	21 ¹³ C NMR <i>Spectroscopy:</i> C-13 - relative abundance, chemical shift, spin-spin coupling. Factors affecting chemical shifts. Proton coupled and decoupled ¹³ C NMR.		
	22 Electron Spin Resonance (ESR) Spectroscopy: Principle - comparison between NMR and EPR - g factor - electron-nuclear interactions - hyperfine interactions - Hyperfine structure - ESR of methyl, phenyl and cycloheptatrienyl radicals.	•	
	Sections from References: Section B		
V	Open Ended Module: Learning through problem solving and plots	12	
	 Categorize molecules into point groups based on symmetry elements Solving problems involving various spectroscopic data Deducing the structure of various compounds from different spectra 		

Sections from References: Section A & Section B		
	1	

Books and References:

Section A

- 1. F. A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn., John Wiley & Sons, New York, 1990.
- 2. A. Salahuddin Kunju & G. Krishnan, Group Theory & its Applications in Chemistry, PHI Learning Pvt. Ltd.2010.

Section B

- 1. C. N. Banwell, Fundamentals of molecular spectroscopy, McGraw-Hill, 1994.
- 2. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press 2006.
- 3. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, 46. Edn., Vishal Publishing Company, New Delhi, 2013.
- 4. Donald A. McQuarrie, John D. Simon, *Physical Chemistry: A Molecular Approach*, University Science Books: Sausalito, CA; 1997.

Further reading

- 1. K.Veera Reddy, Symmetry & Spectroscopy of Molecules 2nd Edn., New Age International 2009.
- 2. H. H. Jaffe and M. Orchin, Symmetry in Chemistry, John Wiley & Sons Inc., 1965.
- 3. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, London, 1962.
- 4. Thomas Engel, Quantum Chemistry & Spectroscopy, Pearson education, 2006.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	1	-	-	-	1	3				1		2
CO 2	2	3	-	-	-	-	3						2
CO 3	-	-	1	-	-	-	3				2		1

CO 4	-	-	2	3	-	-	3		2	3	2
CO 5	-	1	-	-	1	1	3	1	2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignm ent/viva/s eminar	Practical skill Evaluation	End Semester Examinations
CO 1		√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		✓
CO 5		√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry									
Course Title	INORGANIC CHE	MISTRY-II	I							
Type of Course	MAJOR									
Semester	V									
Academic Level	300-399									
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours					
		per week	per week	per week						
	4	3	-	2	75					
Pre-requisites										
	Different segments of environment, Environmental pollution, Different types of pollution, health effect and hazards associated with chemicals, Acid-base concepts, basic idea about chemical analysis									
Course	This course explain		•	-						
Summary	consequences, remed	_		_						
	It reveals the importa	ince of need	or green chen	mstry and gree	en synthesis					
	It gives an idea about solvents	ut major acio	l base conce	pts and reaction	ons in nonaqueous					
	It initiates the studen changing trends of m	-		anced material	s in the demand of					
	This course explores discipline in the mod analysis of inorganic	dern era and	develops skil		=					

Course Outcomes (CO):

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To critically evaluate issues in environment	An	С	Instructor-created exams / Assignments
CO2	To gain insights into the economic and environmental aspects of green chemistry and to contribute the advancement of sustainable practices in the field of chemistry	Ар	C	Assignment / seminar/quizes
CO3	To understand the theories of acids and bases and reactions in non aqueous solvents and to identify compounds as acids and bases	Ap	С	Assignment/Seminar/Class test
CO4	To understand and apply principles of material chemistry and its facets	Ap	С	Assignment/Seminar/Class test
CO5	To equip the students with familiarization in separation and identification of ions	Ap	P	Group work /Assignment/class test/
CO6	Practicum in inorganic qualitative analysis with hands on familiarity with various ions	An	Р	Group work /Assignment/ Viva, Observation of practical skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
I	ENV	VIRONMENTAL CHEMISTRY AND GREEN CHEMISTRY	15	33

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	1	Environment and Environmental pollution, pollutant and	1	
		contaminant, Segments of Environment		
	2	Air Pollution: Types of air pollutants, Gaseous air pollutants	2	
		(oxides of carbon, nitrogen and sulphur), Particulates.		
	3	Effects of air pollution: Smog (London and Los Angeles Smog),	2	
		Global warming, ozone depletion, acid Rain,		
	4	Control of air Pollution, alternative refrigerants	1	
	5	Water Pollution : Sources of water pollution, Eutrophication,	2	
		Bioaccumulation, bioMagnification,		
	6	Water quality parameters (DO,BOD and COD and their	2	
		determination), Toxic metals in water(Pb, Cd and Mg), control of		
		water pollution		
	7	Soil pollution, Thermal pollution, noise pollution, light pollution,	3	
		radiation pollution (Sources and effects)		
	8	Introduction to Green chemistry – Goals of Green chemistry,	2	
		Twelve basic principles of green chemistry- Atom economy- Green solvents- water, supercritical fluids, ionic liquids [mention		
		with examples).		
II	A	CID BASE CONCEPTS AND NON-AQUEOUS SOLVENTS	5	10
	9	_	2	
	9	Major acid-base concepts, Arrhenius, Bronsted-Lowry, Solvent system, Lux-Flood, Lewis and Usanovich concepts.	2	
		system, Lux-1400d, Lewis and Osanovich Concepts.		
	10	Non - aqueous Solvents: Classification – General Properties	1	
	11	Reactions in Liquid Ammonia, liquid SO ₂ and Liquid HF	2	
III		MATERIAL CHEMISTRY	15	33
	12	1		
	13	Ceramic materials: Definition, classification(traditional and	5	
		advanced ceramics), Composition-oxides and nitrides-general		

		properties- applications- structural, Electronics, thermal and biomedical applications						
	14	Catalytic materials : zeolites, alumina- surface properties, supporting materials	3					
	15	Composite materials: Definition and types of composite materials (polymer matrix composites, metal matrix composites, carbon matrix composites- explanation with examples	3					
	Inorganic solids :Perovskites- ABX ₃ - CaTiO ₃ , LaCoO ₃ , spine compounds- AB ₂ O ₄ - MgAl ₂ O ₄							
IV	INO	RGANIC QUALITATIVE AND QUANTITATIVE ANALYSIS	10	22				
	17	Inorganic qualitative analysis: Need for elimination of interfering acid radicals and their elimination methods — oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate	1					
	18	Principles of separation of basic radicals into various groups — Solubility product and Common Ion effect — Their application in the qualitative inorganic analysis.	2					
	19	Micro analysis: merits and application, preparation of sodium carbonate extract and its merits	1					
	20	Inorganic Quantitative Analysis – Gravimetric analysis – Introduction – Types of gravimetric analysis, Precipitation, Advantages and disadvantages of gravimetric analysis –	2					
	21	Properties of precipitates and precipitating agents, Mechanism of precipitate formation- Von Weimarn equation and its applications—Co-Precipitation and post precipitation—	2					
	22	Homogeneous and heterogeneous precipitation – gravimetric factor - Inorganic and Organic precipitating agents and their applications - NH ₃ , H ₂ SO ₄ , NH ₄ SCN, oxine, cupron, cupferron, 1-nitrosonaphthol, dithiocarbamates.	2					

V	INORGANIC CHEMISTRY PRACTICAL III:INORGANIC	30	
	QUALITATIVE AND QUANTITATIVE ANALYSIS		
	1. Inorganic qualitative analysis:		
	a) Study of reactions of following ions,		
	Anions: carbonate, sulphate, fluoride, chloride, acetate,		
	borate, oxalate, phosphate and nitrate		
	Cations: Lead, bismuth, copper, cadmium, iron,		
	aluminium, cobalt, nickel		
	manganese, zinc, barium, calcium, strontium, magnesium		
	and ammonium		
	b) Systematic analysis of mixtures containing two cations and		
	two anions from the above list (Na ₂ CO ₃ extract procedure		
	may be adopted)		
	2. Inorganic quantitative analysis : Gravimetric analysis		
	(Open ended)		
	a) Estimation of barium as barium sulphate or sulphate as		
	barium sulphate can be done		

References:

- 1. A.K. De, Environmental Chemistry, 6th Edn., New Age International Pvt. Ltd., New Delhi, 2006.
- 2. S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edn., S. Chand and Sons, New Delhi, 2008.
- 3. K. Ahluwalia, Environmental Chemistry, Ane Books India, New Delhi, 2008.
- 4. Paul T. Anastas, T. C. Williamson, Green Chemistry Designing Chemistry for the Environment, 2nd Edn., 1998.
- 5. S. C. Ameta, R. Ameta, Green Chemistry: Fundamentals and Applications, CRC Press, 2013.

- 6. Anthony R. West, Solid State Chemistry and its Applications, 2 nd Edn., Wiley-Blackwell, 2014.
- 7. Green Chemistry Environmental friendly alternatives- edited by Rashmi Sanghi & M. M. Srivastava, Narora Publishing House, (2003).
- 8. N.N. Greenwood and A.Earnshaw, *Chemistry of Elements*, 2/e, *Elsevier* Butterworth-Heinemann, 2005.
- 9. J.E.Huheey, E.A.Keiter, R.L.Keiter. O.K.Medhi. *Inorganic Chemistry, principles of structure and reactivity*, Pearson Education, 2006.
- 10. G.L.Miessler, D.A.Tarr, Inorganic Chemistry, Pearson, 2010.
- 11. M.J. Starfield and Shrager, Introductory Material Science, McGraw Hill.
- 12. K.K. Chowla, Composite Materials, Springer Verlag, NY,1987.
- 13.. M. Tinkham, Introduction to Superconductivity, McGraw Hill, 1975.
- 14. A.V. Narlikar and S.N. Edbote, Superconductivity and Superconducting Materials, South Asian Publishers, New Delhi, 1983.
- 15. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Prentice Hall, New Delhi, 1996.
- 16. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	-	1	2	1	2	3		1	1	2	3	2
CO 2	2	1	3	2	2	3	2		1		1	3	2
CO 3	3	1		2	2	3	3		1	1	1	1	2
CO 4	3	-	2		1	3	3		2	1	2	1	2
CO 5	2		2	-	2	2	2		2		2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment /viva/semin ar		End Semester Examinations
CO 1	√	✓		✓
CO 2	√	✓		✓
CO 3	√	>		✓
CO 4	√	√		✓
CO 5	✓	√		✓
CO 6		✓	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry					
Course Title	ORGANIC CHEMISTRY - III					
Type of Course	MAJOR					
Semester	V	V				
Academic Level	300 - 399	300 - 399				
Course Details	Credit	Lecture	Tutorial	Practical	Total	
		per week	per week	per week	Hours	
	4	3	-	2	75	
Pre-requisites	 Methods of preparation of aldehydes, ketones and carboxylic acids. Nomenclature, isomerism and general physical properties of aldehydes, ketones, carboxylic acids and amines. Acidity of carboxylic acids and basicity of amines. 					
Course Summary	To give the students a thorough knowledge about the reactivity, nucleophilic addition and substitution reactions of carbonyl compounds and chemistry of nitrogen containing functional groups and their applications in organic preparations.					

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze and compare the reactivity of aldehydes and ketones in nucleophilic addition reactions using various carbon, nitrogen, oxygen and sulphur nucleophiles	An	P	Instructor- created exams / Quiz /Assignment
CO2	Explain the origin of reactivity of carboxylic acids and their derivatives and analyse nucleophilic acyl substitution reactions and hydrolysis of carboxylic acid derivatives	U	С	Class test /Assignment /Quiz
CO3	Demonstrate the oxidation and reduction reactions of alkenes, alkynes, alcohols, aldehydes, ketones and carboxylic acids using various oxidising and reducing agents	Ap	P	Assignment/ Class test

CO4	Identify the preparation methods and important reactions of nitro compounds, amines and sulpha drugs and explain the properties and synthetic transformations of aryl diazonium salts	Ap	P	Assignments /Seminar presentation
CO5	Evaluate reactions involving α-carbons of carbonyl compounds and conjugated addition reactions of α,β-unsaturated carbonyl compounds and apply active methylene compounds in organic preparations	Е	С	Class test /Assignment /Quiz
CO6	Conduct qualitative tests to identify specific functional groups, such as aldehydes, ketones, carboxylic acids, phenols, nitro compounds, amines, amides, esters etc. and synthesis of some organic compounds like aspirin, cinnamic acid, iodoform, biodiesel etc	An	P	Lab work/Viva Voce

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Unit Content		Marks
I		Chemistry of Carbonyl Compounds-I	15	32
	1	Origin of reactivity of the carbonyl group. Comparison of reactivity of aldehydes and ketones	2	
	2	Nucleophilic addition reactions of aldehydes and ketones (Mechanism expected) - Carbon nucleophiles (Addition of HCN, Grignard reagents), Nitrogen nucleophiles (NH ₃ , amine, hydroxylamine, hydrazine, semicarbazide and DNP reagent), Oxygen nucleophiles (H ₂ O, alcohols), Sulphur nucleophiles (sodium bisulphite)	3	
	3	Keto-enol tautomerism. Reactions involving α carbons of carbonyl compounds - Aldol condensation, Cannizzaro reaction and Benzoin condensation (mechanism expected), Perkin's reaction, Knoevenagel reaction and Haloform reaction (mechanism not expected)	5	
	4	Conjugate addition reactions of α,β -unsaturated carbonyl compounds – 1,2 and 1,4 – addition reactions	2	

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	5	Active Methylene Compounds: Examples – Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected) – Synthetic applications of ethyl acetoacetate	3	
II		Chemistry of Carbonyl Compounds-II	8	18
	6	Origin of reactivity in the carboxylic acid family. Nucleophilic acyl substitution reactions and Mechanism	2	
	7	Comparison of reactivity of Carboxylic Acids and derivatives, Hydrolysis of carboxylic acid derivatives	2	
	8	Fischer esterification (mechanism expected), HVZ reaction, Decarboxylation – Kolbe electrolysis (mechanism expected)	2	
	9	Interconversion of Carboxylic acid derivatives. Introductory idea about β -lactam antibiotics – Structure and action of Penicillin- G	2	
III		Oxidation & Reduction reactions	7	16
	10	Oxidation and reduction of alkenes and alkynes	1	
	11	Oxidation of alcohols with PCC and CrO ₃	1	
	12	Oxidation of aldehydes and ketones with acidified K ₂ Cr ₂ O ₇ , KMnO ₄ , CrO ₃ ; Oppenauer oxidation. Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution)	2	
	13	Reduction of aldehydes and ketones – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride (LiAlH4 and NaBH4) and MPV reduction	2	
	14	Reduction of carboxylic acids (LiAlH ₄ , BH ₃)	1	•
IV		Nitrogen containing compounds	15	32
	15	Nitro compounds: Preparation and important reactions of nitro compounds, Ketones from nitro compounds – Nef reaction (mechanism not required)	2	
	16	Reduction products of nitrobenzene in acidic, neutral and alkaline media	2	
	17	Amines: Preparation – Gabriel phthalimide synthesis, from reduction of nitriles and isonitriles.	1	
	18	Amines: Properties - Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction (with mechanism and stereochemistry)	3	
	19	Electrophilic substitution reactions of aniline (Nitration, Bromination and Benzoylation)	2	

	20	Distinction between 1°, 2° and 3° amines with Hinsberg reagent	1	
	01	and nitrous acid	2	
	21	Preparation and uses of sulpha drugs – Structural formula of sulphapyridine, sulphadiazine, sulphathiazole and sulphaguanidine	2	
	22	Synthetic transformations of aryl diazonium salts, azo coupling. Preparation of methyl orange	2	
V		Practicals - Reactions of Organic Compounds	30	
	I	Analysis of organic compounds from the following list (also prepare the derivatives).	16	
		1. Phenols (phenol, α-naphthol).		
		2. Nitro compounds (nitrobenzene, o-nitrotoluene).		
		3. Amines (aniline, N,N-dimethylaniline).		
		4. Aldehydes and ketones (benzaldehyde, benzophenone).		
		5. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).		
		6. Carbohydrates (glucose, sucrose).		
		7. Amides (benzamide, urea).		
		8. Esters (ethyl benzoate, methyl salicylate).		
		Analysis of about 7 organic compounds containing the above functional groups.		
	II	Organic Preparations (Any two)	8	
		Synthesis of aspirin, cinnamic acid, iodoform and biodiesel		
	III	Open Ended	6	

References:

- 1. R. T. Morrison, R. N. Boyd, Organic Chemistry, Pearson Education, New Delhi.
- 2. I. L. Finar, Organic Chemistry, Vol. I, Pearson Education, New Delhi.
- 3. M. K. Jain, S. C. Sharma, Modern Organic Chemistry, Vishal Publishing Company Co.
- 4. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, A Textbook of Organic Chemistry, Vikas Publishing House.
- 5. P. Y. Bruice, Essential Organic Chemistry, 3rd Edn., Pearson Education, 2015.
- 6. John McMurry, Organic Chemistry, 5th Edn., Thomson Asia Pvt. Ltd.
- 7. C. N. Pillai, Organic Chemistry, Universities Press.
- 8. Vogel's practical organic chemistry.
- 9. John McMurry, Eric Simanek, Fundamentals of organic chemistry, 6th Edn., Thomson India Edition.

10. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and sons, Ltd.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	1	1	1	-	-	3	1	2	2	2	1	2
CO 2	2	1	-	-	_	-	2	1	1	2	2	2	2
CO 3	2	-		2	-	-	2	2	2	1	2	1	2
CO 4	-	-		2	1	1	2	1	1	2	2	1	2
CO 5	3			2	-	-	2	1	1	2	2	2	2
CO 6	-	-	3	2	-	2	3	2	2	2	2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Quiz/ Discussion / Seminar

Midterm Exam

Programming Assignments (20%)

Final Exam (70%)

	Internal Exam	Assignme nt/viva/se minar	Project Evaluation	End Semester Examinations
CO 1	✓	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	✓		√
CO 5	√	✓		√
CO 6		√	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry						
Course Title	INORGANIC CHEMISTRY-IV						
Type of Course	MAJOR						
Semester	VI						
Academic Level	300-399						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours		
		per week	per week	per week			
	4	4	-	-	60		
Pre-requisites	Solid foundation in C	Coordination	Chemistry. U	niqueness of	carbon, covalent		
	bond, and coordinate	bond. Bondi	ng in carbon	monoxide. K	nowledge about		
	minerals and ores. In	nportance of	metal ions in	biological sys	stems. Atomic		
	number, mass numbe	er, isotopes, b	asic idea abo	ut nuclear rad	lioactivity, Nuclear		
	fission and fusion.						
Course Summary	This course enables	the students	s to develop	knowledge	about theories of		
	bonding in coordina	tion compou	nds, stability	constants, c	helating effects. It		
	covers the detailed	d study on	structure,	bonding and	d applications of		
	organometallic com	pounds. It	gives basi	c understand	ding of different		
	metallurgical process	es. It enables	the students	to familiarise	with various metal		
ions, their compounds and their important in biological systems. It of							
	various aspects of nu	clear chemis	try including	nuclear stabil	ity and reactions.		

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools used
		Level*	Category#	
CO1	To Understand and apply theories	U	С	Instructor-created exams
	of bonding in coordination			/ Assignments
	compounds			

CO2	To Classify, interpret and create	U	С	Instructor-created exams
	organometallic compounds,			/ Assignments
	including their applications in			
	synthesis and as catalysts			
CO3	To Describe and perform steps in	Ap	С	Assignment /
	metallurgy and recognize the			seminar/quizzes
	composition and uses of various			
	alloys			
CO4	To Identify the role of metal ions	Ap	С	Assignment/Seminar/Cla
	in biological systems and			ss test
	understand their significance in			
	biological processes			
CO5	To describe knowledge of the	Ap	U	Assignment/class test/
	fundamental aspects and practical			
	applications of nuclear chemistry.			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Unit Content		Mark
I	THE	ORIES OF BONDING IN COORDINATION COMPOUNDS	15	30
	1	Molecular orbital theory-Composition of ligand group orbitals.	2	
	2	MO diagram of octahedral tetrahedral and square planar complexes with and without π -bonding.	4	
	3	Stepwise and overall formation constant and relationship between them, Trends in stepwise formation constants.	3	
	4	Determination of stability constants by spectrophotometric methods. Stabilization of unusual oxidation state.	3	
	5	Thermodynamic origin of chelating effect, Macrocyclic and Template effect.	3	

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

II		ORGANOMETALLIC CHEMISTRY	12	25
	6	Definition, Classification of organometallic compounds on the	2	
		basis of M-C bond with examples. Classification of organic		
		ligands based on hapticity.		
	7	Metal carbonyls-Definition- Classification, 18 electron rule and	2	
		deviation from 18 electron rule, Electron count of mononuclear		
		and polynuclear metal carbonyls (calculation by oxidation		
		number method and covalent method). MOT and the basis for		
		the 18 electron rule.		
	8	General methods of preparation properties and structures of	2	
		mono and binuclear carbonyls of Cr, Mn, Fe, Co and Ni.		
	8	Bonding in metal carbonyls (MO diagram of CO to be	2	
		discussed). Synergic effect and use of IR spectra to explain the		
		extent of back bonding.		
	9	Preparation, Structure, Bonding and Reactions : Zeise's salt,	3	
		Metallocenes- Ferrocene (VBT and MOT).		
	10	Applications of organometallic compounds in synthesis and as	1	
		catalysts, Hydrogenation using Wilkinson's catalyst and		
		Polymerization of alkenes using Ziegler Natta catalyst		
		(mechanism not needed).		
III		METALLURGY	11	23
	11	Discuss the terms: Mineral, Ore, Gaunge, Flux, slag,	2	
		Electrometallurgy – Hydrometallurgy.		
	12	Steps in metallurgy:(a)Pulverization of the ore	2	
		(b)Concentration of the ore (Physical and chemical)		
		(c)Treatment of the concentrated ore-Calcination and roasting		
		(d)Reduction-different methods: Smelting, Gold smith alumino		
		thermic process, Kroll's process, Electrolytic reduction, Self		
		reduction. (e) Refining: Liquation, Distillation.		
	13	Vapour Phase refining, Zone refining, Oxidative refining,	2	
		Electrolytic refining, Poling, Cupellation, Parting process, Ion		
		exchange method.		

	14	Ellingham diagrams for metal oxides – Extractive metallurgy of	3	
		Fe, Ni and Ti.		
	15	Alloys: Definition – Composition and uses of German silver,	2	
		Brass, Bronze, Gunmetal and Alnico. Steel: Open hearth process,		
		Classification of steel, Composition and uses of alloy steels,		
		Composition, Properties and Applications of industrially		
		important stainless steel types, (AISI) (a brief study).		
IV		BIOINORGANIC CHEMISTRY	10	20
	16	Discuss various elements present in the biological system,	2	
		Essential and Non-essential elements, Metal ions in biological		
		system, Trace and bulk metal ions, Role of alkali metal ions in		
		biological systems, Sodium-potassium pump, Structural role of		
		calcium.		
	17	Ligands present in biological systems, Structure of Porphyrin	1	
		and Corrin.		
	18	Structure of heme - Oxygen transport by heme proteins,	2	
		Hemoglobin and Myoglobin, Structure of the oxygen binding		
		site, Nature of heme- dioxygen binding, Cooperativity.		
	19	Structure of Hemerythrin and Hemocyanin.	1	
	20	Metalloenzymes and Metal activated enzymes, Biochemistry of	2	
		Zn – structure and functions of Carboxypeptidase, Carbonic		
		Anhydrase, Biochemistry of Cobalt, Vitamin B 12 and		
		Deficiency diseases.		
	21	Chlorophyll and Photosynthesis (mechanism not expected).	1	
	22	Anticancer drugs. Cis-platin, Oxaliplatin, Carboplatin and	1	
		Auranofin – Structure and Significance.		
V		NUCLEAR CHEMISTRY	12	
	23	The teacher can choose the important topics in the area nuclear	12	
		chemistry: Nuclear stability, N/P ratio, Mass defect (numerical		
		problems), Packing Fraction, Binding Energy per Nucleons,		
		Radioactivity, Group displacement law, Disintegration series,		
		Nuclear fission, Fusion, Reactors: Applications, RadioCarbon		
		dating, Rock dating, Isotopes as tracers.		
-				

Must cover Nuclear stability, n/p ratio, Fission, Fusion,	
Separation of isotopes, Application of isotopes.	

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- 1. D. F. Shriver, P. W. Atkins, Inorganic Chemistry, 5th Edn., Oxford University Press, New York, 2010.
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- 3. J. E. Huheey, E. A. Keitler, R. L. Keitler, Inorganic Chemistry Principles of Structure and Reactivity, 4 th Edn., Pearson Education, New Delhi, 2013.
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- P. Powell, Principles of Organometallic Compounds, 2nd Edn., Chapman and Hall, London, 1988.

Mapping of COs with PSOs and POs:

	PS O1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	-	-	-	1	3				1		1
CO 2	2		1	1	1	2	2		1		2	1	2
CO 3	3	-		-	2	2	3			1			1
CO 4	2				2	1	3					1	1
CO 5	2		-	-	1	3	3					1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment/viva/ seminar	Practical skill evaluation	End Semester Examinations
CO 1	✓	√		✓
CO 2	√	√		✓
CO 3		√		✓
CO 4	√	√		✓
CO 5	√	√		

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry							
Course Title	ORGANIC CHEMISTRY - IV							
Type of Course	MAJOR							
Semester	VI							
Academic Level	300 - 399							
Course Details	Credit	Lecture	Tutorial	Practical	Total			
		per week	per week	per week	Hours			
	4	3	-	2	75			
Pre-requisites	 Distillation ar 	nd chromatog	graphic techni	iques				
	2. Essential and	non-essentia	l amino acids	S				
	3. Chemistry of Fehling's solution test and Tollen's reagent test4. CHE5CJ301							
Course	To give the student	ts a thoroug	gh knowledg	e about the	heterocyclic			
Summary	chemistry and polyn	•		•				
	products, biomolecul	es, dyes, pha	rmaceuticals	and cleansing	gagents			

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	Demonstrate the nomenclature, structure, methods of preparation, reactivity and common reactions of heterocycles including Furan, Pyrrole, Thiophene, Pyridine, Indole, Quinoline and Isoquinoline and demonstrate the structure of Imidazole, Pyrazole, Oxazole, Pyrimidine and Purine.	Ap	P	Seminar presentation /Assignment/Class test
CO2	Examine the classification, isolation, purification and physiological activities of alkaloids and terpenes. Evaluate the classification, structural	U	С	Class test /Quiz /Assignment

	features, reactions and tests of carbohydrates.			
CO3	Understand the concepts of classification, structural features and the significant role of biomolecules like amino acids, proteins, nucleic acids, lipids, steroids and hormones, in nature/human body.	U	С	Seminar Presentation / Instructor created exam
CO4	Analyse the classification, types of polymerisation, and commercially important polymers as well as the importance of glass transition temperature and molecular weight determination of polymers.	An	Р	Instructor-created exams / Home Assignments
CO5	Elucidate the structure of simple organic compounds using spectral techniques.	Ap	Р	Assignment /Seminar presentation /Class test
CO6	Prepare polymers and heterocyclic compounds, isolate and purify natural products and interpretation of spectral data of simple organic compounds.	Ap	Р	Lab work /Viva Voce

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		10	22	
	1	Common Heterocycles: Pyrrole, thiophene, furan, pyridine, indole, quinoline, isoquinoline -Structure (with aromaticity), IUPAC Nomenclature Imidazole, Pyrazole, Oxazole, Pyrimidine and Purine (Structure only)	3	
	2	Furan: Preparation from furfural (Industrial method), Feist-Benary synthesis and Paal-Knorr synthesis, Reactivity and reactions of furan. Furan in nature and medicine – rose furan and ranitidine Pyrrole: Hantzsch pyrrole synthesis, Knorr pyrrole synthesis, biosynthesis (general awareness only). Reactivity and reactions of pyrrole. Ring expansion reaction, Porphobillinogen, chlorophyll and heme.	7	

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		Pyridine: Industrial preparation from coal tar, Chichibabin pyridine synthesis, Bonnemann cyclization, Krohneke pyridine synthesis Reactivity of pyridine- Electrophilic substitution (Nitration, sulphonation, halogenation, alkylation, acylation), Nucleophilic substitution, lewis basicity and coordination compounds, pyridinium chloro chromate (PCC). Indole: Industrial method for the preparation of indole from aniline, Fischer indole synthesis Reactivity of indole- Electrophilic substitution (Nitration, sulphonation, halogenation, alkylation, acylation), oxidation, Diels alder reaction, Indole derivatives in nature-tryptophan Quinoline: Skraup synthesis and Doebner reaction Reactivity of quinoline: Electrophilic substitution, reduction of quinoline, quinoline containing antimalarial drugs (General awareness only) Isoquinoline: Bischler-Napieralski synthesis, Isoquinoline in nature- papaverine and tyrosine, isoquinoline derivatives		
II		as pharmaceuticals as well as neurotoxins Natural Products	9	20
11		Natural Froducts	,	20
	3	Alkaloids: Common alkaloids present in nature, Classification based on structure of heterocyclic ring, isolation and purification, physiological actions of nicotine, quinine and coniine	2	
	4	Classification based on structure of heterocyclic ring, isolation and purification, physiological actions of nicotine,	2	
		Classification based on structure of heterocyclic ring, isolation and purification, physiological actions of nicotine, quinine and coniine Terpenes: Common Terpenes present in nature, isoprene rule and special isoprene rule, Classification, isolation and		
	4	Classification based on structure of heterocyclic ring, isolation and purification, physiological actions of nicotine, quinine and coniine Terpenes: Common Terpenes present in nature, isoprene rule and special isoprene rule, Classification, isolation and purification, significances Carbohydrates: Classification, Common carbohydrates in nature and their structural features, epimers, anomers, reducing sugars and non-reducing sugars, relative and	2	

III		Biomolecules and Polymers	16	34
	8	Amino acids: Structure of essential amino acids and their classifications Proteins and peptides: Structure of proteins and peptides – Primary, secondary, tertiary and quaternary structure. Common proteins and their role in the body. Determination of primary structure of proteins. Protein sequencing methods	3	
	9	Nucleic Acids: Constituents of nucleic acids - nitrogenous bases, nucleosides and nucleotides DNA and RNA – structure and their significance, Vital role of DNA and RNA in nature. DNA fingerprinting and applications	2	
	10	Lipids: Classification- Simple lipids, Complex lipids and derived lipids and Biological functions of lipids Oils and Fats - Acid value, Saponification value and Iodine value, Reichert-Meissl (RM) number of butter.	2	
	11	 Steroids: Classification of steroids – corticosteroids and anabolic-androgenic steroids or sex hormones, examples (Structure is not expected), Cholesterol: Structure, LDL and HDL, significances Hormones: Classification – lipid hormones (eg: testosterone, estradiol), Amine hormones (eg: epinephrine from tyrosine, melatonin from tryptophan), peptide hormone (eg: oxytocin and vasopressin). 	2	
	12	Polymers: Classification of polymers, Biodegradable polymers, Conducting polymers (Introduction only)Types of Polymerisation - Chain and step growth polymerizations - Free radical, ionic and coordination polymerizations with mechanism - Ziegler-Natta polymerization and its advantages	4	
	13	Glass Transition Temperature (Tg), Importance of Tg	1	
	14	Molecular Weight of Polymers, Determination of number average, weight average and viscosity average molecular weight	1	
	15	Commercially important polymers-Polyethylene, PVC, Teflon, PMMA, phenol-formaldehyde resin -properties and uses	1	

	Basic Organic Spectroscopy	10	22
16	Introduction- Spectroscopy-Applications of spectral techniques in the structural elucidation of organic compounds.	1	
17	UV-Visible Spectroscopy: Electronic transitions in molecules $(\sigma \rightarrow \sigma^*, n \rightarrow \sigma^*, \pi \rightarrow \pi^* \text{ and } n \rightarrow \pi^*)$ – Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. λ_{max} calculation for dienes and α,β -unsaturated carbonyl compounds	2	
18	IR Spectroscopy: Concept of group frequencies – fingerprint region – IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides	3	
19	¹ H NMR: Chemical shift – Spin-spin splitting – Interpretation of ¹ H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone.	3	
20	Structure elucidation of simple organic compounds using UV, IR and ¹ H NMR spectroscopic techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate	1	
Pra	acticals - Reactions of Organic Compounds (Any seven)	30	
I	 Preparation of polymers eg: phenol formaldehyde, glyptal resin, nylon-6,6(Any two) Preparation of heterocycles like tetrahydrocarbazole, pyrazole(Any one) Preparation by multicomponent reactions-Biginelli Reaction Preparation of furfural from corn cobs Isolation of natural products - β-carotene /caffeine /Lycopene /Casein Determination of acid value, saponification value and iodine value of fats and oils. Determination of blood and urine sugar by chemical methods Preparation of soap by saponification of oils and fats. Preparation of spectral data of simple organic 	24	
	17 18 19 20	16 Introduction- Spectroscopy-Applications of spectral techniques in the structural elucidation of organic compounds. 17 UV-Visible Spectroscopy: Electronic transitions in molecules (σ→σ**, n→σ**, π→π** and n→π*) − Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. λmax calculation for dienes and α,β-unsaturated carbonyl compounds 18 IR Spectroscopy: Concept of group frequencies − fingerprint region − IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides 19 ¹H NMR: Chemical shift − Spin-spin splitting − Interpretation of ¹H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone. 20 Structure elucidation of simple organic compounds using UV, IR and ¹H NMR spectroscopic techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate Practicals - Reactions of Organic Compounds (Any seven) 1	16 Introduction- Spectroscopy-Applications of spectral techniques in the structural elucidation of organic compounds. 17 UV-Visible Spectroscopy: Electronic transitions in molecules (σ→σ*, n→σ*, π→π* and n→π*) − Chromophore and auxochrome. Study of the UV spectra of butadiene, acetone, methyl vinyl ketone and benzene. λmax calculation for dienes and α,β-unsaturated carbonyl compounds 18 IR Spectroscopy: Concept of group frequencies − fingerprint region − IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides 19 ¹H NMR: Chemical shift − Spin-spin splitting − Interpretation of ¹H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone. 20 Structure elucidation of simple organic compounds using UV, IR and ¹H NMR spectroscopic techniques (ethanol, acetone, acetophenone, acetaldehyde, acetic acid, propanoic acid and ethyl acetate Practicals - Reactions of Organic Compounds (Any seven) 1 1. Preparation of polymers eg: phenol formaldehyde, glyptal resin, nylon-6,6(Any two) 2. Preparation of heterocycles like tetrahydrocarbazole, pyrazole(Any one) 3. Preparation of heterocycles like tetrahydrocarbazole, pyrazole(Any one) 3. Preparation of furfural from corn cobs 5. Isolation of natural products - β-carotene /caffeine /Lycopene /Casein 6. Determination of facid value, saponification value and iodine value of fats and oils. 7. Determination of blood and urine sugar by chemical methods 8. Preparation of hand sanitizer 10. Interpretation of spectral data of simple organic

	11. Identification of λ_{max} of organic compounds (eg:Azo Dye)		
II	Open ended	6	

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- 14. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, S D Sarkar and L Nahar, John Wiley and Sons, Ltd.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2						3	1	1	1	2	1	2
CO 2	2						3	1	2	1	2	2	2
CO 3	2						2	1	2	1	2	2	2
CO 4	2					2	2	1	1	1	2	2	2
CO 5	2	2					2	1	1	2	3	1	2
CO 6			3		1	1	3	1	1	2	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)Final Exam (70%)

	Internal Exam	Assignme nt/Semin ar/Viva/Q uiz	Practical Skill Evaluation	End Semester Examinations
CO 1	√	>		✓
CO 2	~	>		✓
CO 3	√	>		✓
CO 4	>	>		✓
CO 5	>	>		√
CO 6		\	√	√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	PHYSICAL CHEMISTRY – III- CHEMICAL AND PHASE EQUILIBRIA, ELECTROCHEMISTRY AND PHOTOCHEMISTRY								
Type of Course	MAJOR								
Semester	VI								
Academic Level	300 – 399								
Course Details	Credit	Credit Lecture Tutorial Practical Total Hours per week per week per week							
	4	3	-	2	75				
Pre-requisites	CHE2CJ102 and CH concepts in electroch chemistry course sim https://onlinecourses.	emistry and a	must have tal	ken NCERT p					
Course Summary	The chemical reaction forward and reverse runderlying thermod equilibrium. Similar equilibria are also electrochemical procession concepts. In the four corresponding chemical module consists of topics of chemistry.	reactions occupantic printly, thermody xplained as esses are exparth module, cal as well as	ur at equal ranciples that ynamics of the second ralained which interaction physical products.	can explain phase transiti nodule. In the also involves of light with cesses are exp	this state of ions and phase third module, thermodynamic molecules and lained. The final				

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To comprehend the concepts of law of mass action and chemical equilibria	U	F	Assignment/Test

CO2	To understand various phase transitions, construction of phase diagram and its importance in industry	Ap	Р	Assignment/Qui z
CO3	To apply the basic concepts of electrochemistry in constructing electrochemical cells	Ap	Р	Assignment/Qui z
CO4	To evaluate the pH of buffers, conduct potentiometric titrations and conductivity measurements	An	P	Lab work/Quiz
CO5	To know the theory and working of new generation electrochemical power storage systems	U	С	Assignment/Test
CO6	To understand the photochemical principles and to apply the unknown concentration a given sample solution using colorimetry	Ap	P	Discussion/Lab work

^{* -} Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs (45+30)	Marks
I		CHEMICAL EQUILIBRIUM	10	21
	1	Law of mass action, thermodynamic derivation of law of chemical equilibrium.	1	
	2	Relation between Gibbs free energy of reaction and reaction quotient.	1	
	3	Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x (using chemical potential).	3	
	4	Van't Hoff's equation - Le Chatelier principle and its application. Homogeneous and heterogeneous equilibria. Clausius-Clapeyron equation - Applications to solid-liquid, Liquid-vapour, Solid- vapour equilibria	3	

[#] - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	5	Ionic equilibrium: Ionic product of water, pH and pOH, Buffer action, pH of buffer solutions	2	
II		PHASE EQUILIBRIUM	15	33
	6	Concept of phase, Components and Degrees of freedom, Gibbs Phase Rule – Thermodynamic derivation.	3	
	7	Phase diagram for one component systems – Water, CO ₂	2	
	8	Two Component Systems - Phase diagrams for systems involving eutectic - KI/Ice - Freezing mixtures; Pattinson's process. Two-component systems with formation of congruent melting compound-MgZn ₂ . Fractional distillation. Azeotropes.	4	
	9	Partial miscibility of liquids, CST, Miscible pairs, steam distillation Three component systems, water-chloroform-acetic acid system, triangular plots, tie lines	4	
	10	Nernst distribution law: its derivation and applications in solvent extraction.	2	
III		15	33	
	11	Electrochemical cells. Origin of electrode potentials-half cell potential-standard hydrogen electrode, reference electrodes	2	
	13	Electrochemical series, applications	1	
	14	Cell potential, Nernst equation for electrode and cell potentials. Nernst equation for electrode potential and EMF of a cell	2	
	15	Relationship between free energy and electrical energy. Gibbs Helmholtz equation to galvanic cells.	2	
	16	Concentration cells: Concentration cells with and without transference – Liquid junction potential (LJP).	2	
	17	Application of EMF measurements- Solubility of sparingly soluble salt, determination of pH, Potentiometric titrations	2	
	18	Electrochemical power storage and sources- Primary batteries- Dry cell, Storage batteries- Lead acid battery, Ni-Cd battery, Li-ion battery (basic idea only), Fuel cells-Hydrogen-Oxygen fuel cell, Electrochemical capacitors and supercapacitors (basic idea only)	3	
	19	Corrosion of metals- electrochemical theory- Methods to prevent corrosion	1	

IV		PHOTOCHEMISTRY	5	11					
	20	Interaction of light with matter and Beer-Lambert's law, Photochemical process and quantum yield	1						
	21	Photochemical hydrogen-chlorine and hydrogen-bromine reactions-Reasons for high and low quantum yield	2						
	22	Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion, inter system crossing and vibrational relaxation. Quenching of fluorescence – Stern – Volmer equation;							
	22	Photosensitization - Chemiluminescence. Bioluminescence, thermoluminescence.	1						
V		PHYSICAL CHEMISTRY- PRACTICALS-3	30						
		A minimum of 5 practical experiments out of which at least one each from sections 1, 2 and 3 must be performed and reported. For plots/graphs, suitable softwares may be used and printed hard copies may be presented. Practical records may be in handwritten or computer-printed form.							
		Section 1							
		 Construction of phase diagram & determination of eutectic composition and eutectic temperature: Naphthalene-biphenyl system, Naphthalene-diphenylamine system, Biphenyl— diphenylamine system. Section 2 	3						
		2. Influence of KCl/NaCl impurity on miscibility temperature of phenol—water system and determination of concentration of given KCl/NaCl solution. Section 3	3						
		3. Verification of Beer-Lambert law for KMnO ₄ and K ₂ Cr ₂ O ₇ & determination of concentration of the given solution.	3						
		4. Colorimetric Estimation of iron (in ferric alum solution)	3						
		5. Colorimetric Estimation of chromium (in potassium dichromate solution) Section 4	3						
		6. Conductometric titration of strong acid and strong	3						
		base.	3						
		7. Potentiometric titration of strong acid and strong base.8. Preparation of Acidic Buffer and recording pH using pH meter.	3						

9. Open ended		
10. Open ended	3	
	3	
References		
1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry 8th		
Ed., Oxford University Press, 2006.		
2. P. W. Atkins, J. de Paula The Elements of Physical		
Chemistry 7 th Edn., Oxford University Press, Oxford, 2016.		
3. B.R. Puri, L.R. Sharma, M.S. Pathania, <i>Principles of</i>		
Physical Chemistry, 46th Edn., Vishal Publishing		
Company, New Delhi, 2013.		
Further Reading		
(Module II)		
4. S. Glasstone and D H Lewis, Elements of Physical		
Chemistry, 2 nd Edn., Macmillan & Company, UK, 1962.		
5. D. A. McQuarrie, J. D. Simon, Physical Chemistry: A		
Molecular Approach, University Science Books:		
Sausalito, CA; 1997.		
(Module III)		
6. S. Glassstone, An Introduction to Electrochemistry.		
East-West Press Pvt. Ltd., New delhi, 2007.		
7. Praveen Tyagi, <i>Electrochemistry</i> , Discovery Publishing House, 2006.		
(Module III)		
8. K.K. Rohatgi-Mukherjee, Fundamentals of		
Photochemistry, New Age International, 1978.		

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O 5	PS O 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-	3	2	3	2	2	-	2	-	1
CO 2	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 3	3	2	-	-	3	2	3	2	1	-	2	-	1
CO 4	3	1	2	2	3	3	3	2	1	1	1	1	1
CO 5	3	2	-	1	3	3	3	2	1	-	3	-	1
CO 6	3	-	2	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		>		✓
CO 2		>		✓
CO 3	>			✓
CO 4	\			✓
CO 5	\	√		✓
CO 6	√	~	✓	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. CHEMISTRY					
Course Title	THEORETICAL C	HEMISTRY	' III - ADVA	NCED QUA	NTUM	
	CHEMISTRY					
Type of Course	MAJOR					
Semester	VII					
Academic Level	400 - 499					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	ı	2	75	
Pre-requisites	A good understandin	g of the conc	epts learned	in the course.	CHE3CJ201 -	
	Theoretical Chemis	try 1 – Basio	es of Quantu	ım Chemistry	y - Postulates of	
	quantum mechanics	and related c	oncepts, App	plication of the	nese concepts to	
	particle in a 1D box a	and 3D box.				
Course Summary	In the course, CHE3	CJ201, stude	nts learned th	he basic conce	epts of Quantum	
	Chemistry including	the postulate	es of quantum	n mechanics a	and also learned	
	how to apply these	concepts to	o different s	ystems. This	course further	
	develops the concep		-	-		
	relevance. While do					
	application level top		-			
	Students also realize	•	_		•	
	other than hydrogen		-	=		
	could not be exac	•			•	
	approximate technique			•	• •	
	help of computer pro	_		•		
	Thus students are equipped with the basic concepts and methods of a very					
	significant research					
	experience in compu		nistry can be	gained throu	gh the practical	
	sessions given in mod	dule V.				

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	recall the quantum mechanical postulates as the fundamental principles of quantum chemistry.	R	F	Quiz/MCQ Test

CO2	realize the wave functions of hydrogen atom as atomic orbitals.	U	С	Assignment/Viva
CO3	apply 1D Simple Harmonic Oscillator as a preliminary model for deriving the quantised energy levels of normal modes of vibration in molecules.	Ap	Р	Class Test/Problem solving sessions
CO4	relate particle on a sphere as a starting model for deducing the quantised energy levels of rotation in diatomic molecules.	An	Р	Class Test/Problem solving sessions
CO5	<i>justify</i> the use of approximate methods for deducing the wave functions and energy values of multi-electron systems.	Е	Р	Class Test/Problem solving sessions
CO6	propose computational methods for solving real world problems in chemistry	С	M	Assignment/Seminar

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
			(40+30)	
I	Quan	tum Mechanics of Vibrational and Rotational Motions	15	31
	1	Review of the postulates of quantum mechanics.	1	
	2	One-dimensional simple harmonic oscillator (complete treatment):- Method of power series, Hermite equation and Hermite polynomials, recursion relation, wave functions and their plots, energy eigenvalues, important features of the problem, harmonic oscillator model and molecular vibrations.	3	
	3	Cartesian and spherical polar coordinates and their relationships.	1	
	4	Planar rigid rotor (or particle on a ring), the Phi-equation, solution of the Phi-equation.	2	
	5	One particle Rigid rotator (non-planar rigid rotator or particle on a sphere) (complete treatment): The wave	3	

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		equation in spherical polar coordinates, separation of variables, the Phi-equation and the Theta-equation and their solutions, Legendre and Associated Legendre equations, Legendre and Associated Legendre polynomials.		
	6	Spherical harmonics (imaginary and real forms), polar diagrams of spherical harmonics.	2	
	7	Quantization of angular momentum, space quantization, quantum mechanical operators corresponding to angular momenta $(\hat{l}_x, \hat{l}_y, \hat{l}_z, \hat{l}_z)$, commutation relations between these operators, Ladder operator method for angular momentum.	3	
	Section	ns from References: Section A		
II		Quantum Mechanics of Hydrogen-like Atoms	10	25
	8	Potential energy of hydrogen-like systems, the wave equation in spherical polar coordinates, separation of variables, the R, Theta and Phi equations and their solutions, Laguerre and associated Laguerre polynomials, atomic orbitals/wave functions of hydrogen-like atoms and their corresponding energy.	4	
	9	Radial and angular parts of atomic orbitals - Radial functions and radial plots, radial distribution functions and their plots, angular functions (spherical harmonics) and their plots.	2	
	10	The postulate of spin by Uhlenbeck and Goudsmith - Spin orbitals, construction of spin orbitals from orbitals and spin functions.	2	
	11	Pauli's principle of anti-symmetric wave functions - Slater determinants.	2	
	Section	ns from References: Section A		
III		Approximation Methods in Quantum Mechanics	12	28
	12	Many body problem and the need of approximation methods;	1	
	13	Independent particle model – Application to the ground state of helium atom.	1	
	14	Variation method – Variation theorem with proof, illustration of variation theorem using the trial function x	3	

		(a-x) for particle in a 1D-box, variation treatment of the ground state of helium atom.		
	15	Perturbation method – Time-independent perturbation method (non-degenerate case only), perturbation treatment of the ground state of helium atom.	3	
	16	Hartree's Self-Consistent Field method for atoms, Fock modification using spin orbitals & Hartree -Fock Self-Consistent Field (HF-SCF) method for atoms, the Fock operator;	4	
	Section	ns from References: Section A		
IV		Introduction to Computational Chemistry	8	14
	17	Classification of Computational Chemistry methods – Molecular mechanics methods (the concept of the force field) and Electronic structure methods, ab initio and semi-empirical methods (Basic idea only).	2	
	18	Roothan's concept of basis functions - Slater type orbitals (STO) and Gaussian type orbitals (GTO).	1	
	19	Concept of electron correlation and post HF methods. (Elementary idea)	1	
	20	Basis set approximation in ab initio methods - classification of basis sets — minimal, double zeta, triple zeta, split-valence, polarization & diffuse basis sets, Poplestyle basis sets, and their nomenclature.	2	
	21	Gaussian programme – The structure of a Gaussian input file, Types of keywords.	1	
	22	Specification of molecular geometry using a) Cartesian coordinates and b) Internal coordinates. The Z-matrix, Z-matrices of some simple molecules like H ₂ , H ₂ O, HCHO and NH ₃ .	1	
	Section	ns from References: Section B		
V		Computational Chemistry Practical	30	
	1	1. Single point energy calculations of simple molecules like H ₂ O and NH ₃ at the HF/3-21G level of theory.	10	
		2. The effect of basis set on the single point energy of H ₂ O and NH ₃ using the Hartree-Fock method (3-21G, 6-31G, 6-31+G, 6-31+G* basis sets can be used).		

	 3. Geometry optimization of molecules like H₂O, NH₃, HCHO & C₂H₄ at the HF/6-31G level of theory. 4. Computation of dipole and quadrupole moments of HCHO & C₂H₄ at the HF/6-31G level of theory. 		
2	 5. Effect of basis set on the computation of H-O-H bond angle in H₂O using the HartreeFock method (3-21G, 6-31G, 6-31+G, 6-31+G* basis sets can be used). 6. Computation of the energy of HOMO and LUMO of formaldehyde and ethylene at the HF/6-31G level of theory. 7. Effect of substituent (F & Cl) on the geometric parameters (like C-C bond length) of ethylene at the HF/6-31G level of theory. 	8	
3	 8. Comparison of stability of cis-planar and trans-planar conformers of H₂O₂ at the HF/6- 31G level of theory. 9. Comparison of stability of cis- and trans-isomers of difluoroethylene at the HF/6-31G* level of theory. 	6	
Open - ended	 Determination of hydrogen bond strength of H₂O dimer and H₂O trimer at the HF/6- 31+G* level of theory. Computation of the frequencies of normal modes of vibration of molecules like H₂O, NH₃ and CO₂ at the HF/6-31+G* level of theory. 	6	
Section	s from References: Section C		

Books and References:

Section A

- 1. I. N. Levine, Quantum Chemistry, 6th Edn., Pearson Education Inc., 2009.
- 2. P. W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, 4th Edn., Oxford University Press, 2005
- 3. Donald, A. McQuarrie, *Quantum Chemistry*, University Science Books, 1983 (first Indian edition, Viva books, 2003).
- 4. R.K. Prasad, Quantum Chemistry, 3rd Edition, New Age International, 2006

Section B

- 1. Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons, 1999.
- **2.** C. J. Cramer, Essentials of computational Chemistry: Theories and models, John Wiley & Sons 2002.

Section C

- 1. J. Foresman & Aelieen Frisch, Exploring Chemistry with Electronic Structure Methods, Gaussian Inc., 2000.
- 2. David Young, Computational Chemistry A Practical Guide for Applying Techniques to Real-World Problems", Wiley-Interscience, 2001.

Further reading

- 1. F.L. Pilar, Elementary Quantum Chemistry, McGraw-Hill, 1968
- 2. Thomas Engel, Quantum Chemistry & Spectroscopy, Pearson Education, 2006
- 3. Errol G. Lewars, Computational Chemistry: Introduction to the theory and applications of molecular quantum mechanics, 2nd edn., Springer 2011.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	1	-	-	-	2	3				2		2
CO 2	2	3	-	-	1	2	3				1		2
CO 3	-	2		-	1	2	3		2	2	3	1	2
CO 4	-	2			-	2	3		1	2	3		3
CO 5	-	2	-	-	-	3	3				2	2	3
CO 6	-	3	-		-	3	3		2	2	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

	Internal Exam	Assignment/viva/seminar	Practical skill Evaluation	End Semester Examinations
CO 1	>			✓
CO 2		✓		✓
CO 3	>	√		✓
CO 4	>	✓		✓
CO 5	√	√		√
CO 6		√		

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc Chemistry						
Course Title	INORGANIC CHEMISTRY-V						
Type of Course	MAJOR						
Semester	VII						
Academic Level	400-499						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours		
		per week	per week	per week			
	4	3	-	2	75		
Pre-requisites	Theories of acids and bases, Bonding in diborane, Atomic number, mass						
	number, isotopes, Basic idea about nuclear radioactivity, Nuclear fission and						
	fusion, Basic concepts in Coordination Chemistry, Knowledge about magnetic						
	properties of complexes						
Course Summary	This course enables the students to develop knowledge about HSAB principle,						
	Concepts of superacids, Bonding and structure in higher boranes.						
	It deals with detailed nuclear shell models, Nuclear reactions, Neutron activation analysis and Radiation chemistry						
	It covers the electronic spectra of complexes and explanation of d-d transition						
	It gives understanding about the various magnetic properties and its calculation						
	It enables the students to familiarise with various spectral techniques that is used						
	to characterise the metal complexes like ESR, NMR and Mossbauer						
	It covers the different types of reactions that takes place in complexes and their						
	explanations						
	This course enables the students to apply knowledge in the qualitative analysis						
	of mixture of ions and develop skill for separation and estimation of mixtu						
	ions						

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools used
		Level*	Category#	
CO1	Demonstrate a deep	U	С	Instructor-created exams /
	understanding of HSAB			Assignments/Quiz
	principle, Super acid concepts			
	and bonding structure in higher			
	boranes and boron cluster			
	compounds.			
CO2	Explain detailed nuclear shell	U	С	Instructor-created exams /
	models, nuclear reactions,			Assignments/ seminar
	neutron activation analysis and			presentations
	radiation chemistry.			
CO3	Comprehend electronic spectra	U	С	Class test
	of complexes and understand			/Assignment /
	various magnetic properties of			seminar/Quiz
	complexes.			
CO4	Grasp the reactions of	Ap	С	Assignment/Seminar/Test
	coordination compounds, the			
	mechanisms and apply			
	theoretical understandings.			
CO5	To understand chemistry of	U	С	Assignment/Seminar/ Test
	excited state coordination			
	compounds			
CO6	Apply practical skills in the	An	P	Viva Voce/Observation of
	analysis of mixture of metal			practical skill
	ions, specifically rare earth			
	elements and separation and			
	estimation of binary mixture of			
	ions in solution.			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs	Marks
			(45+30)	
I	F	ACID BASE CONCEPTS AND COMPOUNDS OF BORON	10	21
	1	Classification of acids and bases as Hard and Soft	1	
	2	HSAB principle. The theoretical basis of hardness and softness	1	
	3	The Drago-Wayland equation, E and C parameters- Symbiosis, Applications of HSAB concept, Super acids	2	
	4	Electron-deficient compounds- Boron hydrides- Preparation, Reactions, Structure, and Bonding. Styx numbers-Closo, nido, arachno polyhedral structures.	3	
	5	Boron cluster compounds-Wade's rule, Polyhedral borane anion- Carboranes, Metallaboranes and Metallacarboranes.	3	
II		NUCLEAR AND RADIATION CHEMISTRY	7	16
	6	Structure of nucleus: Shell, liquid drop, Fermi gas, Collective and Optical models. Nuclear reaction: Bethe's notation of nuclear process	2	
	7	Types- Reaction cross section, Photonuclear and Thermonuclear reactions. Nuclear fission: Theory of fission, Neutron capture cross section and Critical size, Nuclear fusion.	2	
	8	Neutron activation analysis.	1	
	9	Detection and measurement of radiation- GM and Scintillation counters, Radiolysis of water, Radiation hazards, Radiation dosimetry.	2	
III		SPECTRAL AND MAGNETIC PROPERTIES OF	18	40
		COORDINATION COMPOUNDS		
	10	Spectroscopic ground state, Terms for d^n configuration, Selection rule for d-d transition , Effect of ligand field on R S terms, O_h and T_h complexes.	2	

	11	Orgal diagram, Spectra of 3d (d¹,d²,d³) metal ions complexes,	2	
		Racah parameter, Charge transfer parameter (LMCT. MLCT) with		
		example.		
	12	Types of Magnetic properties: Paramagnetism and Diamagnetism,	2	
		Curie and Curie- Weiss laws. The μ_J , μ_{L+S} , and μ_S expressions		
	13	Orbital contribution to magnetic moment and its quenching, Spin-	3	
		orbit coupling, Temperature independent Paramagnetism, Anti		
		ferromagnetism- Types and exchange pathways. Determination of		
		magnetic moment by Gouy method.		
	14	ESR spectra – Application to copper complexes.	3	
	15	NMR spectroscopy for structural studies of diamagnetic metal	3	
		complexes from chemical shift and spin- spin coupling.		
	16	Mossbauer spectroscopy- the Mossbauer Effect, Hyperfine	3	
		interactions (qualitative treatment). Application to Iron and Tin		
		compounds		
IV		REACTIONS OF COORDINATION COMPOUNDS	10	21
	17	Ligand substitution reactions, Labile and Inert complexes, Rate law,	2	
	17	Ligand substitution reactions, Labile and Inert complexes, Rate law, Classification of mechanisms- D, A and I mechanisms. Substitution	2	
	17		2	
	17	Classification of mechanisms- D, A and I mechanisms. Substitution	2	
		Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes.		
		Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and		
		Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar		
	18	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes	2	
	18	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis	2	
	18	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect.	2	
	18	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner	2	
	18 19 20	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand.	1	
	18 19 20	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand. Methods for distinguishing outer- and inner-sphere redox reactions,	1	
	18 19 20 21	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand. Methods for distinguishing outer- and inner-sphere redox reactions, Photochemical reactions of metal complexes.	1 2	
	18 19 20 21	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand. Methods for distinguishing outer- and inner-sphere redox reactions, Photochemical reactions of metal complexes. Prompt and delayed reactions, Excited states of metal complexes-	1 2	
	18 19 20 21	Classification of mechanisms- D, A and I mechanisms. Substitution reactions in Octahedral complexes. The Eigen-Wilkins Mechanism. Fuoss-Eigenequation. Aquation and base hydrolysis- Mechanism. Substitution reactions in square planar complexes The Trans effect- Applications and theories of Trans effect, The cis effect. Classification of redox reaction mechanisms. Outer sphere and Inner sphere mechanisms, Marcus equation, Effect of the bridging ligand. Methods for distinguishing outer- and inner-sphere redox reactions, Photochemical reactions of metal complexes. Prompt and delayed reactions, Excited states of metal complexes-Inter ligand, ligand field, charge transfer, and delocalized states	1 2	

V		QUALITATIVE MIXTURE ANALYSIS INCLUDING LESS	15*2				
	COM	IMON CATIONS and ESTIMATION OF BINARY MIXTURES	(30)				
	23	1. Inorganic Cation Mixture Analysis					
		Separation and identification of four metal ions including					
		less common elements like W, Se Te, Mo, Ce, , Zr, V, and					
		Li. (Eliminating acid radicals not present). Confirmation by					
		Spot tests.					
		0. Estimation of ions in mixture (Open ended)					
		a) Separation and estimation of binary mixtures of ions in					
		solution [Cu ²⁺ , Ni ²⁺ , Fe ²⁺ , Ca ²⁺ , Mg ²⁺ and (Cr ₂ O ₇) ²⁻] by					
		volumetric, colorimetric or gravimetric methods. Only one					
		of the components to be estimated. Any two combinations					
		can be performed					

REFERENCES:

- 1. N.N. Greenwood and A. Earnshaw, *Chemistry of Elements*, 2/e, *Elsevier* Butterworth-Heinemann, 2005.
- 2. J. E. Huheey, E. A. Keiter, R. L.Keiter. O.K.Medhi. *Inorganic Chemistry, principles of structure and reactivity*, Pearson Education, 2006.
- 3. G.L.Miessler, D.A.Tarr, Inorganic Chemistry, Pearson, 2010.
- 4. D.F.Shriver, P.W.Atkins, *Inorganic Chemistry*, Oxford University Press, 2002
- 5. William W Porterfield, Inorganic Chemistry-Aunified approach, AcademicPress, 2005.
- 6. Keith F Purcell, John C Kotz, *Inorganic Chemistry*, Cengage Learning, 2010.
- 7. James E House, *Inorganic Chemistry*, Academic Press, 2008.
- 8. H.J.Arnikar, Essentials of Nuclear chemistry, New Age International, 2005.
- 9. Friedlander and J.W.Kennedy, Introduction to Radiochemistry, John Wiley and Sons, 1981.

- 10.S. Glastone, *Source Book on Atomic Energy, 3rd*edn., Affiliated East-West Press Pvt.Ltd., 1967.
- 11. B.Douglas, D.McDaniel, J.Alexander, *Concepts and Models of Inorganic Chemistry*, Wiley Student Edition, 2006.
- 12. A.W.Adamson and P.D.Fleischauer, Concepts of Inorganic Photochemistry, Wiley.
- 13. F.A.Cotton and G.Wilkinson, Advanced Inorganic Chemistry, Wiley.
- 14. A.Earnshaw, Introduction to Magnetochemistry, Academic Press, 1968.
- 15 R.L.Dutta and A.Shyamal, *Elements of Magnetochemistry*, S.Chand and Co.1982.
- 16. A.E. Martell, Coordination Chemistry, Vol.1
- 17. R.S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East- West Press Pvt. Ltd.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O 5	PS O 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	3	2	3	2	2	1	3	1	1
CO 2	3	2	1	1	3	2	3	2	1	1	3	1	1
CO 3	3	2	1	-	2	2	3	2	1	-	3	1	2
CO 4	3	2	-	-	2	3	3	2	1	-	3	-	1
CO 5	3	2	ı	1	2	3	3	2	1	-	3	-	1
CO 6	2	1	3	3	3	3	3	2	1	2	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1	✓	√		✓
CO 2	√	√		✓
CO 3	~	✓		✓
CO 4	√	√		✓
CO 5	√	√		✓
CO 6	√	√	√	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	ORGANIC CHEMI	ISTRY V			
Type of Course	MAJOR				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture	Tutorial	Practical	Total
		per week	per week	per week	Hours
	4	3	-	2	75
Pre-requisites	Preliminary idea abo photochemistry, free reagents.			•	·
Course Summary	This course explores photochemistry, free			•	·

Course Outcomes (CO):

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand and apply concepts of stereochemistry, conformations and asymmetric synthesis	U	C	Test /Seminar
CO2	To apply principles of physical organic chemistry including acidity, basicity and reaction mechanisms	U	p	Discussion/ Assignment
CO3	To demonstrate ability to generate carbanions and conduct a variety of condensation and other organic reactions	An	Р	Quizzes/Test
CO4	To analyze the role of photochemistry in chemical	Ap	Р	Discussion/Seminar /Assignment

	reactions and apply concepts to radical chain reactions			
CO5	To Conduct common organic reactions and apply select reagents in redox and substitution reactions	Ap	Р	Assignment/Test
CO6	To empower students in setting up the reaction and purification process	Ap	Р	Lab work/Viva

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		Stereochemistry III	13	28
	1	Optical isomerism shown by molecules have stereocenters other than C, N, P, S. Axial chirality - Planar chirality and helicity. Nomenclature - Prochirality, Re, Si Nomenclature.	3	
	2	Stereoselective and stereospecific reaction - Effect of configuration on Substitution - Addition and Elimination reactions.	2	
	3	Conformations of 1,2 disubstituted compounds - Carbonyl compounds - Mono and disubstituted cyclohexanes, A-value -Decalin, Bridged bicyclic systems, Anomeric effect, The effect of conformation on reactivity.	4	
	4	Asymmetric synthesis: - Resolution methods - Chiral pool approach - Chiral auxiliary approach - Chiral reagents - Chiral catalyst. (SAMP/RAMP method - Sharpless epoxidation)	4	
II		Physical Organic Chemistry	10	22
	5	Acidity and basicity of organic compounds - Equilibrium - Rate- Rate limiting step - Intermediates and transition states, Reaction profile diagrams, Kinetic and Thermodynamic control of reactions.	5	
	6	Hammond postulate Curtin-Hammett principle.	1	
	7	Methods of determining Reaction Mechanisms	1	
	8	Isotopic labeling, Kinetic isotopic effects, Crossover studies, Detection of intermediates	3	
III		Formation of C-C bonds	13	28
	9	Generation of carbanions from carbonyl compounds, Lithium enolates, Enamines and Silyl enol ethers, O and C-alkylation.	2	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

			_	1
	10	Crams's rule and Felkin Ahn model	2	
	11	Aldol condensation from enolates - Enamine and silyl enol ethers, Mukyamma aldol reaction - Zimmerman Traxler model, Intramolecular reactions.	3	
	12	Claisen condensation - Perkin Reaction - Knovenagel reaction, Conjugate addition	2	
	13	Robinson annulation - Wittig and related reactions,	2	
		Reactions of enols - Acid-mediated reactions of aldehydes and ketones.		
	14	Organometallic reagents- Grignard reagents - Alkyl lithium agents, Preparation and its reaction with carbonyl compounds and nitriles.	2	
IV		Photochemistry and free radical reactions	9	20
	15	Photochemistry : Fate of an excited molecule - Chemical reactions of excited molecules,	1	
	16	Photochemistry of carbonyl compounds: Norrish type I and II cleavage – α -cleavage, γ -hydrogen abstraction, Paterno Buchi reaction.	2	
	17	Isomerization (cis-trans isomerization in retina, isomerization in benzene), Photosensitization, Di-pi-methane rearrangement, Oxa-di-pi-methane rearrangement.	2	
	18	Free radical reactions: Radical chain reaction, NBS allylic bromination, Acyloin reaction, HLF reaction, Hunsdiecker-Borodin reaction	2	
	19	Generation of C radicals from alkyl halides using AIBN-tributyltin hydride and their cyclizations (5-exo mode only). Radical inhibitors, methods of detecting radical intermediates.	2	
V		Practicals	30	
	1.	Introduction to organic lab	4	
	2	 Double stage preparations (iodobenzene from aniline/benzil benzilic acid/triphenyl imidazole and its dimerization/ Hydroquinone-benzoquinone anthracene/ caprolactam/ bromoaniline from acetanilide or any reaction based on oxidation/reduction/condensation/rearrangement (purification of the prepared compounds by recrystallization and measurement of melting point) Column chromatography 	20	
		3. Steam distillation 4. Thin layer chromatography		
	3	4. Thin layer chromatography Open ended	6	

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- 1. Organic Chemistry, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press
- 2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley
- 3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education
- 4. Advanced Organic Chemistry, David E. Lewis, Oxford Univ Pr; Illustrated edition
- 5. Principles of Organic Synthesis, R. O. C. Norman & J. M. Coxon, 3rd Ed., CRC press, 2000.
- 6. Organic Mechanisms- Reactions, Stereochemistry and Synthesis, R. Bruckner, Springer 2007.
- 7. The Art of Writing Reasonable Reaction Mechanisms, R. B. Grossman, 3rd Ed., Springer, 2019.
- 8. Modern Physical Organic Chemistry, E. V. Anslyn & D. A. Dougherty, University Science Books, 2015.
- 9. Name reactions J J Li, Springer.
- 10. Stereochemistry of Organic Compounds Ernest L. Eliel and Samuel H. Wilen,
- 11. Stereochemistry of Organic Compounds, D. Nasipuri, 4th Ed., New Age Publications, 2020.
- 12. Stereochemistry: Conformation and Mechanism, P S Kalsi, New Age International Publishers
- 13. Volgel's practical organic chemistry
- 14. Quinone Synthesis and a Visual Introduction to Column Chromatography: An Undergraduate Experiment, Danielle L. Pearson and Russell R. A. Kitson, J. Chem. Educ. 2022, 99, 3731–3734, https://doi.org/10.1021/acs.jchemed.1c00940

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	ı	1	ı	1	ı	3		2		2		2
CO 2	2		-	-	-	1	3		2		3		2
CO 3	2	1		-	-	1	3		2		3		3
CO 4	2	ı			1	ı	3		2		2		3
CO 5	3		-	-	-	-	3		1		2		3
CO 6	-	-	3		-	-	3		2		2		3

Correlation Levels:

Level	Correlation
1	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

	Internal Exam	Assignment/ viva/seminar	Practical skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2		√		√
CO 3	√			√
CO 4		√		√
CO 5	√	√		√
CO 6		√	√	√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	PHYSICAL CHEMISTRY IV – STATISTICAL THERMODYNAMICS						
Type of Course	MAJOR						
Semester	VII						
Academic Level	400 - 499						
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	3	-	2	75		
Pre-requisites	CHE2CJ102, CHE3C quantum chemistry, c			•	ea about		
Course Summary	The bulk properties of matter are linked with its microscopic properties and it is important to consider a molecular approach to quantitatively explain the physical and chemical properties. This course explores the basics of statistical thermodynamics and thermodynamics of irreversible processes and solutions, molecular dynamics theories.						

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools used
		Level*	Category#	
CO1	To Understand and apply	U	C	Test
	concepts of statistical			/Seminar/Assignment
	thermodynamics and			
	quantum statistics in			
	chemical applications			
CO2	To Calculate	U	P	Test/
	thermodynamic			Assignment/Seminar
	properties using partition			
	functions			
CO3	To Apply thermodynamic	An	P	Quiz/Seminar/Assignm
	principles to solutions			ent

	and comprehend irreversible processes			
CO4	To understand theories of molecular reaction dynamics	U	С	Test/Seminar /Assignment
CO5	To analyse potential energy surfaces in order to understand reaction dynamics	An	С	Assignment/Test
CO6	To apply concepts of statistical thermodynamics in simulation experiments	Ap	M	Lab work/Viva

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		STATISTICAL THERMODYNAMICS- I	15	26
	1	Fundamentals: Concept of distribution, thermodynamic probability and most probable distribution.	2	
	2	Ensembles, statistical mechanics for systems of independent particles and its importance in chemistry	2	
	3	Thermodynamic probability & entropy, idea of microstates and macrostates, statistical weight factor (g)	2	
	4	Sterling approximation, and Maxwell- Boltzmann distribution of molecular energies.	2	
	5	The molecular partition function and its relation to the thermodynamic properties, derivation of third law of thermodynamics, equilibrium-constant & equi-partition principle in terms of partition functions, factorisation of the molecular partition function into translational, rotational, vibrational and electronic parts, the corresponding contributions to the thermodynamic properties.	4	
	6	Relation between molecular & molar partition functions, Evaluation of partition functions and thermodynamic properties for ideal monoatomic and diatomic gases.	3	
II		10	26	
	7	Quantum Statistics: Bose-Einstein distribution law, Bose-Einstein Condensation, application to liquid helium.	3	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	8	Fermi - Dirac distribution law, application to electrons in metals.	2		
	9	Relationship between Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.	2		
	10	Heat capacities of solids: Classical and quantum theories, Einstein's theory of atomic crystals and Debye's modification.	3		
III	Т	THERMODYNAMICS OF SOLUTIONS AND IRREVERSIBLE PROCESSES	15	30	
	Fugacity, Activity, Activity coefficient, Standard state of substance (for solute and solvents), Duhem-Margules equation and its applications				
	12	Thermodynamics of ideal solutions, Deduction of the laws of Raoult's ebullioscopy, cryoscopy, and osmotic pressure.	2		
	13	Non ideal solutions, Deviations from Raoult's law.	2		
	14	Excess functions: Excess free energy, excess entropy, excess enthalpy, excess volume.	2		
	15	Simple examples of irreversible processes, general theory of non-equilibrium processes	2		
	16	Entropy production, The phenomenological relations, Onsager reciprocal relations	2		
	17	Application to the theory of diffusion, thermal diffusion, thermo- osmosis and thermo- molecular pressure difference, electro-kinetic effects, the Glansdorf-Pregogine equation.	2		
IV		MOLECULAR REACTION DYNAMICS	5	16	
	18	Reactive encounters: Collision theory	1		
	19	Diffusion controlled reactions	1		
	20	The material balance equation	1		
	21	Potential energy surfaces: Attractive and repulsive surfaces	1		
	22	Theories of unimolecular reactions: Rice -Ramsperger and Kassel (RRK) model.	1		
V	A mir	Practicals nimum of three experiments/simulations must be performed and ded	30		
			5		

 3. 4. 6. 7. 	By using MS Excel, Scilab, Python or any other suitable programs, simulate and plot the probability of macrostates in coin tossing experiments By using a suitable computer program (MS Excel, Scilab or other) determine and plot Maxwell speed distribution function for different gases By using a suitable computer program (MS Excel, Scilab or other), determine and plot Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac distribution functions Simulation of specific heat of solids (diamond) using Dulong Petit, Einstein and Debye model Scan around a single bond in N2 molecule to find out the minimum energy in the PE diagram by using Gaussian, ORCA, Gamess or similar packages. (HF method, 6-31G basis set) Calculation of Potential energy surface of H2O molecule with respect to change of bond angles and bond distances by using Gaussian, Gamess or similar packages (HF method, 6-31G basis set) Calculation of Potential Energy Surface of ethane by changing the dihedral angle, in order to understand the most stable conformation by using Gaussian, Gamess or similar packages Calculation of Potential Energy Surface of n-butane by changing the	5 5 5 5 5	
	dihedral angle, in order to understand the most stable conformation by using Gaussian, Gamess or similar packages	5 5	
9.	Open ended	3	
	Open ended		
	References		
	 Module I and II Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York) D. A. McQuarrie, J. D. Simon, Physical Chemistry – A Molecular Approach, (Viva, 2001.) T. Engel, P. Reid, Thermodynamics, Statistical Thermodynamics & Kinetics, Pearson Education, Inc: New Delhi, 2007. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Classical, Statistical and irreversible, Pearson Education, New Delhi, 2013. A. Ben-Naim, Statistical Thermodynamics Based on Information: A Farewell to Entropy, World Scientific, Singapore 		

Module III and IV

- 6. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York)
- 7. D. A. McQuarrie, J. D. Simon, Physical Chemistry A Molecular Approach, (Viva, 2001.)
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Module V

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- 14. Advanced Physical Chemistry: Practical Guide, C. Arora and S. Bhattacharya, Bentham Books, UAE, 2022
- 15. H. Singh, *Resonance*, December 1996, Page 49-59, A Simple Experiment to Study the Statistical Properties of a Molecular Assembly with Two or Three State Dynamics

Further reading

- 16. G.S. Rush Brooke, *Statistical mechanics*, Oxford UniversityPress.
- 17. T.L. Hill, *Introduction to statistical thermodynamics*, Addison Wesley.
- 18. K. Huary, Statistical mechanics, Thermodynamics and Kinetics, JohnWiley.
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- 21. M. C. Guptha, *Statistical Thermodynamics*, Wiley eastern Ltd.,1993
- 22. Pigoggine, *An introduction to Thermodynamics of irreversible processes*, Interscience Publisher
- 23. B.G. Kyle, *Chemical and Process Thermodynamics*, 2nd Edn, Prentice Hall of India
- 24. K.J.Laidler, J.H.Meiser and B. C. Sanctuary, *Physical Chemistry*, Houghton Mifflin Company, New York, 2003.
- 25. Richard I. Masel, *Chemical Kinetics and Catalysis*, Wiley Interscience, 2001

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O 5	PS O 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	3	2	3	2	2	1	2	1	1
CO 2	3	2	1	1	3	2	3	2	1	1	2	1	1
CO 3	3	2	-	1	3	2	3	2	1	-	2	-	1
CO 4	3	2	1	-	3	3	3	2	1	-	1	-	1
CO 5	3	3	2	1	3	3	3	2	1	-	3	-	1
CO 6	3	3	1	3	3	3	3	2	1	2	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		√		✓
CO 2		>		✓
CO 3	√	√		✓
CO 4	√	✓	√	✓
CO 5	√	√		✓
CO 6	√	√	✓	√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	INSTRUMENTAL METHODS OF ANALYSIS						
Type of Course	MAJOR						
Semester	VII						
Academic	400-499						
Level							
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	3	-	2	75		
Pre-requisites	1. Fundamentals	of Electrock	nemistry.				
	2. Fundamentals3. Fundamentals						
Course	This course provid	es a thorou	gh overviev	v of essentia	al analytical		
Summary	techniques in chem	istry and m	aterials scien	nce, covering	separation,		
	spectroscopy, surface	ce character	ization, and	thermal/elec	troanalytical		
	methods. The cour	se emphasiz	zes practical	application	s, preparing		
	students for precise of	hemical ana	lysis in vario	us scientific a	nd industrial		
	fields. The practical	module ensu	ures hands-oi	n-training on	some of the		
	important methods.						

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the basic principles and instrumentation of chromatographic techniques for the separation of mixture of chemicals (products)	Ap	Р	Instructor-created exams / Quiz /Assignment
CO2	To identify the instrumentation and applications of important spectroscopic methods for chemical analysis.	Ap	Р	Class test /Assignment /Quiz
CO3	To know the role of imaging techniques to study various materials and surfaces.	U	С	Assignment/ Class test
CO4	To understand and analyse the principles and instrumentation of various thermal analytical methods	An	С	Assignments /Seminar presentation

CO5	To understand and apply	Ap	С	Assignments		
	electroanalytical methods			/Seminar		
				presentation		
* - Re	emember (R), Understand (U), App	ly (Ap), Analyse	e (An), Evaluate (E)), Create (C)		
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)						
Metacognitive Knowledge (M)						

Module	Unit	Content	Hrs	Marks
I	Separation	techniques	6	10
	1	Brief outline of Paper and Thin-Layer Chromatography (TLC),	1	-
	2	Ion exchange chromatography: Principle, cation and anion exchange resins, its application in separation of ions.	1	-
	3	Gas Chromatography (GC) – Principle, GC Instrumentation – Injectors, column, detectors (TCD, FID, ECD) and applications.	1	
	4	Hyphenated GC Technique - GC-MS	1	-
	5	High Performance Liquid Chromatography (HPLC): Principle, instrumentation - Column, stationary phases, column packing, mobile phase, detectors. Effects on Separation of Composition of the Mobile Phase and applications	2	
II	Spectrosco	pic and related methods	15	36
	6	UV-Visible Spectrometry: Beer-Lambert's law, Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments. Difference between Colorimeter & spectrophotometer.	2	
	7	Flame emission and Atomic Absorption Spectroscopy (AAS): Introduction, principle. Instrumentation and Analytical applications.Inductively Coupled Plasma-Atomic/Optical emission spectroscopy (ICP-AES or ICP-OES)- theory, instrumentation and applications. ICP-MS method. Analytical Applications	3	
	8	Fourier transform-Infrared spectroscopy (FT-IR)- FT-IR instrumentation and analytical applications. Raman spectroscopy, Principle, instrumentation, Surface enhanced Raman Spectroscopy (SERS), Raman microscopy	3	

	9	Fluorescence spectroscopy, Theory, Instrumentation and Analytical applications, Confocal laser-scanning microscopy	2	
	10	FT-NMR spectroscopy, basic principle, instrumentation, spectrometers with different frequencies of operation, ESR/EPR spectroscopy, ENDOR (Electron-Nuclear double resonance) technique	3	
	11	Mass spectrometry, Instrumentation and applications, MALDI-TOF method and instrumentation	2	
III		Photoelectron spectroscopy and X-ray diffraction	14	32
	12	Scanning Electron Microscopy (SEM) Instrumentation, Operating Principle, Secondary - Electron Images, Backscattered- Electron Images, operating conditions and sample preparation.	2	
	13	Transmission Electron Microscopy (TEM): Instrumentation, General Design, Resolution, Electron Sources, TEM grids, electron lenses, Bright and Dark field images, Applications.	2	
	14	Scanning probe microscopy methods: Principle, instrumentation and applications of Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM).	3	
	15	Photoelectron Spectroscopy Techniques - X-Ray Photoelectron Spectroscopy - Instrumentation for XPS, Sample Introduction and Handling for Surface Analysis, Analytical Applications of XPS, Auger Electron Spectroscopy - Instrumentation and Applications.	3	
	16	Powder and Single crystal X-ray diffraction, basic principle, instrumentation and applications.	4	
IV	Thermal and	d Electroanalytical methods of analysis (12 h)	10	20
	17	Thermogravimetry - TGA Instrumentation, Analytical Applications of Thermogravimetry, Derivative Thermogravimetry, Sources of Error in Thermogravimetry.	2	
	18	Differential Thermal Analysis (DTA) - Instrumentation - Analytical Applications of DTA.	1	
	19	Differential Scanning Calorimeter (DSC), Instrumentation and applications.	1	
	20	Classification of electroanalytical methods, Potentiometry- Three and Two electrode systems, Types of indicator Electrodes. Analytical Applications of Potentiometry.	2	
	21	Coulometry – Electrogravimetry, Instrumentation for Electrogravimetry and Coulometry, Applied Potential, Analytical Determinations Using Faraday's Law.	2	

	22	Cyclic Voltammetry, Theory Instrumentation and applications	2
V	Practicals		30
	Open Ended	At least 5 practical experiments must be performed from the given below list.	
		Evaluation of the refractive index of the given liquid and also find its molar refractivity	
		2. Determination of the order of a reaction and velocity constant for the inversion of cane sugar by acid by polarimetric method	
		3. Study of the complex formation between ferric ion and salicylic acid to find the formula and stability constant of the complex via colorimetry	
		4. Preparation and characterization of silver/gold nanoparticles by uv-vis spectroscopy	
		5. Estimation of band-gap for Cu nanoparticles using absorption spectroscopy	
		6. Estimation of glucose via enzymatic method by using colorimetry	
		7. Determination of Na and K ions in unknown solutions via flame photometric method	
		8. Determination of calcium content of milk samples/unknown Calcium salt solutions using flame photometer	
		9. Thermogravimetric analysis of a salt hydrate (such as CaC ₂ O ₄ . H ₂ O, CuSO ₄ .5 H ₂ O)	

10. Powder X-ray diffraction measurement, indexing of patterns and determination of unit cell parameters of crystalline solids (like NaCl, KCl or any other)	
11. Synthesis of nanoparticles and estimation of crystallite size from powder X-ray diffraction patterns by Scherrer equation.	
12. Determination of the formal reduction potential (E ₀) and n values for the [Fe(CN) ₆] ³⁻ / [Fe(CN) ₆] ⁴⁻ couple in 0.1M KNO ₃ from the 2mM cyclic voltammogram	
13. Determination of the concentration of unknown K ₃ [Fe(CN) ₆]solution using a calibration graph of concentration vs. peak height from cyclic voltammogram	
14. Separation of a mixture of amino acids by Thin Layer Chromatography (TLC) and identify the test amino acids by measuring their R _f values.	
15. Preparation of Silica nanoparticles by a one-sep process (Stöber process) and morphological analysis via scanning electron microscopy	
16. Open ended	
17. Open ended	
18. Open ended	

References:

1. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, a. 9th Edn., Cengage Learning., 2014.

- 2. D.A. Skoog, F.J. Holler, T.A. Nieman, Principles Of Instrumental Analysis, Engage Earning India Edn.
- 3. H. H. Willard, L. L. Merrit, jr., J. A. Dean and F. A. Settle, Jr., Instrumental Methods of Analysis, 6th ed., CBS 1986.
- 4. Vogel's Text Book of Quantitative Organic Analysis, 2th ed. ELBS
- 5. Dr. B. K. Sharma, Instrumental Methods of Chemical Analysis, 3rd Edition 2004.
- 6. James W. Robinson, Eileen M. Skelly Frame, George M. Frame II, Undergraduate Instrumental Analysis, Seventh Edition, CRC Press.

Mapping of COs with PSOs and POs : Correlation Levels:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O 5	PS O 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	3	3	2	3	2	2	1	2	1	1
CO 2	3	2	-	3	3	2	3	2	1	-	2	-	1
CO 3	3	2	1	2	3	2	3	2	1	1	2	1	1
CO 4	3	2	1	2	3	3	3	2	1	-	1	1	1
CO 5	3	3	2	2	3	3	3	2	1	-	3	1	1
CO 6	3	3	1	3	3	3	3	2	1	2	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		√	✓	✓
CO 2		√	✓	✓
CO 3		✓	✓	✓
CO 4		√	✓	✓
CO 5		√	√	✓
CO 6		√	√	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry	B.Sc Chemistry				
Course Title	INORGANIC CHE	MISTRY-V				
Type of Course	MAJOR/MINOR					
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	4	-		60	
Pre-requisites	Bonding in Coordina	tion compou	nds			
	Classification of ligar	nds				
	Bonding in CO mole	cule				
	Basic idea of IR spec	troscopy				
	Metal ions in biologic	cal systems				
Course Summary	This course explain	ns in detail	the structu	re, bonding	and reactions of	
	organometallic comp	ounds. It de	als with the	bonding in m	etal carbonyls and	
	provides application skill in evaluating the bonding and structural characteristics					
	of metal carbonyls using IR spectroscopy. It identifies the application of					
	organometallic comp	ounds. It de	scribes differ	ent organome	etallic polymers. It	
	evaluates bioinorgani	ic compound	s and their bi	ological action	ns	

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Equip with comprehensive understanding of organometallic compounds	U	C	Instructor-created exams / Assignments/Quiz
CO2	Identify bonding, synthesis, reactions and applications of metal carbonyls and apply IR spectroscopy to analyse structure and bonding characteristics of metal carbonyls	An	Р	Assignment / seminar/quizzes/Class test

CO3	Apply organometallic compounds in synthetic chemistry	Ap	С	Assignment/Seminar/Class test
CO4	Provide with deep understanding of the interplay between bio inorganic compounds and biological systems	U	С	Class Test/ Assignment/Viva Voce
CO5	Identify and distinguish different categories of organometallic polymers and understand their applications	U	С	Assignment/class test/Seminar

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Mark
			(48+12)	
I		ORGANOMETALLIC COMPOUNDS	10	21
	1	Organometallic compounds. Classification and nomenclature.	1	
	2	Zeise's salt, The 16 and 18 electron rules. Electron counting-covalent and ionic models	1	
	3	Main group organometallics-alkyl and aryl groups 1, 2, 12, 13, 14 and 15, Synthesis, Structure and Applications.	2	
	4	Transition metal to carbon multiple bond-the metal carbenes and carbynes.	2	
	5	Transition metal complexes with chain π ligands—synthesis, structure, bonding and reactions of complexes of ethylene, allyl, butadiene and acetylene.	4	
II		METAL CARBONYLS	15	31

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	6	Metal carbonyls- Bonding modes of CO.	1	
	7	IR spectroscopy as a tool to study bonding and structure of metal carbonyls.	1	
	8	Synthesis of Metal carbonyls, Direct and reductive Carbonylation	3	
	9	Reactions of Metal carbonyls-Activation of metal carbonyls,	2	
	10	Disproportion, Nucleophilic addition, electrophilic addition to the carbonyl oxygen, Carbonyl cation, anions and hydrides	3	
	11	Collmann's reagent, Migratory insertion of carbonyls	2	
	12	Oxidative decarbonylation. Photochemical substitution. Microwave assisted substitution.	3	
III		LICATIONS OF ORGANOMETALLIC COMPOUNDS IN GANIC SYNTHESIS AND HOMOGENEOUS CATALYSIS	11	22
	13	Complex formation and activation of H ₂ , N ₂ , O ₂ , NO by transition metals	3	
	14	Catalytic steps, Oxidative addition, Reductive elimination and Insertion reactions.	2	
	15	Hydrozirconation of alkenes and alkynes	1	
	16	Homogeneous catalysis. Hydrogenation, Isomerization of alkenes, alkyne, Cycloadditions, Ziegler-Natta catalysis	3	
	17	Hydroformylation of alkenes, Monsanto acetic acid process and Wacker process. Metal complexes in enantioselective synthesis	2	
IV	BIG	DINORGANIC COMPOUNDS AND THEIR FUNCTIONS	12	24
	18	Metallo enzymes, Iron enzymes: Structure and functions of Cytochrome P-450, catalase and peroxidase	3	
	19	Copper enzymes: Oxidase, superoxide dismutase and tyrosinase.	2	
	20	Lewis acid role of Zn (II), Structure and functions of Carboxypeptidase and Carbonic anhydrase	2	
	21	Chlorophyll, Photosynthesis, Photosystem I and II. Nitrogen fixation - Nitrogenases.	3	
	22	Storage and transport of metal ions- ferritin, transferrin and siderophores. Toxic effect of metals	2	
V		ORGANOMETALLIC POLYMERS (Open ended)	12	

The following topics related with organometallic polymers can be selected by the teacher

- 1. Polymers with organometallic moieties as pendant groups. Polymers with organometallic moieties in the main chain
- 2. Condensation polymers based on ferrocene, rigid rod polyynes, Poly (ferrocenyl silane)s and their application
- 3. Polygermanes and Polystannanes
- 4. Polymers prepared by ring opening polymerisation
- 5. Organometallic dendrimers

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 Synthesis and Applications, Second edition, University Press, 2013.
- 2. R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, Fourth edn. 2005, Wiley Interscience.
- 3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry. 5th edition, John and Wiley, 1999.
- 4. R.S. Drago. Physical Methods in Inorganic Chemistry, 2nd edition, affiliated east west press, 1993.
- 5. P. Powell, Principles of Organometallic Chemistry, 2nd edition, Chapman and Hall, London, 1998.
- 6. S. F. A. Kettle, Concise coordination chemistry, Nelson, 1969.
- 7. S. F. A. Kettle, Physical Inorganic Chemistry-A Coordination chemistry Approach, Spectrum academy publishers, 1996.
- 8. Purcell and Kotz, Inorganic Chemistry. 10. D. J. Shriver, P. W. Atkins, Inorganic Chemistry, 5th edition, Oxford university press, 2010.
- 9. J.E. Huheey, E.A. Keiter, R.L. Keiter. O.K. Medhi, Inorganic Chemistry,

principles of structure and reactivity, Pearson Education, 2006.

- 10. James E House, Inorganic Chemistry, Academic Press, 2008.
- 11. B. Douglas, D. McDaniel, J. Alexander, Concepts and Models of Inorganic Chemistry, Wiley Student Edition, 2006.
- 12. R.C. Mehrothra and A. Singh, Organometallic Chemistry, A Unified Approach, Wiley Eastern.
- 13. Piet W.N. M.van Leeuwen, Homogeneous Catalysis, Springer, 2010.S.J. Lippard and J.M.Berg, Principles of Bioinorganic Chemistry, University ScienceBooks.
- 14. I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., 1998.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2	1	2				1		1
CO 2							2				1		2
CO 3				1	1	2					1	1	2
CO 4	2				2	1	3				2	1	1
CO 5	2					1	2				2	1	2

Correlation Levels:

Level	Correlation
ı	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

	Internal Exam	Assignment/ Seminar/ vivavoce	Practical skill evaluation	End Semester Examinations
CO 1	√	>		✓
CO 2	√	~		✓
CO 3	√	✓		✓
CO 4	√	√		✓
CO 5	✓	✓		

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry	B. Sc. Chemistry								
Course Title	ORGANIC CHEMISTRY VI									
Type of Course	Major/Minor	Major/Minor								
Semester	VIII									
Academic	400 - 499									
Level										
Course Details	Credit	Practical	Total							
		per week	per week	per week	Hours					
	4	3	1	2	75					
Pre-requisites	Preliminary ideas abo	out common	rearrangemer	nt reactions, p	ericyclic					
	reactions and gives a	n insight to v	arious spectr	oscopic techn	iques.					
Course	This course explore	s common r	earrangemen	t reactions, p	ericyclic					
Summary	reactions and gives a	n insight to v	arious spectr	oscopic techn	iques.					

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and apply various rearrangement reactions to electron deficient Carbon, Nitrogen and Oxygen	U	С	Test /Seminar
CO2	Comprehend and utilize pericyclic reactions, specifically electrocyclic, cycloaddition and sigmatropic rearrangement reactions	U	p	Dicussion/ Assignment
CO3	Able to explain the principles of UV-Visible-Spectroscopy, IR spectroscopy, interpret their spectra and use Mass spectrometry in molecular mass determination	An	P	Quizes/Test

CO4	Understand and analyze both H NMR and C NMR spectra of simple organic molecules for structure elucidation of organic compounds	Ap	P	Discussion/Seminar /Assignment
CO5		An	P	Viva Voce/Observation of practical skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks			
I		Common rearrangement reactions	8	18			
	1	Rearrangement to electron deficient Carbon-Wagner - Meerwin rearrangement, Pinacol-Pinacolone rearrangement, Tiffeneau-Demjanov, Dienol-Phenol.	2				
	2 Rearrangement to electron-deficient Nitrogen - Beckmann, Lossen, Hofmann, Curtius.						
	3 Rearrangement to electron-deficient Oxygen - Baeyer-Villiger, Dakin reaction.						
	4 Acyl carbene rearrangements - Wolff, Arndt-Eistert synthesis.						
	5	Anionic rearrangements - Favorskii and Benzilic acid rearrangements.	1				
II		Pericyclic reactions	11	24			
	6	Electrocyclic reaction – ring-opening reaction and ring closure reactions in butadiene and hexatriene, con rotation and disrotation of HOMO and LUMO of butadiene and hexatriene for product formation.	2				
	7	Cycloaddition reactions - 2+2 and 4+2 cycloadditions – antarafacial and suprafacial additions, Examples for thermal and photochemical cyclo addition reactions.	2				
	8 Diels alder reaction - dienes and dienophiles in Diels alder reaction, distereoslectivity, hetero Diels-Alder reaction.						
	9	Dipolar cycloaddition - Huisgen cycloaddition, Click chemistry (azide-alkyne cycloaddition as example).	1				

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	10	Sigmatropic rearrangement - Sigmatropic rearrangements: 1,3 and 1,5 and 1,7 shifts of hydrogen atoms (explanation based on frontier molecular orbitals).	2			
	11	Cope rearrangement and Claisen rearrangement, 2,3-rearrangement, chelotropic reaction, FMO and Moebius-Hückel Approach.	2			
III		UV-Visible-spectroscopy and Mass spectrometry	13	28		
	12	UV-Visible-spectroscopy- basic principles, Factors affecting redshift and blueshift, λ max calculation for dienes and α , β -unsaturated carbonyl compounds and polyenes.	3			
	13	IR spectroscopy- basic principles, Factors affecting absorption frequencies, Fingerprint and functional group region.	2			
	14	IR spectra of functional groups-alkenes, Alkynes, Aromaticcompounds, Alcohols, Phenols, Carbonyl, Carboxylic acid derivatives,nitro, cyano, sulfoxide.	2			
	15	Mass spectrometry- Theory, Molecular ion peak, Fragment ions, Molecular mass determination, Metastable ion.	3			
	16	Isotopic effect, N Rule, Index of hydrogen deficiency, McLafferty rearrangement, Ionization methods.	3			
IV	NMR Spectroscopy					
	17	NMR Spectroscopy - Basic principles, Chemical shift values in low resolution spectra	3			
	18	High resolution H NMR spectra: Spin-spin splitting, Pascals triangle for Splitting patterns and calculation of coupling constant, Factors affecting coupling constant	3			
	19	Interpretation of 1H NMR and C NMR spectra of simple organic molecules	3			
	20	Structure elucidation of simple organic compounds using UV, IR and 1H NMR spectroscopic techniques.	4			
V		Practicals	30			
	1.	Introduction to organic lab	4			
	2	 Estimation of aniline/phenol Estimation of glucose organic compounds by colorimetry Estimation of drug molecules by titration/colorimetry Double stage preparations (Synthesis of dihydroxy triptycene from anthracene and hydroquinone, reductive amination and its structure analysis) - any one Cannizzaro reaction of p-chlorobenzaldehyde and isolation of products 	20			

		 6. Column chromatography 7. Identification of unknown molecule via spectroscopic analysis (measure the spectra and analyse if the instruments are accessible, otherwise analyse the provided the spectra) 		
	3	Open ended	6	

References

- 1. Organic Chemistry, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press
- 2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley
- 3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education
- 4. Advanced Organic Chemistry, David E. Lewis, Oxford Univ Pr; Illustrated edition
- 5. Principles of Organic Synthesis, R. O. C. Norman & J. M. Coxon, 3rd Ed., CRC press, 2000.
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- 7. The Art of Writing Reasonable Reaction Mechanisms, R. B. Grossman, 3rd Ed., Springer, 2019.
- 8. Name reactions J J Li, Springer.
- 9. Spectrometric Identification of Organic Compounds, 8ed Paperback 1 March 2022
- 10. Robert M. Silverstein, Francis X. Webster, David J. Kiemle, Wiley.
- 11. Introduction to Spectroscopy, D. L. Pavia, 5th Ed., Cengage, 2015.
- 12. Organic spectroscopy, William Kemp.MACMILLAN; SECOND edition
- 13. Spectroscopy of Organic compounds, P S Kalsi. New Age International Private Limited
- 14. Volgel's practical organic chemistry. Pearson India
- 15. Quinone Synthesis and a Visual Introduction to Column Chromatography: An Undergraduate Experiment, Danielle L. Pearson and Russell R. A. Kitson, J. Chem. Educ. 2022, 99, 3731–3734, https://doi.org/10.1021/acs.jchemed.1c00940

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	1	1	-	-	1	3		2	1	3		2
CO 2	2		1	ı	1	1	3		2	1	3		2
CO 3	-	-		-	2	2	3		2	2	3		3
CO 4	-	-			3	3	3		2	2	3		3

CO	_	3	_	2	2	2	2	2	2	2
5	_	3	-	3	3	3	3	2	3	3

Correlation Levels:

Level	Correlation			
-	Nil			
1	Slightly / Low			
2	Moderate /			
	Medium			
3	Substantial /			
	High			

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

	Internal Exam	Assignm ent/viva/s eminar	Project Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2		√		√
CO 3	√			√
CO 4		√		√
CO 5	✓	√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. C	Sc. Chemistry						
Course Title	PHYSICAL CHEMISTRY V- ADVANCED TOPICS IN SOLID							
	STATE AND ELECTROCHEMISTRY							
Type of Course	MAJOR /MINOR							
Semester VIII								
Academic Level	400-499	9						
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours			
	4	4	-	-	60			
Pre-requisites	Preliminary ideas about structure and bonding in solids, Physical properties of solids, Dynamic electrochemistry, Solid surfaces: Adsorption and heterogenous catalysis It is desirable for the students to familiarise with the previous physical and theoretical chemistry courses, CHE2CJ102, CHE3CJ201, CHHE4CJ205, CHE5CJ301, CHE6CJ306, CHE7CJ401, and CHE7CJ401							
Course Summary	Physical properties of solids are intriguing and they are of huge technological interest. In fact, our everyday life in the modern times is intimately connected to these exciting solid materials. First two modules of this course are designed to appreciate the science of structure-property relations in solids. The third module deals with the kinetics of electrochemical processes and basic idea of some electroanalytical methods. The fourth module gives a deeper insight to the importance of surface of solids in heterogeneous catalysis.							

Course Outcomes (CO):.

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	To understand the importance	U	С	Test
	of structure and bonding in			/Seminar/Assignment
	solids			
CO2	To analyse and correlate the	Ap	P	Test
	structure with various physical			/Seminar/Assignment
	properties in solids			_
CO3	To comprehend the concepts	U	F	Test
	of equilibrium			/Seminar/Assignment
	electrochemistry			

CO4	To apply the knowledge of	Ap	P	Test
	electrode kinetics in			/Seminar/Assignment
	electrochemical processes and			
	electroanalytical techniques			
CO5	To understand theory of	U	С	Test
	multilayer adsorption of			/Seminar/Assignment
	molecules on solid surfaces			
CO6	To apply the knowledge of	Ap	P	Test/Labwork/Viva
	adsorption for the			
	development of			
	heterogeneous catalysts			

Module	Unit	Content	Hrs	Marks
I		STRUCTURE AND BONDING IN SOLIDS	12	26
	1	Ionic bonding, radius ratio rules and structure of simple Ionic solids (NaCl, KCl, CsCl, ZnS, NiAs, CaF ₂ etc.), Partial covalent bonding in solids,	2	
	2	Perovskite and Spinel-type structures Qualitative MO diagram of hypothetical cyclic molecules of Hydrogen- H ₂ , H ₄ , H ₅ , H ₆ , H _n . Orbital interactions in solids and Band theory as applied to hypothetical one dimensional H-atom crystal, Brillouin zone, Band dispersion curves, Density of States (DOS), The Fermi level	2	
	3	Band width and nature of band dispersion and DOS in 1D H-atom crystal with varying H-H distances, Peirls distortion, Crystal orbital overlap population,	2	
	4	Band dispersion curves of 1D- chain of p - and d orbitals (1D-chain of eclipsed PtL ₄ complexes), Band theory extended to two dimensions- 1 s orbitals, sigma and piinteractions of 2 p orbitals	2	
	5	Band structure of 3D solids: Qualitative idea of band gap,, direct and indirect band gaps, metals, insulators and semiconductors, Ohm's law, definition of resistivity and conductivity of solids, Topological Insulators (basic idea only)	2	
	6	Bandwidth and its slope, electrical conductivity in solids and charge carriers, electrons and holes, mobility of charge carriers, charge carrier concentration, effective mass, concept of polarons, Structure-property relation in solids	2	
II		PHYSICAL PROPERTIES OF SOLIDS	12	26
	7	Semiconductors: p- and n-type doping, transistors- Photovoltaic effect and Solar energy conversion	3	

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		materials, Examples: Si, CuInSe ₂ , and		
		Methylammonium lead bromide, Solar cells		
		Thermoelectric materials for heat to electricity direct		
		conversion, Seebeck and Peltier effects, Examples: Bi ₂ Te ₃ , PbTe		
	8	Dielectrics, Ferroelectrics, Ferroelectricity in BaTiO ₃ ,	2	
	O	Piezoelectrics, Piezoelectricity in (Pb,Zr)TiO3,		
		Transducers		
	9	Optical properties of solids: Luminescence and	2	
		phosphors, Lasers- Ruby Laser, Semiconducting lasers,		
		Light emitting diodes (LED)		
	10	Magnetic materials: Theory and examples of	2	
		Ferromagnetic, Antiferromagnetic, and Ferrimagnetic		
		materials, Classification of Hard and Soft magnets with		
		examples, their crystal structures and their uses, Ferrites, Nd ₂ Fe ₁₄ B, SmCo ₅ , Multiferroics and examples		
	11	Superconductivity, BCS theory, Critical temperature and	3	
		critical field, Type-1 and Type-2 superconductors,		
III		Meissner effect, Oxide-based superconductors. DYNAMIC ELECTROCHEMISTRY	18	30
111	12	The nature of electrolytes, Ion activity, Ion-ion and ion-	2	30
	12	solvent interaction, The electrical potential in the vicinity	4	
		of an ion- Ionic thickness.		
		of an ion- ione theriess.		
	13	The Debye-Hückel equation (derivation), Limiting and	3	
		extended forms of the Debye- Hückel equation,		
		Applications of the Debye-Hückel equation to calculate the		
		effect of ionic strength on ion reaction rates in solution -		
		Primary and secondary salt effect		
	14	Electrical double layer: Helmholtz -Perrin theory, Gouy	2	
		Chapman Model and Stern theory. Electrokinetic		
		phenomena – zeta potential		
	15	Electrode kinetics of electrode processes, Overpotential,	3	
	10	the Butler-Volmer equation-The relationship between		
		current density and overvoltage, the Tafel equation.		
	16	Polarization: electrolytic polarization, dissolution and	2	
		deposition potentials, concentration polarization		
	17		2	
	17	Determination of hydrogen overvoltage and oxygen	2	
		overvoltage. Metal deposition over voltage, Principles of Polarography- the half-wave potential		
	10		2	
	18	Basic idea of Electrocatalysis, Application of	2	
		electrocatalysis in Hydrogen Evolution Reactions (HER)		
	19	Basic principles of Galvanostatic and Potentiostatic	2	
		methods in electrochemistry: Chronoamperometry,		Ī

	Coulometry, Cyclic voltammetry, Chronopotentiometry, Impedance spectroscopy		
IV	SOLID SURFACES: ADSORPTION AND HETEROGENEOUS CATALYSIS	6	16
	Adsorption at solid surfaces: Adsorption isotherms, BET equation – derivation, Determination of surface area and pore structure of adsorbents- physical adsorption methods, X-ray methods, mercury intrusion method, chemisorption methods,	2	
	Features of heterogeneous catalysis: Langmuir - Hinshelwood mechanism and Eley-Rideal mechanism - illustration using the reaction 2CO + O ₂ > 2CO ₂	2	
	Basic idea of experimental methods to determine surface composition of catalysts: X-ray and UV photoelectron spectroscopy (XPS, UPS), Electron energy loss spectroscopy (EELS), Surface extended X-ray absorption fine structure spectroscopy (SEXAFS)	2	
V	Open ended	12	
	 Computer simulations of crystal structures of various structure types from available cif files, Simulation of reciprocal lattice using suitable computer programs Demonstration of band dispersion curves of simple systems such as graphene, band structure calculation of Si by using Quantum Espresso or other software packages. Explanation of electrical conductivity measurements of semiconductors via four-point probe method, Magnetic hysteresis in soft and hard magnets, Optical band gap by using diffuse reflectance spectroscopy (Virtual lab) demonstration of Cyclic voltammetry and impedance spectroscopy Adsorption experiments on activated charcoal and other solid surfaces References		
	References		
	Modules I and II		
	1. Solid State Chemistry and Applications by A. R. West, 2 nd edition, 2014, Wiley		
	2. How Chemistry and Physics Meet in the Solid State, Roald Hoffmann, Angew. Chem. Int. Ed. Engl. 26 (1987) 846-878		
	Module III		
	3. Electrochemical methods: Fundamentals and Applications, by Allen J. Bard and Larry R. Faulkner, 2 nd Edition		

- 4. Volume 2a, Modern Electrochemistry, 2nd edition, Fundamentals of Electrodics by John O'M Bockris, Amulya K. N. Reddy, and Maria Gamboa-Aldeco,
- 5. Volume 1, Modern Electrochemistry, 2nd edition, Ionics by John O'M Bockris, and Amulya K. N. Reddy

Module IV

- 6. Physical Chemistry: Thermodynamics, Structure and Change, 10th Edition, P. Atkins and J. de Paula, (W. H Freeman and Company, New York)
- 7. K. Laidler, Chemical Kinetics, 3rd Ed., Pearson Education, New Delhi, 2004.

Further reading

- 8. C. N. R. Rao and J. Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Ed., Cambridge University Press, 2004.
- 9. Introduction to Surface Physical Chemistry, K Christmann, Springer-Verlag, Berlin, 1991
- 10. Direct Energy Conversion, Andrea M. Mitofsky, 2018

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	-	-1	3	2	3	2	2	1	2	1	1
CO 2	3	2	1	1	3	2	3	2	1	ı	2	1	1
CO 3	3	2	1	1	3	2	3	2	1	ı	2	1	1
CO 4	3	2	1	ı	3	3	3	2	1	ı	1	1	1
CO 5	3	2	-	1	3	3	3	2	1	ı	3	1	1
CO 6	3	-	2	3	3	3	3	2	1	2	3	2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment /viva	Practical skill evaluation	End Semester Examinations
CO 1		✓		✓
CO 2		√		✓
CO 3	√			✓
CO 4	√			✓
CO 5	√	√		✓
CO 6	√	✓	√	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	RESEARCH METI	RESEARCH METHODOLOGY IN CHEMISTRY					
Type of Course	MAJOR						
Semester	VIII						
Academic	400 - 499						
Level							
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	4	-	-	60		
Pre-requisites	1. A strong gras	p of foundati	onal chemist	ry principles a	ind		
	terminology.						
	2. Understandin	g of basic res	search concep	ots.			
Course	This course provides	a comprehen	sive overviev	w of research	nethodology		
Summary	in chemistry, covering	g the processo	es involved ir	n conducting r	esearch, data		
	analysis techniques,	the role of	of computers	s in chemist	ry research,		
	analytical techniques	, scientific w	riting, and res	search ethics.	Students will		
	develop essential ski	ills and knov	vledge to con	nduct research	n effectively		
	and ethically in the fi	eld of chemi	stry.				

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the sequential processes involved in research, from topic formation to publication, encompassing hypothesis development, data collection, analysis, hypothesis revision, and effective communication of findings.	U	F	Instructor created exams / Quiz /Assignment
CO2	Develop proficiency in analyzing chemical data, including error classification, measurement accuracy, precision assessment, and statistical analysis application.	An	С	Class test /Assignment /Quiz
CO3	Acquire competency in utilizing computers for chemistry research, covering hardware, software, programming languages, operating	U	Р	Assignment/ Class test

	systems, and specific applications like MS Office and scientific software.			
CO4	Apply various analytical techniques, such as chromatography, spectroscopy, electroanalysis, and thermal analysis, effectively in chemical research.	Ap	С	Assignments /Seminar presentation
CO5	Gain proficiency in scientific writing, including report structuring, language usage, and citation styles, while adhering to ethical standards like plagiarism avoidance and responsible data handling.	U	М	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks	
I		Introduction to Research Methodology			
	1	Formation of the Topic	1	•	
	2	2 Hypothesis: Conceptual Definitions, Operational Definition 2			
	3	Gathering of Data, Analysis of Data, Revising of Hypothesis, Conclusion	3		
	4 Literature Survey: Journals, Books, and E-resources				
	5	Presentation and Publication of Research Output	3		
II Data A		Data Analysis and Interpretation	12	24	
	6	Errors in Chemical Analysis: Classification of Errors, Accuracy, Precision, and Reproducibility of Measurement	3		
	7	Methods of Analysis in Chemistry: Instrumental and Non-Instrumental	2		
	8	Presentation of Data: Mean, Standard Deviation	2		
	9	Comparison of Results: "t" Test, "f" Test, Chi-Square Test	2		
	10	Least Squares Analysis, Weighted Least Squares Analysis, Regression Coefficient, Rejection of Results	3		
III		Applications of Computers in Chemistry	12	24	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	11	Types of Computers: Mainframe, Mini, Micro, Supercomputers, Personal Computers	2	
	12	Computer Hardware: CPU, Input and Output Devices, Memory, Peripheral Devices, Auxiliary Storage Devices	2	
	13	Computer Software: System Software, Application Software, Programming Languages: Machine Language, Assembly Language, High-Level Languages, Interpreter and Compiler	3	
	14	Operating Systems: Disk Operating System, Windows, macOS, Linux	2	
	15	Use of Internet in Research: Websites, Search Engines, e Journals, e-Libraries, INFLIBNET	1	
	16	Software Packages and Scientific Applications in Chemistry: Origin, Chemsketch, Chemdraw	2	
IV		Analytical Techniques for Chemical Research	12	26
	17	Chromatography: Thin layer chromatography, Column chromatography, Paper chromatography	2	
	18	Gas liquid chromatography, High pressure liquid chromatography (HPLC)	3	
	19	Spectroscopic methods: UV-Visible, IR,	1	
	20	NMR, Mass and ESR	2	
	21	Electroanalytic methods: Polarography, Coulometry, Cyclic voltammetry	2	
	22	Thermal analysis: thermogravimetry (TG)- differential thermal analysis (DTA) and differential scanning calorimetry (DSC)	2	
V		Scientific Writing and Ethics of Research	12	
	Open Ended	Significance of Report Writing, steps in Writing Report: Introduction, review of literature, scope, Materials and methods, Results and discussion, conclusions, Bibliography, Citation, Acknowledgements, Layout, Structure, and Language of typical reports, use of Illustrations, and tables, Overview of popular citation styles: APA, MLA, ASA, Chicago Manual of Style, Oral presentation: Planning, Preparation, Practice, Making presentation, Use of visual aids, Importance of effective communication. Environmental Impacts, Ethical Issues, Commercialization, Copyright, Intellectual Property Rights, Reproduction of Published Material, Plagiarism, Citation and Acknowledgement, Reproducibility, Accountability		

References:

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- 10. RA, DA. How to Write and Publish a Scientific Paper. Cambridge University Press, London, 1992.
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- 12. Bouchoux, D. E. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	P O 6	P O 7
CO 1	2	1		2	2	2	2	2	1	1	2	2	2
CO 2	2	2		2	2	2	3	2	2	2	2	2	2
CO 3	2	2		2	2	2	2	2	2	3	2	1	2
CO 4	2	2	2	2	3	2	3	1	1	1	2	1	2
CO 5	2	1		2	2	2	3	2	3	2	2	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
 Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/viva /seminar/Quiz	Project Evaluation	End Semester Examinations
CO 1	✓	√ √		✓
CO 2	✓	√ √		✓
CO 3	√	√		✓
CO 4		/ /		✓
CO 5		/ /		✓

ELECTIVE COURSES IN MAJOR

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				B. Sc. Chemistry						
Course Title	GREEN CHEMISTRY										
Type of Course	ELECTIVE IN MA	ELECTIVE IN MAJOR									
Semester	V										
Academic	300-399										
Level											
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours						
		per week per week per week									
	4	4	-	-	60						
Pre-requisites	1. Proficiency in	n chemistry p	rinciples and	terminology.							
	2. Familiarity w	ith environm	ental issues.								
	3. Understandin	g of synthetic	c organic che	mistry princip	oles and						
	methods.										
Course	The course provide	s a compre	hensive ove	erview of the	fundamental						
Summary	principles, technique	s, and applic	ations of Gre	een Chemistry	, empowering						
	students with the kno	wledge and s	kills to addre	ss environme	ntal challenges						
	through the adoption	of sustainabl	le chemical p	ractices							

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understanding of fundamental principles of green chemistry and their socio-environmental significance.	U	F	Instructor- created exams / Quiz /Assignment
CO2	Ability to employ alternative starting materials and green reagents in chemical processes, emphasizing sustainability.	Ap	С	Class test /Assignment /Quiz
CO3	Understand and apply knowledge about green solvents and catalysts in the context of sustainable chemical practices.	U	Р	Assignment/ Class test

CO4	Apprehend the role of Green Energy and techniques such as microwave and ultrasound assisted reactions in environment-friendly chemical reactions.	An	P	Assignments /Seminar presentation
CO5	Evaluate the practical applications and limitations of green chemistry, and its influence on the world.	Е	Р	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Unit Content				
I		Introduction to Green Chemistry	12	20		
	1	Green Chemistry - Some important environmental laws (Thewater (prevention and control of pollution) act, 1974, The environmental protection act of 1986, The air (prevention and control of pollution) act 1981) pollution prevention Act of 1990.	2			
	2	Emergence of green chemistry	1			
	3	Need for Green Chemistry (Prevention and minimization of hazardous products, Reduction of chemical waste and byproducts).	2			
	4	Goals of Green Chemistry. Anastas' twelve principles of green chemistry	2			
	5	Detailed explanation of each postulate with suitable examples	5			
II	Al	ternative starting materials and reagents in green chemistry	12	20		
	6	Use of renewable starting materials: Illustrate with examples such as biodiesel, bioethanol	3			
	7	Polymers from renewable resources.	2			
	8	Green synthesis using Dimethyl carbonate	2			
	9	Green oxidants [Hydrogen peroxide (H ₂ O ₂), Oxygen(O ₂)]	3			
	10	Photochemical synthesis of vitamin D, Advantages compared to conventional synthesis	2			

^{# -} Factual Knowledge(F) Conceptual Knowledge(C) Procedural Knowledge(P) Metacognitive Knowledge(M)

III		12	20	
	11	Ionic liquid -Definition and design.	2	
	Use of ethyl ammonium nitrate, Ethyl-3-methylimidazolium (EMIM) Chloride and EMIM dicyanamide			
	13	Green synthesis using water as solvent	1	-
	14	Green synthesis using supercritical carbon dioxide as solvents	1	-
	15	Solid state synthesis	2	-
	16	Comparison of green solvents and conventional organic solvents. Green catalysis	2	-
	17	Biocatalysis and photocatalysis.	2	-
IV	Green Energy and techniques			20
	18	Mechanism of microwave assisted reaction	2	-
	19	Microwave assisted solvent free synthesis of copper phthalocyanine	1	-
	20	Microwave assisted reactions in water (Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction).	4	
	21	Mechanism of ultrasound assisted reactions, sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)	3	
	22	Comparison of green and conventional method for one important molecule (oxidation of toluene to benzoic acid by microwave assisted method)	2	
V		Open Ended	12	20
	I	Click chemistry, waste management, renewable energy, can suggest experiments, awareness about presidential green chemistry awards, Limitations of green chemistry.	12	

References:

- 1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005
- 2. Anastas, P.T, Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998
- 3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
- 4. Cann, M.C. and Connely, M.E. Real-World Cases in Green Chemistry, American Chemical Society, Washington, 2000
- 5. Ryan, M.A. and Tinnesand, M., Introduction to Green Chemistry, American Chemical Society, Washington, 2002

- 6. Lancaster, Mike, Green Chemistry an Introductory Text 2nd Ed., RSC Publishing,. ISBN: 9781-84755-873-2
- 7. Anastas, P.T and Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press, 1998
- 8. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC, 2002
- 9. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC, 2002.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		1		1	3	
CO 2	1						3		1		3	2	2
CO 3						3	3		1		1	3	
CO 4						3	3		1		3	3	2
CO 5			3				3		1		1	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	NANOSCIENCE AND NANOTECHNOLOGY								
Type of	ELECTIVE IN MAJOR								
Course									
Semester	V	V							
Academic	300-399								
Level									
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours				
		per week	per week	per week					
	4	4	-	-	60				
Pre-requisites					and terminology. aterials science.				
Course	This course offers a	comprehen	sive introduc	ction to the i	nterdisciplinary field of				
Summary	nanoscience, coverir	ng the funda	amental prin	ciples, synth	esis methods, structural				
	properties, and diverse applications of nanomaterials. Through a blend of theoretical								
	lectures and practical	al demonstra	tions, studer	nts will gain	insight into the unique				
	properties and potent	ial application	ons of materia	als at the nano	scale.				

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the history, scope, definitions, and fundamentals of nanoscience and nanotechnology, including the study of nanomaterials	U	F	Instructor- created exams / Quiz /Assignment
CO2	Apply various methodologies for nanoparticle synthesis and characterization, gaining practical understanding and applications	Ap	С	Class test /Assignment /Quiz
CO3	Grasp the structures and properties of diverse nanomaterials, including carbon, organic, and inorganic	U	Р	Assignment/ Class test

	nanomaterials, and understand their applications			
CO4	Examine and apply the principles of photovoltaic energy conversion, targeted drug delivery, and other applications of nanomaterials	An	С	Assignments /Seminar presentation
CO5	Construct ideas about size and shape-dependent catalysis, interactions between biomolecules and nanoparticle surfaces and applications in biology	Ap	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks	
I	Introdu	uction to Nanoscience	12	20	
	History and Scope - Feynman's Vision, Moore's Law, Faraday's experiment and Lycurgus cup.				
	2	Definitions of Nanoscience and Nanotechnology. Energetics of nanomaterials – kinetic stability, need for surface modification.	2		
	3	Classification of Nanomaterials – 3D, 2D, 1D and 0D, confinement of electrons and phonons, quantum dots.	3		
	4 Surface to volume ratio, Quantum size effect, Surface Effect.				
	5	Size-dependent variation in physical- chemical- electronics-catalytic properties.	3		
II	Metho	ds for nanoparticle synthesis and characterization	12	20	
	6	Top-down approach - Ball milling, nanolithography.	1		
	7	Bottom-up approach - Growth of nanocrystals in solution - Nucleation and Ostwald ripening. Capping agents - Dispersibility, -OH and -SH based capping agents.	2		
	8	Methods of synthesis - precipitation, sol-gel, hydrothermal, microemulsion, chemical reduction, chemical vapour deposition and self-assembly.	3		

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	Open Ended	Size and shape dependent catalysis by nanomaterials, Interaction Between Biomolecules and Nanoparticle Surfaces, Applications of Nanomaterials in Biology.	12	
V		atalysis and Nanobiology (Open Ended)	12	20
	22	Surface Plasmon Resonance (Eg: Ag or Au nanoparticles) and its application	2	
	21	Carbon nanomaterials as adsorbents for remediation and hydrogen storage.	2	
	20	Photodegradation of dyes using TiO ₂ - mechanism	2	
	19	Targeted Drug Delivery using magnetic nanoparticles - functionalization using drug molecules, dispersibility, drug release.	3	
	18	Principle of photovoltaic energy conversion, TiO ₂ based DSSC-Components and mechanism.	3	
IV	Applica	ations of nanomaterial	12	20
	17	Electrical and optical properties (Eg: TiO ₂ , CdS) Nanomagnetism – Superparamagnetism (Eg: Fe ₃ O ₄). Nanocomposites and their advantages	3	
	16	Organic nanomaterials – Structure and applications of dendrimers and liposomes. Inorganic nanomaterials	2	
	15	Graphene- Dependence of edge geometry on electrical, magnetic and optical properties. Oxidative exfoliation synthesis, properties and uses.	2	
	14	CNT- chiral, zig-zag and armchair CNT, are discharge synthesis, electrical and mechanical properties	2	
	13	Fullerenes - structure of C60, laser ablation synthesis, doping and superconductivity in M3C60.	2	
	12	Carbon Nanomaterials and the nature of carbon bonds.	1	
III	Structu	re and Properties of Nanomaterials	12	20
	11	AFM- Introduction to scanning probe methods - components, schematic diagram, tapping and scanning modes of AFM)	2	
	10	SEM & TEM- Electron wavelength by De-Broglie relation, resolution and resolving power, electron-sample interaction, components, schematic diagram, bright and dark field imaging	2	
	9	Characterization of nanomaterials by XRD - Theory, factors affecting line broadening, Scherrer equation.	2	

References:

- 1. Poole, C. P., & Owens, F. J. Introduction to nanotechnology. Wiley-Interscience
- 2. Vollath, D. Nanomaterials: An Introduction to Synthesis, Properties and Applications. John Wiley & Sons.
- 3. Pradeep, T. Textbook of nanoscience and nanotechnology. McGraw-Hill Education.
- 4. Rao, C. N. R., Müller, A., & Cheetham, A. K. (Eds.). *Nanomaterials chemistry: recent developments and new directions*. Wiley-VCH Verlag GmbH
- 5. Murty, B., Shankar, P., Raj, B., Rath, B. B., & Murday, J. S. *Textbook of Nanoscience and Nanotechnology*. Springer
- 6. Kamat, P. V., Murakoshi, K., Wada, Y., & Yanagida, S. Semiconductor nanoparticles. In Handbook of Nanostructured Materials and Nanotechnology (pp. 291-344). Academic Press.
- 7. Pathak, Y. V. (Ed.). Surface modification of nanoparticles for targeted drug delivery. Cham, Switzerland: Springer
- 8. Thomas, S., Kalarikkal, N., Oluwafemi, O. S., & Wu, J. (Eds.). *Nanomaterials for solar cell applications*. Elsevier.
- 9. Varin, R. A., Czujko, T., & Wronski, Z. S. *Nanomaterials for solid state hydrogen storage*. Springer.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1					1	3		1		1		
CO 2				1	2	3	3		1		3		2
CO 3						1	3		1				
CO 4				2		1	3		1		3		2

СО		1	1	3	1	1	3
5							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry	B. Sc. Chemistry						
Course Title	BIO CO-ORDIN	BIO CO-ORDINATION CHEMISTRY						
Type of Course	ELECTIVE IN N	MAJOR						
Semester	V							
Academic Level	300-399							
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	4	4	-	-	60			
Pre-requisites	2. Interaction	n of ligands v	mical bondin with metal ior ganic Chemis		on bond			
Course Summary	The course provide effects of ligands between ligands Evaluate the function biological system metals (Fe, Cu, Zn of coordination co	Is in biolog and metal ic tions and im as. Demonst a) roles in bio	ical systems ons, compreh pacts of bulk rate knowled logical syster	. Analyze thend stability metals (Na, dge of trace ms. Evaluate the	of complexes. K, Ca, Mg) in and ultratrace			

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand classification and significance of ligands and summarise ligand effects in biological systems	U	F	Instructor-created exams / Quiz /Assignment
CO2	Analyze ligand interactions with metal ions in biological systems	An	С	Class test /Assignment /Quiz
CO3	Evaluate the functions and impacts of bulk metals (Na, K, Ca, Mg) in biological systems	E	Р	Assignment/ Class test
CO4	Demonstrate knowledge of trace and ultratrace metals (Fe, Cu, Zn) roles in biological systems	An	Р	Assignments /Seminar presentation

С	O5	Evaluate the applications of co-	Е	P	Assignments
		ordination compounds in medical			/Seminar
		therapy			presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		LIGANDS IN BIOLOGICAL SYSTEMS	12	20
	1	Classification of ligands	1	-
	2	Biologically significant ligands- H ₂ O, NH ₃ , Amino acids, peptides, proteins and DNA- RNA bases	4	
	3	Chelate effect and Macrocyclic effect	2	-
	4	Significance of Chelate and Macrocyclic and macrobicyclic effects in biological systems.	5	
II		LIGAND INTERACTIONS IN BIOLOGICAL SYSTEMS	12	20
	5	Classification of metal ions into bulk, trace and ultra-trace elements	1	-
	6	Concept of hard and soft acids and bases	2	-
	7	Selectivity of ligands to different metals	2	-
	8	Essentials of Crystal-Field splitting	2	-
	9	Stability of complexes- thermodynamic and kinetic stability. Stability constant. Factors affecting stability of metal complexes, metal centered and ligand centered properties	4	
	10	Inert and Labile complexes	1	-
III	F	ROLE OF BULK METALS IN BIOLOGICAL SYSTEMS: (Na. K, Ca and Mg)	12	20
	11	Ionophores and its classification. Selectivity of ionophores.	1	4
	12	Active and passive transport	1	1
	13	Sodium potassium pump-mechanism- enzymes responsible for Na-K pump	2	
	14	Potassium deficiency and K excess effects in biological systems.	1	1

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	15	Structural role of Calcium in Muscle contraction, bone management and teeth management (qualitative).	3	
	16	Role of Ca in blood clotting, Storage and transfer of Calcium (Brief idea)	2	
	17	Role of Magnesium- structural and functional role in biological systems.	2	
IV		ROLE OF TRACE AND ULTRATRACE METALS IN BIOLOGICAL SYSTEMS (Fe, Cu and Zn)	12	20
	18	Oxygen management Fe proteins (Haemoglobin and myoglobin), Metal management Fe proteins (ferritin and transferrin), electron management Fe proteins (cytochromes and Fe-S proteins)	3	
	19	Oxygen management Cu proteins (Hemocyanin), Metal management Cu proteins (ceruloplasmin), electron management Cu proteins (cytochromes and plastocyanin)	3	
	20	Biological role of Zn- Lewis acids role, structural role, and functional role- Zinc enzymes (carbonic anhydrase)	3	
	21	Biological role of cobalt- Vitamin B12 co-enzymes	1	
	22	Bioinorganic aspects of Photosynthesis and nitrogen fixation (Brief discussion). Nitrogenase enzyme (qualitative)	2	
V		APPLICATION OF COORDINATION COMPOUNDS IN MEDICINE AND THERAPY- OPEN ENDED	12	20
	23	Arthritis drugs (Gold based), Diabetic drugs (Vanadium based). Chelation therapy – Use of Dimercapto propanol. Chemotherapy-Cis platin and new generation Pt drugs- Drug resistance and DNA repair mechanism of Pt drugs.	12	

References

- 1. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry- Principles of structure and reactivity, Pearson education.
- 2. D.E. Fenton, Bi- Coordination Chemistry, Oxford, 1995
- 3. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, Oxford University Press
- 4. Rosette M. Roat-Malone-Bioinorganic Chemistry-A short Course-John Wiley & Sons, INC., Publication.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3				2		1
CO 2	2						3				3		2
CO 3	3				1		3						
CO 4					2	1	3				3		3
CO 5						1	3				2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry										
Course Title	FOOD CHEMISTRY										
Type of Course	ELECTIVE IN MA	ELECTIVE IN MAJOR									
Semester	V										
Academic	300-399										
Level											
Course Details	Credit	Lecture	Tutorial	Practical	Total						
		per week	per week	per week	Hours						
	4	4	-	-	60						
Pre-requisites	1. A brief understan	ding on com	position of va	arious foodstu	ffs						
	2. Chemical change	s in food dur	ing processin	g and storage							
Course	The Course provides	s an understa	anding on str	ructure, classi	fication and						
Summary	properties of food nu	trients. Comp	prehend the c	hemistry of fo	ood spoilage,						
	methods of food pre	servation. Id	entify the rol	le of natural a	and artificial						
	food additives and a	adulterants, t	heir types, a	nd methods of	of detection.						
	Apply techniques to	analyze food	samples for	adulteration a	and pesticide						
	residues using gas of	chromatograp	hy, liquid c	hromatograph	y and mass						
	spectrometry.										

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand structure, classification, and properties of food nutrients including carbohydrates, proteins, lipids, vitamins and minerals	U	F	Instructor-created exams / Quiz /Assignment
CO2	Comprehend the chemistry of food spoilage, methods of food preservation, and the concept and impact of food packaging and storage	Ap	С	Class test /Assignment /Quiz
CO3	Identify the role of natural and artificial food additives and	An	Р	Assignment/ Class test

	adulterants, their types, and methods of detection			
CO4	Apply techniques to analyze food samples for adulteration and pesticide residues using gas chromatography, liquid chromatography and mass spectrometry.	Ap	P	Assignments /Seminar presentation
CO5	Open ended- Evaluate the impact of modern eating habits on health and wellbeing, classifying fast foods, junk foods, instant foods and condiments, and their health effects	E	P	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks	
I		Introduction to Food Chemistry- food nutrients			
	1	Carbohydrates: Classification of carbohydrates. Structure andproperties of Glucose and Fructose (monosaccharides), Maltose, lactose and sucrose (oligosaccharide) and starch and cellulose (polysaccharide)	3		
	2	Proteins: Introduction to food protein. Structure, classification and physicochemical properties of protein. denaturation, protein determination	3		
	3	Lipids: Classification – Fats and oils – Hydrogenation – Analysis of fats and oils – Acid value, Saponification value and Iodine value.	3		
	4	Minerals: Food minerals, minerals containing Calcium, Iron, Iodine, Sodium and Potassium. Deficiency and toxicity disorders.	2		
	5	Vitamins: Classification, Sources and deficiency diseases.	1		
II		Food Preservation	12	20	
	6	Microorganism in food-chemistry of food spoilage: Definition, types of spoilage - physical, enzymatic, chemical and biological spoilage. Mechanism of spoilage.	3		

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	7	Methods of food preservation -traditional (drying, smoking, sugaring, freezing, salting, fermentation)	1	
	8	modern methods of food preservation (HPP, PEF, pasteurisation, vacuum packaging, MAP, ohmic heating)	2	
	9	Physical and chemical Additives: – definition, types, Class I and Class II preservatives	2	
	10	Food Packaging and storage - Biodegradable and edible packaging. Environmental concerns, recycling and disposal of packaging waste, Desirable materials for packaging	2	
	11	Shelf life of foods – Definition, intrinsic and extrinsic factors controlling shelf life.	1	
	12	Storage conditions, nutrition value.	1	
III		Food Additives and Adulterants	12	20
	13	Natural and artificial additives for colour and taste- synthetic and natural sweeteners, acidulants, buffering salts, anticaking agents.	4	
	14	Food adulteration - definition and reasons for food adulteration	3	
	15	Methods of adulteration	2	
	16	Common Food Adulterants in Chilli Powder, Tea dust, turmeric powder, milk, vegetable oil, coffee powder	3	
IV		Chemical analysis of food	12	20
	17	Detection of adulteration in various foods-Jam, Tea, Coffee Wheat Flour, Butter, Milk powder, Jelly, Cocoa powder	4	
	18	Analysis of pesticides and insecticides in food	1	
	19	Qualitative Analysis: Gas Chromatography (GC) Liquid Chromatography (LC)	2	
	20	Introduction to HPLC-Separation mechanisms. UV and MS detection	2	
	21	Chromatogram interpretation	2	
	22	Mass Spectrometry (MS)	1	
V		Open Ended- Modern Food Habits	12	20
	23	Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits, Healthy cooking methods	12	

References

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- 2. John M. Deman, Principles of Food Chemistry, Springer International edition, Third edition, 2007.
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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		2		1		
CO 2	2				1	2	3		2		1		1
CO 3				1	3	1	3		3		1		
CO 4				2	3	1	3		3		1		1
CO 5				3		3	3		2		1		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/Practi cal Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry										
Course Title	POLYMER CHEMISTRY										
Type of Course	ELECTIVE IN MAJOR										
Semester	VI										
Academic	300-399										
Level											
Course Details	Credit Lecture Tutorial Practical Total										
		per week	per week	per week	Hours						
	4	4	-	-	60						
Pre-requisites	Basic understanding of organic chemical reactions and molecular										
	structure.										
Course	The course covers p	olymers con	prehensively	, including c	lassification,						
Summary	polymerization met	hods, prope	erties, proce	essing, and	commercial						
	applications. Studen	its classify	polymers by	y origin, sy	nthesis, and						
	structure, analyzing			•							
	polymer property k	knowledge t	o control p	erformance	and explore						
	processing technique		-								
	calendering, and inje		•	•							
	commercial polymers			g a thorough u	nderstanding						
	of their importance in	n various ind	ustries.								

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the classification of polymers based on origin, synthesis, structure, and intermolecular forces.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Analyze chain and step growth polymerizations, discerning mechanisms and factors influencing polymerization processes.	An	С	Class test /Assignment /Quiz
CO3	Apply knowledge of polymer properties such as molecular weights, viscosity, and rheological behaviour to predict and control polymer performance.	Ap	С	Assignment/ Class test

CO4	Understand various polymer processing techniques including bulk, solution, and suspension polymerizations.	U	С	Assignments /Seminar presentation
CO5	Evaluate the suitability of different commercial polymers for specific industrial applications, utilizing understanding of polymer properties and processing techniques	E	С	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit							
I	Introduction to Poly	mers Types of Polymerisation	12	20				
	1	Polymers and macromolecules – Monomers – Homo	1					
		and hetero polymers – Copolymers.						
	2	Classification based on origin (natural, semi synthetic	2					
		and synthetic) and synthesis (addition and						
		condensation).						
	3	3 Classification based on structure (linear, branched chain						
	and cross linked) and intermolecular forces							
		(elastomeres, fibres, thermoplastics and thermosetting						
		polymers)						
	4	Tacticity in polymers- polymer chain flexibility- factors	2					
		affecting chain flexibility						
	5	Glass transition temperature and crystalline melting	2					
		points- variation and structures- molecular						
		interpretation of glassy state of polymers						
	6	Chain and step growth polymerizations – Free radical,	3					
		ionic and coordination polymerizations with						
		mechanism – Zeigler-Natta polymerization	12					
II	1			20				
	7	Molecular weights of polymers: Average molecular	2					
		weights - Number average and Weight average						
		molecular weights						
	8	Sedimentation average (Method of determination not	3					
		required) and Viscosity average molecular weight -						
		determination of viscosity average molecular weight						
	9	Polydispersity index and molecular weight distribution;	3					
		Molecular weight and Degree of						
		polymerization.						
	10	Introduction to polymer melt rheology Newtonian fluids- non-Newtonian fluids. Bingham plastics, pseudo	4					
		plastics- rheopectic and thixotropic behaviour-						
		rheological measurements						

^{# -} Factual Knowledge(F) Conceptual Knowledge(C) Procedural Knowledge(P) Metacognitive Knowledge(M)

III	Polymerisation Tec	chniques and Polymer Processing	12	20
	11	Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacial polycondensation polymerizations.	2	
	12	Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming.	1	
	13	Additives for compounding rubbers- mastication, two roll milling, internal mixing, compounding ingredients, pigments.	2	
	14	Processing aids- processing methods for manufacture of products: blending, calendaring, extrusion and moulding.	3	
	15	Different elastomer curing systems: efficient, semi efficient, conventional and sulphurless cure mechanism of vulcanization, sulphur vulcanizing systems, non-sulphur vulcanizing systems for olefin rubbers	3	
	16	Polymer composites, Properties and its different types- Process of tailoring properties	1	
IV	Polymer Testing ar	nd Commercial Polymers (12 hrs)	12	20
	17	Importance of standards and standard organizations- processability and performance- testing of plastics and rubbers material characterization tests such as hardness, tensile stress/strain, compression stress/strain, shear stress/strain, flexural stress/strain, tear tests, rebound resilience, friction, creep, fatigue.	2	
	18	Pollution due to plastics – Recycling of plastics - Plastic identification codes.	2	
	19	Preparation, Structure, properties and applications of: Polyolefins (HDPE, LDPE, PP and PS); Vinyl polymers (PVC, PVP and EVA, Saran); fluoro polymers (Teflon); Acrylic polymers (PAN and PMMA)	2	
	20	Preparation, Structure, properties and applications of: Aromatic polyamides: (kevlar); Polyester (terylene); Polycarbonate (lexan); Polyurethanes; Resins- Glyptal and formaldehyde resins (UF, MF and PF).	2	
	21	Preparation, Structure, properties and applications of: Rubbers (natural rubber, silicone rubber, and polyurethane elastomers, EPDM, BR, SBR, nitrile rubber, Neoprene, Butyl rubber).	2	
	22	Preparation, Structure, properties and applications of: Fibers: (nylon 66 and nylon 6,). Adhesives: (cyanoacrylate, epoxy adhesives, and polyvinyl acetate (PVA) adhesives). Biodegradable Polymers (polylactic acid (PLA) and polyhydroxyalkanoates (PHA)). Conductive Polymers (polyaniline and polyacetylene-concept of doping.	2	
V		ymer Chmeistry (12 hrs)	12	20
	Open Ended	Synthesis of Polyaniline Synthesis of Phenol Formaldehyde Resin	12	

Molecular weight determination using viscometric	
method	
Problem solving related to molecular weight calculation	

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- 13. M. P. Stevens, Polymer Chemistry: An Introduction, 3rd Edn., Oxford University Press, 2005.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2						3		2		1		
CO 2	2				1	2	3		3		1		1
CO 3				1	3	1	3		3		1		
CO 4				2	3	1	3		3		1		1

СО		3	3	3	2	1	1
5							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Practi cal Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	INDUSTRIAL CHEMISTRY								
Type of Course	ELECTIVE IN MAJOR								
Semester	VI								
Academic	300-399								
Level									
Course Details	Credit	Lecture	Tutorial	Practical	Total				
		per week	per week	per week	Hours				
	4	4	-	-	60				
Pre-requisites	Prior understa	anding of bas	sic chemistry	principles and	l chemical				
	reactions.								
	2. Introductory l	knowledge o	f industrial pı	cocesses and to	erminology.				
Course	The course provides	a comprehe	nsive overvie	w of chemica	al industries,				
Summary	covering industrial	processes,	waste mana	agement, pet	rochemicals,				
	pharmaceuticals, fert	tilizers, and	Kerala's cher	mical industri	es. Students				
	learn about water to	reatment, sat	fety measure	s, and the pa	roduction of				
	synthetic petrol, phar	rmaceuticals	, and fertilize	ers. By exami	ning various				
	industries, students g	ain valuable	insights into	their operation	ns, preparing				
	them for roles in the	chemical sec	tor.						

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend industrial requirements, including water treatment methods, waste management, and safety protocols.	U	F	Instructor- created exams / Quiz /Assignment
CO2	Investigate natural gas, coal, and crude oil composition, as well as the distillation processes involved	An	С	Class test /Assignment /Quiz
CO3	Analyse drug classifications, terminology, and the preparation of common drugs like paracetamol and aspirin.	An	С	Assignment/ Class test

CO4	Evaluate the production methods of nitrogenous, phosphatic, and potash fertilizers, including NPK fertilizers.	Е	P	Assignments /Seminar presentation
CO5	Scrutinize chemical industries in Kerala, focusing on their location, raw materials, and the chemistry involved in product preparation	E	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I	Introduc	tion (12 hrs)	12	20
	Requirements of an industry – location – water – industrial water treatment.			
	2	Water softening methods: Clark's process - lime soda process - Ion exchange process)		
	3	Safety measures – pilot plants – ISO certification.	2	
	4 Solid waste management -incineration method, Composting process, disposal.		2	
	5 Liquid waste management- Dewatering, sedimentation, Root-Zone Treatment.		2	
	6	Gaseous waste management-absorption, adsorption, combustion.	2	
II	Petroche	emical Industry (12 hrs)	12	20
	7	Introduction. Natural gas – CNG, LNG and LPG. Coal: Classification based on carbon content – carbonisation of coal – composition and uses of various fractions.	2	
	8	Crude Oil: Constitution and distillation – composition and uses of different distillates – ignition point, flash point and octane number – cracking.	2	
	9	Catalysts used in Petroleum Industries: Structure, selectivity and applications. Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.	3	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	10	Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates.	3	
	11	Usage and depletion of petroleum products – need for alternative fuel – hydrogen as the future fuel.	2	
Ш	Pharmace	eutical Industry (12 hrs)	12	20
	12	Drugs: Definition – History of drugs – Terminology: Prodrug, pharmacy, pharmacology, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	13	Antipyretics, analgesics and antacids (definition and examples, structures not expected)	2	
	14	Antihistamines, antibiotics, antiseptics and disinfectants, (definition and examples, structures not expected)	2	
	15	Anti-inflammatory agents, Sedatives, Tranquilizers, Hypnotics and Antidepressant drugs (definition and examples, structures not expected) – Preparation of paracetamol and aspirin.	3	
	16	Drug toxicity – Thalidomide tragedy (a brief study) – Effective use of drugs – Over dosage – Prescription and non-prescription drugs – Definition, examples, uses and side effects	2	
	17	Drug abuse- Medical applications of metal and metal oxide nanomaterials.	1	
IV	Fertilizer	Industry (12 hrs)	12	20
	18	Introduction- Nitrogeneous, phosphatic and potash fertilizers, NPK fertilizers, NPK value, Manufacturing methods of ammonium nitrate- Prilling method, Stengel method.	3	
	19	Urea-Manufacture from ammonia and carbon dioxide.	1	•
	20	Monoammonium Phosphate (MAP) and Diammonium Phosphate (DAP)- Manufacture from ammonia and phosphoric acid.	2	
	21	Potassium Chloride (muriate of potash)- main steps involved in the manufacture. Mining of the K mineral, Separation of the main ingredient and purifying.	3	
	22	Potassium Sulphate (sulfate of potash) - Manufacture from langbeinite (K ₂ SO ₄ . MgSO ₄) and KCl. NPK (17-17-17)-Granulation method of manufacture.	3	
V	Chemical	industries in Kerala: (12 hrs)	12	20
	Open ended	Location, raw materials, chemistry involved in the preparation and uses of the following, caustic soda and chlorine – Travancore	12	

•	Cochin Chemicals Ltd., TiO2 pigment from ilmenite – Travancore Titanium Products Ltd.	

References:

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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		2		2		1
CO 2	2						3		2		2		1
CO 3					1	1	3		2		2		1
CO 4						1	3		2		3		12
CO 5						1	3		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t/Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry					
Course Title	ADVANCED ENERGY MATERIALS					
Type of Course	ELECTIVE IN MA	JOR				
Semester	VI					
Academic	300-399					
Level						
Course Details	Credit	Lecture	Tutorial	Practical	Total	
		per week	per week	per week	Hours	
	4	4	-	-	60	
Pre-requisites	Completion o	f an introduc	tory organic	chemistry or r	naterial	
	science cours	e is required.				
	2. Prior knowled	dge of semice	onductor phys	sics, particular	rly related	
	to energy ban	ds and semic	onductor dev	vices, is necess	sary.	
Course	This course covers es	sential comp	onents and te	chnologies fo	r sustainable	
Summary	energy production.	Starting with	n global ener	rgy needs and	d renewable	
	sources, it explores e	lectrode prod	cesses and sol	ar cell materi	als. Students	
	learn about photovol	taic principl	es, fuel cell	types, and en	ergy storage	
	methods like batteric	es and super	rcapacitors. T	The course al	so discusses	
	emerging technologi	es for renew	able energy	conversion, s	uch as solar	
	thermal and water		_			
	understanding of ma		for sustaina	ble energy so	olutions and	
	future energy technol	logies.				

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend the basic principles of energy harvesting and conversion technologies and the significance of materials in these processes.	U	F	Instructor- created exams / Quiz /Assignment
CO2	Assess the performance of different energy harvesting materials and devices, considering factors like efficiency and environmental impact	An	С	Class test /Assignment /Quiz

CO3	Engineer and refine systems for energy production using various materials	Ap	С	Assignment/ Class test
CO4	Grasp how energy storage technologies operate, including batteries and supercapacitors	U	С	Assignments /Seminar presentation
CO5	Evaluate the strengths and weaknesses of energy storage materials and technologies, focusing on factors such as lifespan and energy capacity	An	С	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content		Marks
I	Energy Requirement		8	14
	1 World energy requirement. Need for sustainable energy sources.		1	
	2	Sustainable Sun's energy. Current status of renewable energy sources.	2	
	3	Overview of electrode processes. Reversible cells and irreversible cell reactions.	3	
	4	Primary and Secondary cells.	2	
II	Materia	ls for Energy Harvesting	16	26
	5	Solar Cells: Solar spectra, Semiconductors as Solar cell materials. P-N junction diode – Energy band diagram.	2	
	6	Principles of photovoltaic energy conversion – generation of photovoltage. I-V curves of solar cells.	3	
	7	Types of photovoltaic Cells. First generation solar cell materials - Single and polycrystalline Silicon, Amorphous silicon.	3	
	8	Second generation solar cell materials: CdSe, CdTe, Copper Indium Gallium Selenide.	3	
	9	Third generation solar cell materials - Quantum Dots, Organic materials, Dyes.	3	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	10	Types of Organic solar cells - Dye-sensitized solar cell (DSSC) and Polymer solar cells - General overview only.	2	
III	Material	ls for Energy Conversion	12	20
	11	Fuel Cells: General overview of fuel cell technology.	1	
	12	Types of fuel cells - Alkaline, solid oxide, proton exchange membrane, and Direct methanol. Materials for electrodes, electrolytes in Fuel Cells.	4	_
	13	Working principles of H ₂ -O ₂ fuel cell.	1	
	14	Hydrogen economy. Hydrogen generation and storage; limitations. Recent progress in fuel cells.	3	
	15	Piezoelectric and Pyroelectric materials – Energy conversion mechanism with examples.	2	
	16	Thermo-electrics materials – Energy conversion mechanism with examples.	1	
IV	Materials for Energy Storage			
	17	Different types of batteries	1	
	18	Electrode materials, electrolyte and cell reactions of Dry/Alkaline cell and Mercury cell battery. Discharge characteristics, Energy density.	2	-
	19	Electrode materials, electrolyte and cell reactions of Lead-acid battery and Ni-Cd battery, Discharge characteristics, Energy density.	2	
	20	Electrode materials, electrolyte and cell reactions of Ni-Hydrogen battery and Lithium-ion/Lithium-polymer battery. Discharge characteristics, Energy density.	2	
	21	Supercapacitors- Types of Electrochemical Supercapacitors.	2	
	22	Electrode and electrolyte interfaces and their capacitances, Charge-Discharge characteristics, Energy/power density.	3	
V	Renewal	ble energy conversion methods	12	20
	Open Ended	Solar thermal technologies, Water splitting and photocatalysis, Energy-related environmental aspects: CO ₂ capture, utilization, and conversion; recovery and recycling of energy materials.	12	

References:

 Chetan Singh Solanki, Solar photovoltaics: fundamentals, technologies and applications -Third ed. - New Delhi PHI Learning Private Limited, 2011.

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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1					1	3		1		2		1
CO 2	2				1	2	3		1		3		2
CO 3				1	2	1	3		2				3
CO 4					3	1	3		2		3		3
CO 5				2		3	3		2		2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		√
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	MATERIAL SCIEN	NCE			
Type of Course	ELECTIVE IN MA	JOR			
Semester	VI				
Academic	300-399				
Level					
Course Details	Credit	Lecture	Tutorial	Practical	Total
		per week	per week	per week	Hours
	4	4	-	-	60
Pre-requisites	1. Basics of soli	d-state chem	istry		
	Brief idea abo	out material p	properties		
Course	The course in Mater	ial Science p	provides a co	mprehensive	overview of
Summary	various materials an	nd their pro	perties, foci	using on app	olications in
	different fields. It cov	vers the class	ification of m	aterials based	on structure
	and function, mecha	nical proper	ties, testing	methods, and	specialized
	materials such as	s ferroelec	tric, piezoe	lectric, mag	gnetic, and
	superconducting m	aterials. Ac	lditionally,	it discusses	composite
	materials, including	their definiti	on, classifica	tion, processi	ng methods,
	and applications. Thr	ough this cou	ırse, students	gain a solid u	nderstanding
	of different materials	and their sig	nificance in	modern techn	ology.

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	Develop an understanding of the classification of materials based on structure and function.	U	F	Instructor-created exams / Quiz /Assignment
CO 2	Acquire knowledge of mechanical properties and testing methods to evaluate material behavior.	U	С	Class test /Assignment /Quiz
CO 3	Explore specialized materials such as ferroelectric, piezoelectric, magnetic, and	Е	С	Assignment/ Class test

	superconducting materials and their applications.			
CO 4	Gain insight into composite materials, including their classification, processing techniques, and real-world applications.	Е	P	Assignments /Seminar presentation
CO 5	Develop the ability to analyze and predict material behavior in various environments and applications	Е	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks			
I							
	1	Scope and importance of materials science. Classification of materials. Functional classification. Classification based on structure.	2				
	2	Mechanical properties – significance and terminology, the tensile test, true stress and true strain, bend test, hardness of materials.	3				
	3	Definition of ceramics. Traditional and new ceramics. Structure of ceramics. Atomic interactions and types of bonds.	2				
	4	Phase equilibria in ceramic systems, one component and multi component systems.	2				
	5	Use of phase diagrams in predicting material behavior.	1				
	6	Electrical, Magnetic, and Optical properties of ceramic materials.	2				
II	Materials fo	r Special Purposes – I	12	20			
	Production of ultra-pure materials - zone refining, vacuum distillation and electro refining.		2				
	8	Ferroelectric and piezoelectric materials - general properties. Classification of ferroelectric materials.	2				

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	9	Theory of ferroelectricity, ferroelectric domains, applications.	3	
	10	Theory of Piezoelectricity. Piezoelectric materials and applications.	3	
	11	Metallic glasses - preparation, properties and applications.	2	
III	Materials fo	r Special Purposes – II	12	20
	12	Magnetic materials, ferri, ferro and antiferromagnetism.	2	
	13	Metallic magnets, soft, hard & superconducting magnets.	2	
	14	Ceramic magnets, low conducting and superconducting magnets.	2	
	15	Superconducting materials - metallic and ceramic superconducting materials.	2	
	16	Theories of superconductivity, Meissner effect.	2	
	17	High temperature superconductors - structure and applications.	2	
IV	Composite N	Materials	12	20
	18	Definition and classification of composites, fibres and matrices.	2	
	19	Composites with metallic matrices – processing, solid and liquid state processing, deposition.	3	
	20	Ceramic matrix composite materials – processing, mixing & Pressing, liquid state processing, sol-gel processing & vapor deposition technique.	3	
	21	Interfaces in composites - mechanical & microstructural characteristics.	2	
	22	Applications of composites.	2	
V	Materials for	Energy Harvesting and Storage	12	20
	Open Ended	Detailed study of materials used in data storage devices, light harvesting, energy storage, lasers and bioengineering.	12	

References:

- 1. W.D. Eingery, H.K. Dowen and R.D. Uhlman, Introduction to Ceramics, John Wiley.
- 2. A.G. Guy, Essentials of Material Science, McGraw Hill.
- 3. M.J. Starfield and Shrager, Introductory Material Science, McGraw Hill.
- 4. S.K. Hajra Choudhary, Material Science and Engineering, Indian Book Dist. Co., Calcutta.
- 5. M.W. Barsoum, Fundamentals of Ceramics, McGraw Hill, 1997.
- 6. M. Tinkham, Introduction to Superconductivity, McGraw Hill, 1975.
- 7. A.V. Narlikar and A.N.Endnote, Superconductivity and Superconducting Materials, South

Asian Publishers, New Delhi, 1983.

- 8. S.V. Subramanyan and E.S. Rajagopal, High Temperature Superconductors, Wiley Eastern Ltd., 1988.
- 9. Azaroff and Brophy, Electronic Processes in Materials, McGraw Hill, 1985.
- 10. C.M. Srivastava and C. Srinivasan, Science of Engineering Materials, Wiley Eastern Ltd., 1987. R.J. Young, Introduction to Polymer Science, John Wiley and Sons.
- 11. K.K. Chowla, Composite Materials, Springer-Verlag, NY, 1987.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1					1	3				3		1
CO 2					1	2	3		1		2		1
CO 3				1	3	1	3		1		2		3
CO 4				2	3	1	3		1		2		3
CO 5				3		3	3		1		2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	\	√		√
CO 2	√	√		√
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry							
Course Title	INDUSTRIAL CAT	ALYSIS						
Type of Course	ELECTIVE IN MA	JOR						
Semester	VIII							
Academic	400-499							
Level								
Course Details	Credit	Lecture	Tutorial	Practical	Total			
	per week per week Hours							
	4	4	-	-	60			
Pre-requisites	 Basic underst 	anding of sur	rface chemist	ry				
	2. A sound know	vledge in rea	ction kinetics	and thermod	ynamics			
Course	The catalysis cours	e covers ca	atalyst prepa	ration, deact	ivation, and			
Summary	applications across	various field	s. It include	s fundamenta	l principles,			
	preparation method	s, deactivat	tion mechar	nisms, and	regeneration			
	techniques. Additiona	ally, it explor	es phase tran	sfer catalysis,	biocatalysis,			
	and industrial cataly	sis, focusing	on their pri	nciples, mech	nanisms, and			
	applications such as	oil-based c	hemistry, hy	drocarbon sy	nthesis, and			
	environmental prote	ction. Ultim	ately, studen	ts gain a co	mprehensive			
	understanding of cata	alytic process	ses and their	applications i	n chemistry,			
	environmental science	e, and mater	ials science.					

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental concepts in catalysis, including catalyst preparation, mechanisms of catalytic reactions, and catalyst deactivation processes.	U	F	Instructor-created exams / Quiz /Assignment
CO2	Apply various preparative methods, such as phase transfer catalysis, biocatalysis, and industrial catalysis, in the synthesis and transformation of chemical compounds.	Ap	С	Class test /Assignment /Quiz

CO3	Analyze and classify catalyst deactivation processes, including poisoning, coke formation, and sintering, and explore methods for catalyst regeneration.	An	С	Assignment/ Class test
CO4	Evaluate the principles and applications of industrial catalytic processes in oil-based chemistry, hydrocarbon synthesis, environmental protection, and polymerization reactions.	E	P	Assignments /Seminar presentation
CO5	Explore emerging catalytic technologies such as biodiesel production, photocatalysis, and electrocatalysis, and understand their potential applications and challenges in contemporary industries and research fields.	E	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I	Catalyst Preparative Methods and Deactivation		12	20
	1	Support materials -Preparation and structure of supports, Surface properties.	2	
	2	Preparation of catalysts- Introduction of precursor compound, Pre-activation treatment, Activation process.	2	
	3	General methods of synthesis of zeolites. Mechanism of nuclear formation and crystal growth. Structures of some selected zeolites. Zeolites A, X and Y. Shape selective catalysis.	3	
	4	Deactivation of catalysts- Classification of catalyst deactivation processes, Poisoning of catalysts, Coke formation on catalysts, Sintering of catalysts.	3	

[#] - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	5	Regeneration of deactivated catalysts. Feasibility of regeneration. Description of coke deposit and kinetics of regeneration	2	
II	Phase Transfer	Catalysis	12	20
	6	Basic concepts in phase transfer catalysis. Phase transfer catalyzed reactions and their basic steps.	2	
	7	Effect of reaction variables on transfer and intrinsic rates. Outline of compounds used as phase transfer catalysts. Use of quaternary salts.	3	
	8	Macrocyclic and macrobicyclic ligands. PEG's and related compounds.	3	
	9	Use of dual phase transfer catalyst or co-catalyst in phase transfer systems.	2	
	10	Separation and recovery of phase transfer catalysts. Insoluble phase transfer catalysts.	2	
Ш	Biocatalysis	•	12	20
	11	Enzymes. An introduction to enzymes. Enzymes as proteins.	2	
	12	Classification and nomenclature of enzymes. Structure of enzymes. Working of enzymes. Effect on reaction rate. Thermodynamic definitions.	2	
	13	Catalytic power and specificity of enzymes. Optimization of weak interactions between enzyme and substrate in the transition state.	3	
	14	Binding energy, reaction specificity and catalysis. Specific catalytic groups contributing to catalysis. Immobilized biocatalysts.	3	
	15	Definition and classification of immobilized biocatalysts. Immobilization of coenzymes.	2	
IV	Industrial Catal	lysis	12	20
	16	Oil based chemistry- Catalytic reforming, Catalytic cracking, Paraffin cracking, Steam cracking.	1	
	17	Hydrocarbons from synthesis gas. Fisher-Tropsch process. Mobil process for conversion of methanol to gasoline hydrocarbons.	2	
	18	Catalysis for environmental protection, removal of pollutants from exhausts, mobile and static sources.	2	

	20	Hydroformylation of olefins. Carbonylation of organic substrates. Conversion of methanol to acetic acid. Synthesis of vinyl acetate and acetic anhydride. Palladium catalyzed oxidation	3	
	21	of ethylene. Acrylonitrile synthesis. Zeigler-Natta catalysts for olefin polymerization.	1	
	22	Propene polymerization with silica supported metallocene/MAO catalysts	1	
V	Open Ended Mo	dule	12	20
	Open Ended	Biodiesel via catalytic process, Photocatalysis, Electrocatalysis, A survey of important Indian catalytic industries and their products. Experiments involving preparation of catalysts and catalytic reactions.	12	

References:

- 1. J.R. Anderson and M. Boudart (Eds), "Catalysis, Science and Technology", Vol 6, Springer- Verlag, Berlin Heildberg, 1984.
- 2. R.B. Anderson, "Experimental methods in catalysis research", Vol I, II, Academic press, NY, 1981.
- 3. R. Szostak, "Molecular sieves: principles of synthesis and identification", Van Nostrand, NY, 1989.
- 4. R. Hughes, "Deactivation of catalysts", Academic press, London, 1984.
- 5. C.M. Starks, C.L. Liotta and M. Halpern, "Phase Transfer Catalysis Fundamentals, Applications and Industrial Perspectives", Chapman & Hall, New York, 1994.
- 6. A.L. Lehninger, "Principles of Biochemistry", Worth Publishers, USA, 1987.
- 7. G. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley-VCH, Weinheim, 1997.
- 8. R.J. Farrauto and C.H. Bartholomew, "Fundamentals of Industrial Catalytic Processes", Blackie Academic and Professional Chapman and Hall, 1997.
- 9. R. Pearce and W.R. Patterson, "Catalysis and chemical processes", Academic press, Leonard Hill, London, 1981

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		1		1		
CO 2	2				1	2	3		1		2		1
CO 3						1	3		2		2		1
CO 4				2		1	3		2		2		2
CO 5				2	1	3	3		2		2		2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Practi cal Exam	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		✓
CO 5	√	√		√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	ADVANCED ORGANIC CHEMISTRY						
Type of Course	ELECTIVE IN MAJOR						
Semester	VIII						
Academic	400 – 499						
Level							
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	4	-		60		
Pre-requisites	Prior knowled	dge of chemi	cal bonding a	and structure	of molecules		
	2. Understanding the reaction mechanism of different reactions						
	and rearrangements.						
Course	This course covers reactions, synthesis planning, supramolecular						
Summary	chemistry, and drug	design					

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand and apply named reactions and reagents in organic synthesis	U	Р	Quizzes /Seminar
CO2	To formulate synthetic strategies employing synthons, protecting groups, and reagents	An	С	Discussion/ Assignment
CO3	To conceptualize non- covalent interactions and applications in supramolecular chemistry	An	С	Seminar / Discussion
CO4	To Comprehend the principles of drug design and understand the	Ap	F	Discussion/Seminar /Assignment

	stages of drug development			
CO5	To Rationalize the mechanisms of redox reactions and substitution reactions involved in organic synthesis	Ap	An	Seminar/discussion

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		Named Reactions and Reagents	9	18
	1	Reformatsky reaction, Baeyer-Villiger oxidation, Beckman rearrangement,	3	
	2	Benzilic acid rearrangement, Benzoin Condensation, Claisen rearrangement,	2	
	3	Clemmenson reduction, Dies-alder reaction, Knoevenagel condensation,	2	
	4	Pictet-Spengler reaction, Strecker amino acid synthesis, Simmons-Smith reaction,	2	
II		13	26	
	5	Target molecules, Synthons, synthetic equivalents (anionic and cationic)	1	
	6	Disconnection	1	
	7	Protecting groups-alcohols (Bn, PMB, Ac, TBS) explain the concept with a reaction	2	
	8	Protecting groups-aldehydes (cyclic acetal) explain the concept with a reaction	2	
	9	Protecting groups-amines (Bz, Boc, Fmoc) explain the concept with a reaction	2	
	10	Protecting groups-acids (Me and t-Bu ester) explain the concept	2	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		with a reaction						
	11 Convergent and linear synthesis (demonstrate with an example)							
	12	Functional inter-group conversions (Any one example), retrosynthesis of chalcones.	2					
III		Supramolecular Chemistry	13	26				
	13	4						
	14	Crown ethers	2					
	15	Cyclodextrins	2					
	16	Cryptands, catenanes and rotaxanes.	2					
	17 Importance of supramolecular chemistry in living systems.							
IV		13	28					
	18	Introduction to medicinal chemistry	2					
	19	Therapeutic index, solubility, Intermolecular binding forces in drug target interactions- (electrostatic, H bonding, van der Waals, dipole-dipole).	3					
	20	Introduction to various drug targets; Proteins- Enzymes- Receptors- their roles, neurotransmitters, receptor activation and regulation.	3					
	21	Introduction to Pharmacodynamics and pharmacokinetics (ADME); affinity and efficacy.	3					
	22	Types of drugs, stages of drug development (basic concept only).	2					
V		Open ended	12					
	Mode	rn Techniques in Organic Synthesis/Asymmetric Synthesis/Total esis						

References

- 1. Organic Chemistry, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press
- 2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley
- 3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education.
- 4. Advanced Organic Chemistry, Jerry March.
- 5. Advanced Organic Chemistry, David E. Lewis, Oxford Univ Pr; Illustrated edition.
- 6. Principles of Organic Synthesis, R. O. C. Norman & J. M. Coxon, 3rd Ed., CRC Press, 2000.

- 7. The Art of Writing Reasonable Reaction Mechanisms, R. B. Grossman, 3rd Ed., Springer, 2019
- 8. Name reactions J J Li, Springer.
- 9. Medicinal Chemistry, Sriram and Yogeeswari, Pearson Education India; 2nd edition.
- 10. An Introduction to Medicinal Chemistry, Graham Patrick, Oxford University Press; International edition.
- 11. Organic Chemistry, Morrison Boyd & Bhattacharjee, Pearson Education India; 7th edition

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1						3		1		1		2
CO 2	2						3		2		3		3
CO 3	2						3		2		3		3
CO 4					2	1	3		2		3		3
CO 5				2	1	3	3		2		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	MODERN ORGANIC SYNTHESIS						
Type of Course	ELECTIVE IN MAJOR						
Semester	VIII						
Academic	400 - 499						
Level							
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	4	-	-	60		
Pre-requisites	Preliminary idea abo	ut Reaction n	nechanism, re	eagents, organ	ometallic		
	chemistry, and Greer	n methods					
Course	This course explores various name reactions in organic chemistry,						
Summary	reagents, multistep synthesis, biochemical synthesis and modern trends in						
	synthesis.						

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To develop an understanding and application of different named organic reactions	U	С	Test /Seminar
CO2	To gain expertise in theusage and reactions of various reagents, focusing on catalysis and substitution	U	С	Dicussion/ Assignment
CO3	To master the skills for multistep synthesis and biochemical synthesis with an emphasis on retrosynthetic analysis	An	С	Quizes/Test
CO4	To examine modern trends in synthesis, stressing on non-conventional methods,	Ap	Е	Discussion/Seminar /Assignment

	catalysts and eco-friendly approaches			
CO5	To evaluate the role of organic compounds and reactions in pharmaceutical chemistry with open-ended, practical outcomes	-	Р	Assignment/Test

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Hrs	Marks	
Ι		Named organic reactions	12	26
	1	Peterson Reaction, Julia Reaction, Ugi Reaction, Passerini reactions	1	
	2	Ene reaction, Ritter Reaction, Biginelli reaction, Skraup quinoline synthesis	2	
	3	Dess Martin oxidation, Baylis Hillman reaction, Eschenmoser–Tanabe fragmentation	2	
	4	Nazarov cyclization, McMurry coupling, Pauson–Khand reaction	2	
	5	Pummerer rearrangement, Ramberg-Bäcklund reaction, Rubottom oxidation, Rupe rearrangement	3	
	6	Staudinger reduction, Vilsmeier-Haack reaction, Wacker oxidation	2	
II		12	26	
	7	Reactions of carbene, umpolung, N-heterocyclic carbenes	1	
	8	Organocatalysis, Pd catalyzed reactions-Heck, Suzuki,	1	
	9	Suzuki, Stille Coupling	1	
	10	Cu catalyzed reactions- Buchwalds coupling	2	
	11	Synthesis of heterocycles by dipolar cycloaddition	2	
	12	Asymmetric hydrogenation	1	
	13	Alkenyl, allyl and ary silanes and their substitution reaction	2	
	14	Silanes and organo boron reagents and their reactions.	2	
III		Multistep synthesis and biochemical synthesis	12	30

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	15	Reterosynthetic analysis and Total synthesis of Longifoline (Corey, year),	3	
	16	Pencillin V (author, year) and cephallosporin (author, year), Tamiflu (author year)	3	
	17	Biosynthesis of mono and diterpenes,	2	
	18	Biosynthesis of morphine	2	
	19	Bio synthesis of lipids, fatty acids.	2	
IV		Modern Trends in Synthesis	12	16
	20	E factor, Non-conventional and eco-friendly reaction media- ionic liquids, supercritical CO ₂ .	4	
	21	Non-conventional energy sources- microwave, sonochemistry, electroorganic synthesis, visible light photocatalysis. Biomass valorisation, organocatalysis.	4	
	22	Reactions on solid acids bases, reactionson solid support, flow chemistry, enzyme catalyzed reactions, mechanochemistry, fluorous chemistry.	4	
V	Open	ended-	12	
	23	Advanced spectroscopic methods/organo main group chemistry		

References

- 1. ORGANIC CHEMISTRY, by Jonathan Clayden, Nick Greeves, Stuart Warren, Oxford University Press.
- 2. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Wiley.
- 3. Organic Chemistry Paperback, Francis Carey, McGraw-Hill Education
- 4. Advanced Organic Chemistry, David E. Lewis, Oxford Univ Pr; Illustrated edition
- 5. Principles of Organic Synthesis, R. O. C. Norman & J. M. Coxon, 3rd Ed., CRC Press, 2000.
- 6. Name reactions J J Li, Springer.
- 7. Spectrometric Identification of Organic Compounds, 8ed Paperback 1 March 2022 Robert M. Silverstein, Francis X. Webster, David J. Kiemle, Wiley
- 8. Introduction to Spectroscopy, D. L. Pavia, 5th Ed., Cengage, 2015.
- 9. Organic Synthesis Special Techniques, V. K. Ahluwalia and Renu Aggarwal, Narosa Publishing house, Second Edn, 2015.
- 10. Organic chemistry, Stereochemistry and chemistry of natural products, I. L. Finar Vol. 2, Pearson.
- 11. Volgel's practical organic chemistry.

- 12. The Ritter Reaction: Trapping a Carbocation with a Nitrile, R. David Crouch, Journal of Chemical Education 1994 71 (8), A200, DOI: 10.1021/ed071pA200
- 13. Advanced methods of organic synthesis, W. Carruthers and Iain Colgham, Cambridge University Press; 4th edition (10 April 2015)

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		1	1	1	1	3		1		1		2
CO 2	2		1	1	1	1	3		2		3		3
CO 3	2	-	2	2	1	2	3		2		3		3
CO 4	2	-	2	2	2	2	3		2		3		3
CO 5	1	-	1	1	1	1	3		2		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Practi cal Exam	Assignme nt /Viva	Practical Skill Evaluation	End Semester Examination s
CO 1	√	√		✓
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry					
Course Title	COMPUTATIONAL CHEMISTRY					
Type of Course	ELECTIVE IN	MAJOR				
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture per	Tutorial	Practical	Total	
		week	per week	per week	Hours	
	4	4	-	-	60	
Pre-requisites		_		mistry principles, in	_	
		, chemical bone	ding, molecul	ar geometry, and cl	nemical	
	reactions.					
	2.Knowledge of	basic physics p	principles, par	ticularly classical r	nechanics	
	and electromagn	etism, as well a	as an understa	nding of quantum	mechanics	
	at an introductor	y level.				
Course	This course prov	ide students w	ith theoretical	knowledge and pr	actical skills	
Summary	in using computational methods to solve chemical problems. The course					
	covers a range of topics, including introduction to computational methods,					
	molecular mode	molecular modeling, and molecular dynamics simulations, and emphasizes				
	hands-on experie	ence with comp	outational too	ls and software.		

СО	CO Statement	Cognitiv e Level*	Knowled ge Category #	Evaluation Tools used
CO1	Understand the history, scope, definitions, and fundamentals of computational chemistry including computational methods and Molecular modelling Techniques.	U	F	Instructor- created exams / Quiz /Assignment
CO2	Apply a variety of computational methods used in chemistry, such as molecular mechanics (MM), and Monte Carlo	Ap	С	Class test /Assignment /Quiz

	simulations, to solve chemical problems and analyze molecular systems.			
CO3	Effectively utilize computational software package Guassian commonly employed in chemical research, to perform calculations, analyze data, and visualize molecular structures and properties.	U	Р	Assignment/ Class test
CO4	Interpret computational results obtained from simulations and calculations, including molecular structures, energetics, spectroscopic properties, and reaction mechanisms, and relate them to experimental observations.	An	С	Assignments /Seminar presentation
CO5	Explore applications of computational chemistry in various fields, such as drug discovery, materials science, catalysis, and environmental chemistry, and understand how computational methods contribute to advancing scientific research and solving real-world problems.	Ap	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content		Marks
I	Intro	9	15	
	1	Theory, computation & modeling – Definition of terms.	2	
	2	Need of approximate methods in quantum mechanics. Computable Quantities – structure, potential energy surfaces and chemical properties.	3	
	3	Cost & Efficiency – relative CPU time, software & hardware.	2	
	4	Classification of computational methods.	2	
II	Comp	outer Simulation Methods- I	9	15

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	6	Introduction – molecular dynamics and Monte Carlo methods.	2	
	7	Calculation of simple thermodynamic properties - energy, heat capacity, pressure and temperature, phase space, practical aspects of computer simulation.	3	
	8	Periodic boundary conditions, Monitoring the equilibration.	2	
	9	Analyzing the results of a simulation, error estimation.	2	
III	Comp	uter Simulation Methods- II	12	20
	10	Molecular dynamics (MD) method – molecular dynamics using simple models	2	
	11	MD with continuous potentials, finite difference methods, choosing the time step, setting up and running a MD simulation.	3	
	12	Monte Carlo (MC) method - calculating properties by integration, .	3	
	13	Metropolis method, random number generators.	2	
	14	MC simulation of rigid molecules.	2	-
IV		io Methods and basic concepts of Density Functional y in Computational Chemistry	18	30
	15	Review of Hartree – Fock method for atoms, SCF treatment of polyatomic molecules.	2	
	16	Closed shell systems - restricted HF calculations; Open shell systems – ROHF and UHF calculations; The Roothan – Hall equations, Koopmans theorem	2	
	17	HF limit & electron correlation, Introduction to electron correlation (post -HF) methods	3	
	18	Basics of DFT- Applications of computational chemistry in various fields, such as drug discovery, materials science, catalysis, and environmental chemistry, and understand how computational methods contribute to advancing scientific research and solving real-world problems.	3	
	19	Hydrogen-like, Slater-type & Gaussian type basis functions, classification of basis sets — minimal, double zeta, triple zeta, split-valence, polarization & diffuse basis sets, even tempered & well-tempered basis sets, contracted basis sets,	3	

	consistent basi	Pople-style basis sets and their nomenclature, correlation consistent basis sets, basis set truncation error, effect of choice of method/ basis set (model chemistries) on cpu time.					
V	Representation of Calculatins (Open Er	Molecular Geometry and Guassian aded)	12	20			
	Open Ended	Specification of molecular geometry using a) Cartesian coordinates and b) Internal coordinates. The Z-matrix, Z-matrices of some simple molecules like H2, H2O, formaldehyde ammonia and methanol. Simple calculations using Gaussian programme	12				

References:

- C. J. Cramer, Essentials of computational Chemistry: Theories and models, John Wiley & Sons 2002.
- 2. Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons LTD1999.
- J. Foresman & Aelieen Frisch, Exploring Chemistry with Electronic Structure Methods, Gaussian Inc., 2000.
- 4. David Young, Computational Chemistry- A Practical Guide for Applying Techniques to Real- World Problems", Wiley -Interscience, 2001.
- 5. Errol G. Lewars, Computational Chemistry: Introduction to the theory and applications of molecular quantum mechanics, 2 nd edn, Springer2011.
- 6. I.N. Levine, Quantum Chemistry, 6th Edition, Pearson Education Inc., 2009.
- 7. P.W. Atkins & R.S. Friedman, Molecular quantum mechanics, 4th Edition, Oxford University Press, 2005.
- 8. W. Koch, M.C. Holthausen, "A Chemist's Guide to Density Functional Theory", Wiley VCH Verlag2000.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	1					3		1	1	1		1
CO 2	2	2					3		2	2	2		2
CO 3		3					3		2	2	2		3
CO 4		3					3		2	2	2		3
CO 5		3					3		2	2	2		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t/Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3	√	√		✓
CO 4	√	√		✓
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	PETROCHEMICALS AND COSMETICS								
Type of Course	ELECTIVE IN MAJOR								
Semester	VIII								
Academic	400-499								
Level									
Course Details	Credit	Lecture	Tutorial	Practical	Total				
		per week	per week	per week	Hours				
	4	4	1	-	60				
Pre-requisites	1. A fundamental und	derstanding o	of general che	emistry is esse	ntial.				
	2. Proficiency in orga	anic chemistr	y is crucial, a	as petrochemic	cals and				
	cosmetics are primar	ily composed	of organic c	ompounds.					
	3. Knowledge of ana								
	characterization and	analysis of po	etrochemicals	s and cosmetic	products,				
	such as chromatograp	phy, spectros	copy, and ma	iss spectromet	ry, may be				
	beneficial.								
Course	This course aim to pr								
Summary	of petroleum products								
	necessary for career	-	_	. •					
		control, and environmental compliance. Study of the various ingredients							
	used in cosmetics, i	_	eir sources,	functions, pro	perties, and				
	effects on the skin an	d hair.							

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	A comprehensive understanding of the petrochemical industry, including its role in the global economy, key players, and major processes involved.	U	F	Instructor- created exams / Quiz /Assignment
CO2	Understanding of the composition of petroleum, including the various hydrocarbon compounds present and their physical and chemical properties. Understanding of synthetic methods for producing	Ap	С	Class test /Assignment /Quiz

	organic compounds from hydrocarbons.			
CO3	Realizing the physical and chemical properties of different hydrocarbon fractions in crude oil, including their boiling points, densities, viscosities, and reactivities. Familiarity with the principles of distillation. Understanding of the equipment and processes used in crude oil distillation.	Ŭ	P	Assignment/ Class test
CO4	Familiarise with the diverse range of products derived from petroleum refining and the purification techniques employed to remove impurities from petroleum products.	An	С	Assignments /Seminar presentation
CO5	Explore applications of petro chemistry in various fields, such as cosmetic and perfume industry and also the various ingredients used in perfumes and cosmetics, including natural and synthetic fragrances, essential oils, emollients, surfactants, preservatives, colorants, and other functional additives.	Ар	M	Assignments /Seminar presentation

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I	Introduction	n to Petrochemistry	9	15
	1	Introduction. Petroleum. Refining of crude oil.	2	
	2	Fuels for internal combustion engines. Knocking, Octane	3	
		number. Unleaded petrol. Diesel Engine and Cetane number.		
	3	Cracking. Thermal, Catalytic. Mechanism of cracking process.	2	
	4	Reforming Activation Gasoline. Petrochemicals.	2	
II	Hydrocarbo	ons from Petroleum and Industrial organic synthesis	12	20
	6	Introduction. Raw materials. Saturated hydrocarbons from natural gas. Uses of saturated hydrocarbons. Unsaturated	2	
		hydrocarbons – Acetylene, Ethylene, Propylene.		
	7	Aromatic hydrocarbons - Benzene. Toluene. Chemical	3	
		processing of paraffin hydrocarbons. Chemical processing of		
		ethylene hydrocarbons. Chemical processing of acetylene. Chemical processing of aromatic hydrocarbons.		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	8	Introduction to industrial organic synthesis from Petroleum. The raw materials and basic processes. Chemical process used in industrial organic synthesis.	2	
		in industrial organic synthesis.		
	9	Petrochemicals- Methanol. Important points. Ethanol. Important	3	
		points. Rectified spirit from beer. Methylated spirit. Proof spirit.		
		Preparation of the absolute alcohol from rectified spirit.		
	10	Acetaldehyde. Acetic acid. Isopropanol. Ethylene glycol.	2	
		Glycerine. Acetone. Phenol. Formaldehyde. Important points.		
III	Compositio	n of Petroleum Crude and Distillation of Crude Petroleum	15	25
	11	Composition of petroleum crude. Composition of the petroleum	2	
	11	products. Isomeric compounds. Classification of petroleum	_	
		crude		
	10			
	12	Physical Properties and Test Methods. 1. Viscosity: Other	5	
		methods for finding out viscosity. Viscosity of an oil blend. Use		
		of the figure for finding out viscosity. Viscosities of		
		hydrocarbons. 2. Density, 3. Surface and interfacial tensions. 4.		
		Refractive Index. 5. Flash and fire points. 6. Cloud and pour		
		points. 7. Aniline point. 8. Diesel index. 9. Cetane number. 10.		
		Octane number and knock characteristics.		
	13		3	
	13		3	
		petroleum emulsion. Electric desalting plants. Methods of		
		petroleum distillation. Distillation of crude petroleum		
	14	Treatment of the residual liquid processing of liquid fuels such	3	
		as petroleum and petroleum products. Storage tanks.		
		Rectification columns. Cap tray or bubble tray columns.		
	15	Heat exchange apparatus. Steam space heaters or boilers.	2	
		Condensers. Pipe furnaces. Pipelines. Fitting Compressors and		
		pumps.		
IV	Petroleum	products and their purification	12	30
1 1	16	Introduction. Classification of petroleum products. Liquefied	2	30
	10		2	
		hydrocarbons, gases and fuels. Fuel oils or boiler oils. Fuel for		
	1.5	Jet engines and gas turbine engines.		
	16	Lubricants, Paraffins, ceresins, petroleum. Miscellaneous	2	
		petroleum products.		
	17	Products of petrochemical and basic organic synthesis. Dye	2	
		intermediates. Lacquers. Solvents. Thinners.		
	18	Absorptive and adsorptive purification. Sulphuric acid	3	
		purification.	-	
	19	Hydrorefining. Purification in a DC electric field. New methods	3	
		of purification. De mercaptanisation.	5	
V	Donfrance		12	20
v	Perfumes a	nd Cosmetics (Open Ended)	12	20
	Open	Perfumes: Introduction. Esters. Alcohols. Ketones. Ionones.	12	
	Ended	Nitromusks. Aldehydes. Diphenyl compounds. Production of		
		natural perfumes. Flower perfume. Fruit flavours. Artificial		
		flavours. Colognes and after shave preparation. Deodorants and		
		Antiperspirants. Cosmetics: Introduction. Shampoos.		
		Ingredients. Recipe. Hair dyeing. Materials used. Colour and		
	i .	i ingresiente, recipe, mani arenig, materiale abea, coloui alla j		

Curl of Hair. Creams and Lotions. Skin Chemicals. Their
ingredients. Preparation and recipe. Lipsticks. Ingredients.
Preparation and recipe.

References:

- 1. B. K. Sharma, Industrial Chemistry, Goel Publication, Goa.
- 2. N. K. Sinha, Petroleum Refining and petrochemicals,
- 3. John W. Hill, Chemistry for Changing times, Surject Publication
- 4. Uttam Ray Chaudhuri, "Fundamentals of Petroleum and Petrochemical Engineering", Boca Raton London New York.
- 5. S ukumar Maiti, "Introduction to Petrochemicals" India Book House Pvt Ltd.
- 6. Gabriella Baki, Kenneth S. Alexander, "Introduction to Cosmetic Formulation and Technology", Wiley.
- 7. Tony Curtis, David Williams, "Introduction to Perfumery", Micelle Press; 2nd edition ., 2000.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C O 1		1	2				3		1		2		1
C O 2		1		1	2		3		1		1		1
C O 3						3	3		2		2		1
C O 4						3	3		2				1

C			3	3	2	2	1
О							
5							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	√	√		√
CO 2	√	√		✓
CO 3	√	√		√
CO 4	√	√		✓
CO 5	√	√		✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	ADVANCED TOPI	ADVANCED TOPICS IN INORGANIC CHEMISTRY				
Type of Course	ELECTIVE IN MA	JOR				
Semester	VIII					
Academic Level	400-499					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	4	-	-	60	
Pre-requisites	IR spectroscopy Types of ligands Preliminary idea about ESR, Mossbauer and NMR spectra of complexes Ligand exchange reactions Types of magnetic properties of complexes					
Course Summary	Types of magnetic properties of complexes This course gives an insight to the application of IR spectroscopy in coordination complexes This course helps to analyse complexes using ESR, Mossbauer and NMR spectra It provides the knowledge of fascinating applications of complexes in medical field This course explains the anomalous magnetic properties of complexes This course enables the student to analyse different characteristics of a complex using various spectroscopic techniques					

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and apply infrared spectroscopy techniques for characterizing coordination compounds	Ap	С	Instructor-created exams / Assignments
CO2	Interpret the role of ESR and Mossbauer spectroscopic techniques in	Ap	С	Assignment / seminar/Quiz

	elucidating complex structures			
CO3	Evaluate the application of metal complexes in the medicinal field and their interaction with biological entities	E	С	Assignment/Seminar/Class test
CO4	Analyze the significance of anomalous magnetic moments in understanding complex structures and dynamics	An	С	Class Test/ Assignment/Viva Voce
CO5	Perform spectral analysis of complexes and solve related problems using IR, ESR and Mossbauer techniques	Ap	P	Group work /Assignment/class test/

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

26
26
7

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	6	Application of IR spectroscopy in coordination complexes –	2	
II		CHARACTERIZATION OF COORDINATION COMPLEXES USING ESR AND MOSSBAUER SPECTROSCOPIC TECHNIQUES	10	22
	1	ESR spectra- Introduction	1	
	2	Importance of g values in structure elucidation of complexes	1	
	3	Application of ESR measurements to magnetically dilute and concentrated complexes -	2	
	4	Mossbauer spectra - application to iron complexes –	2	
	5	Factors affecting the chemical shift in coordination complexes	2	
	6	NMR spectra of diamagnetic copper complexes	2	
Ш		APPLICATIONS OF METAL COMPLEXES IN MEDICINAL FIELD	15	28
	1	Introduction – DNA-metal complex interaction –	2	
	2	Effect of Ligand exchange reactions and redox reactions in biological activity of metal complexes -	2	
	3	Effect of catalytic activity and photo physical activity on biological activity	2	
	4	Virtual screening of pharmacological behaviour - Drug likeness and bioavailability	2	
	5	Lipinski's Rule of 5 - Pharmacokinetic analysis of a drug molecule –ADMET	2	
	6	Analysis – In vitro and in vivo studies	2	
	7	Molecular docking.	1	
	8	Biological activities of transition metal complexes of Schiff bases, aromatic hydrazones	2	
IV	AN	NOMALOUS MAGNETIC MOMENTS OF METAL COMPLEXES	10	22
	1	Introduction – Equilibrium between two spin states	1	
	2	Magnetically non-equivalent sites in the metal ions – solute-solvent interactions	1	
	3	solute-solute interaction – configurational equilibrium – Antiferromagnetism – types –	2	
	4	antiferromagnetic exchange pathways –examples of antiferromagnetic binuclear complexes (Cu(II), V(IV))	2	

	5	Binuclear complexes with non-equivalent ions	2	
	6	Ferromagnetism – Trinuclear complexes	2	
V	SPEC	CTRAL ANALYSIS OF COMPLEXES (Open ended)	12	
	-	SR and Mossbauer spectral analysis of some complexes lem solving)		

REFERENCES

- 1. Concise Coordination Chemistry, 1/e, R Gopalan & V Ramalingam, Vikas Publishing
- 2. C.N. Banwell, Fundamentals of molecular Spectroscopy, 3rd ed. TMH, New Delhi, 1983.
- 3. E.A.V. Ebsworth, Structural Methods in Inorganic Chemistry, 3rd ed., ELBS, Great Britain, 1987.
- 4. Drago, R. S. Physical Methods in Chemistry W. B. Saunders: Philadelphia, 1977.
- 5. Elements of Magnetochemistry by R L Dutta and A Shyamal, Edition, 2; Publisher, Affiliated East-West Press, 1993; ISBN, 818533692X, 9788185336923
- 6. Textbook of Drug Design and Discovery, Edited by Kristian Strømgaard Povl Krogsgaard-Larsen Ulf Madsen, CRC Press Taylor & Francis Group.
- A Closer Look at Coordination Complexes, Sandeep Kaur-Ghumaan, Series: Chemistry Research and Applications, BISAC: SCI013030, DOI: https://doi.org/10.52305/ENZL4915

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C O 1	3	1	2				3		1		1		1
C O 2	3	1		1	2		3		1		1		2
C O 3	3				2	2	3		1		2		3
C O 4						2	3		1		2		3
C O 5						2	3		1		3		3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

	Internal Theory/Pr actical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	V	V		V
CO 2	V	V		√
CO 3	V	√		V
CO 4	V	√		V
CO 5	V	V		V

MINOR COURSES

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	BASIC INORGANIC AND NANO CHEMISTRY				
Type of Course	MINOR				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours
		per week	per week	per week	
	4	3	-	2	75
	Concept of atom and	molecule			
Pre-requisites	Constituents of the at	om, Rutherfo	ord's model o	of the atom.	
	Periodic table and cla	assification o	f elements to	different bloc	ks,
	Basic knowledge of o	qualitative an	d quantitativ	e analysis	
	Titration and use of i	ndicators			
Course Summary	This course is intend	ed to provide	basic knowl	edge in inorga	anic chemistry and
	nanochemistry. The s	tudent gets a	n understandi	ng of the Bohr	model of the atom
	and the modern quant	tum mechani	cal model of t	the atom throu	gh the first module
	of this course. Differ	ent types of o	chemical bone	ding are also in	ncluded in the first
	module. General proj	perties of the	atom and the	e variation of	these properties in
	the periodic table are	also discusse	ed in this cou	se. Basic prin	ciples of analytical
	chemistry are include	ed in the thir	d module of	this course wh	nich includes acid-
	base titration, redox titration, complexometric titration, and mixture analysis.				
	This course also tries to explore the basic principles and importance of				
	nanochemistry. To n		•		
	titration experiments	are incorpora	ated into this	course structu	re.

CO	CO Statement	Cognitiv	Knowledge	Evaluation
		e Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement	U	С	created exams
	of electrons in an atom.			/ Quiz
				/Assignment
CO2	To discuss the chemical bonding,			Instructor-
	theories of chemical bonding and	U	F	created exams
	predict molecular shapes using			/ Quiz
	VSEPR theory			/Assignment

CO3	To Comprehend periodic properties, understand laws and the concept of	IJ	F	Instructor- created exams
	the modern periodic table, and its	O	1	/ Quiz
	implications			/Assignment
CO4	To Master the principle of volumetric			Instructor-
	analysis, understand the separation	U	C	created exams
	of cations in qualitative analysis			/ Quiz
				/Assignment
CO5	To understand the basics of Nano			Instructor-
	chemistry & to describe the synthesis	U	F	created exams
	of nanomaterials, carbon nanotubes,			/ Quiz
	and their applications,			/Assignment
CO6	To Perform different titrations and			Lab work
	execute open-ended experiments	Ap	P	
	safely and effectively			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyze (An), Evaluate (E), Create (C)

Module	Unit	nit Content		Mark
		Atomic structure and Chemical Bonding	15	34
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
I	3	Quantum numbers and their significance	1	
	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle - Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O, PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ . NH ₄ +, SO ₄ ² -	2	
	7	Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP ² (ethylene), SP ³ (CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)	2	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	1	,		
	8	Molecular Orbital theory: LCAO – Electronic configuration of H ₂ , B ₂ , C ₂ , N ₂ , O ₂ and CO – Calculation of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories	2	
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves,	_	
		X-ray studies of Henry Mosley, Moseley's periodic law	2	
		- Modern periodic law – Long form periodic table.		
II	10	Periodicity in properties: Atomic and ionic radii,		
		Ionization enthalpy - Electron affinity (electron gain	3	
		enthalpy) - Electronegativity, valency, Oxidation		
		number (Representative element), metallic and non-		
		metallic character, inert pair effect,		
		Analytical Chemistry	15	34
	11	Atomic mass - Mole concept -	2	
		Molar volume - Oxidation and reduction – Equivalent		
	12	mass. Methods of expressing concentration: Molality,	2	
	12	molarity, normality, ppm, and mole fraction.	<i>2</i>	
	13	Dilution formula, Theory of volumetric analysis –	3	
		Acid-base, redox, and complexometric titrations:	3	
III	14	acid-base, redox, and complexometric indicators.	2	
111		Double burette method of titration: Principle and	_	
		advantages.		
	15	Principles in the separation of cations in qualitative	2	
		analysis		
	16	Common ion effect and solubility product and its	2	
		applications in qualitative analysis		
	17	Microanalysis and its advantages. Accuracy &	2	
		Precision (mention only).	1.0	
		Nano Chemistry	10	20
	18	Introduction, Definition of nanomaterials and		
	10	Introduction, Definition of nanomaterials and nanotechnology –Classification of nanomaterials	2	
		based on dimension with examples for each 0D, 1D,	4	
IV		and 2D		
	19	Synthesis of nanomaterials: top-down processes and	2	
		Bottom-up processes	_	
	20	Carbon nanotubes, Types of Carbon nanotubes –		
		SWCNT and MWCNT, Synthesis of Carbon nanotubes	3	
		- electric arc discharge, laser ablation, and chemical		
		vapor deposition.		

	21	Important properties of carbon nanotubes and applications of carbon nanotubes.	1	
	22	Fullerenes, graphene - (basic concept only, no	2	
	22	classification is required) Applications of	_	
		nanomaterials.		
		Basic Inorganic Chemistry Practical:	30	
		Acid-Base titrations and Redox titrations	30	
		General Instructions		
		For weighing electronic balance must be used. For		
		titrations, double burette titration method should be		
		used. Standard solution must be prepared by the		
		student. Use a safety coat, gloves, shoes and goggles in		
		the laboratory. A minimum of 7 experiments must be		
		done. Out of the seven experiments, one is to be open-		
		ended which can be selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts,		
		gas poisoning, Electric shocks, Treatment of fires,		
		Precautions and preventive measures.		
		Weighing using electronic balance, Preparation of		
		standard solutions.		
		Neutralization Titrations		
	I	1. Strong acid – strong base.		
		or wear acta strong case.		
		Redox Titrations - Permanganometry:		
	II			
		5. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt		
		Redox Titrations - Dichrometry		
		· ·		
		using internal indicator.		
		7. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt		
		using external indicator.		
X 7				
V				
	III	1		
	111			
		- I		
		powder.		
V	III	 Estimation of oxalic acid. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt Redox Titrations - Dichrometry Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator. Redox Titrations - Iodimetry and Iodometry: Estimation of iodine. Estimation of copper Open-ended experiments - Suggestions Iodometry: Estimation of chromium. Determination of acetic acid content in vinegar by titration with NaOH. Determination of alkali content in antacid tablets by titration with HCl. Determination of available chlorine in bleaching 		

References

- 1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
- 5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. M. A. Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.
- 8. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.
- 9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	06							
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	√	√	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	BASIC INORGANIC AND BIO-INORGANIC CHEMISTRY							
Type of Course	MINOR							
Semester	I							
Academic Level	100-199							
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	4	3	-	2	75			
	Concept of atom and	molecule						
Pre-requisites	Constituents of the at	tom, Rutherfo	ord's model o	of the atom.				
	Periodic table and cla	assification o	f elements to	different bloc	eks,			
	Basic knowledge of o	-	d quantitativ	e analysis				
	Titration and use of i	ndicators						
Course Summary	This course is intend	ed to provide	e basic know	ledge in inorg	anic chemistry and			
	nanochemistry. The s	_		•				
	and the modern quan				~			
	of this course. Differ	* -		_				
	module. General pro	=						
	the periodic table are			-	•			
	chemistry are include	ed in the thir	d module of	this course wl	hich includes acid-			
	base titration, redox		-					
	This course also tries	-			•			
	understand the bioch	•			•			
	skills acid-base titrat	ion, and redo	ox titration ex	xperiments are	e incorporated into			
	this course structure.							

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement of	U	C	created exams
	electrons in an atom.			/ Quiz
CO2	To discuss the chemical bonding,			Class test
	theories of chemical bonding and predict	U	F	/Assignment /
	molecular shapes using VSEPR theory			Quiz

CO3	To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications	U	F	Class test /Assignment / Quiz
CO4	To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis	U	C	Class test /Assignment / Quiz
CO5	To Explain roles of metal ions in biological systems and understand the biochemistry of certain key elements	U	F	Class test /Assignment / Quiz
CO6	To Perform different titrations and execute open-ended experiments safely and effectively	Ap	Р	Lab work

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks		
		Atomic structure and Chemical Bonding	15	34		
	1					
		2				
		Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.				
	2	Schrödinger wave equation (Mention the equation				
		and the terms in it), - Concept of orbitals, comparison	2			
		of orbit and orbital.				
	3	Quantum numbers and their significance	1			
I	4	Pauli's Exclusion principle - Hund's rule of maximum				
		multiplicity - Aufbau principle – Electronic	2			
		configuration of atoms.				
	5	Chemical Bonding: Introduction – Type of bonds.				
		Ionic bond, Covalent bond, Coordinate bond, and	2			
		hydrogen bond (Intermolecular and intramolecular				
		hydrogen bond with examples).				
	6	VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O,	2			
		PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ .				
		NH ₄ +, SO ₄ ² -				
	7	Valence Bond theory - Hybridisation involving s, p				
	and d orbitals: SP (acetylene), SP ² (ethylene), SP ³		2			
		(CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)				
	8	Molecular Orbital theory: LCAO – Electronic				
		configuration of H_2 , B_2 , C_2 , N_2 , O_2 and CO – Calculation	2			

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		of bond order and its applications. (Bond length and		
		bond strength), Comparison of VB and MO theories Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves,	3	10
		X-ray studies of Henry Mosley, Moseley's periodic law	2	
п		- Modern periodic law – Long form periodic table.	_	
II	10	Periodicity in properties: Atomic and ionic radii,		
		Ionization enthalpy - Electron affinity (electron gain	3	
		enthalpy) – Electronegativity, valency, Oxidation		
		number (Representative element), metallic and non-		
		metallic character, inert pair effect,		
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept -	2	
		Molar volume - Oxidation and reduction – Equivalent		
	10	mass.	2	
	12	Methods of expressing concentration: Molality,	2	
	12	molarity, normality, ppm, and mole fraction.	3	
	13	Dilution formula, Theory of volumetric analysis –	3	
III	1.4	Acid-base, redox, and complexometric titrations:	2	
1111	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and	<i>Z</i>	
		advantages.		
	15	Principles in the separation of cations in qualitative	2	
		analysis		
	16	Common ion effect and solubility product and its	2	
		applications in qualitative analysis –		
	17	Microanalysis and its advantages. Accuracy &	2	
		Precision (mention only).		
		Bio-inorganic Chemistry	10	20
	18	Metal ions in biological systems - Biochemistry of	2	
		iron, Haemoglobin and myoglobin,		
	19	O ₂ and CO ₂ transportation (mechanism not	2	
		required) - Chlorophyll and photosynthesis		
IV	20	(mechanism not expected)		
	20	Elementary idea of structure and mechanism of	2	
	21	action of sodium potassium pump		
	21	Biochemistry of zinc and cobalt. Toxicity of metal ions (Pb, Hg and As).	2	
	22	Anticancer drugs: <i>Cis</i> -platin, oxaliplatin,—Structure and		
		significance.	2	
		Basic Inorganic Chemistry Practical:	30	

		General Instructions	
		For weighing electronic balance must be used. For	
		titrations, double burette titration method should be	
		used. Standard solution must be prepared by the	
		student. Use a safety coat, gloves, shoes and goggles in	
		the laboratory. A minimum of 7 experiments must be	
		done. Out of the seven experiments, one is to be open-	
		ended which can be selected by the teacher	
		Importance of lab safety – Burns, Eye accidents, Cuts,	
		gas poisoning, Electric shocks, Treatment of fires,	
		Precautions and preventive measures.	
		Weighing using electronic balance, Preparation of	
		standard solutions.	
		Neutralization Titrations	
		1. Strong acid – strong base.	
	I	2. Strong acid – weak base.	
		3. Weak acid – strong base.	
		Redox Titrations - Permanganometry:	
		4. Estimation of oxalic acid.	
		5. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt	
V	II	3. Estimation of 1 c2+/1 c504./1120/1910in 3 sait	
		Redox Titrations - Dichrometry	
		6. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt	
		using internal indicator.	
		7. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt	
		using external indicator.	
		Redox Titrations - Iodimetry and Iodometry:	
		8. Estimation of iodine.	
		9. Estimation of copper	
		Open-ended experiments - Suggestions	
		Iodometry: Estimation of chromium.	
	III	Determination of acetic acid content in vinegar by	
		titration with NaOH.	
		Determination of alkali content in antacid tablets by	
		titration with HCl.	
		Determination of available chlorine in bleaching	
		powder.	

References

- 1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 4. Satya Prakash, Advanced Inorganic Chemistry, Vol. 1, 5th Edn., S. Chand and Sons, New

Delhi, 2012.

- 5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. G. L. Meissler, D. A. Tarr, *Inorganic Chemistry*, 3rd Edn. Pearson Education, 2004.
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- 9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

Mapping of COs with PSOs and POs:

	PSO	PSO	PSO	PSO	PSO	PSO	PO						
	1	2	3	4	5	6	1	2	3	4	5	6	7
CO 1	2				2		1				1		
CO 2	2				2		1				1		
CO 3	1				2		1				1		
CO 4	1		1		2		1				1		
CO 5	1				2		1				1		
CO 6			2		1		1		1		2		

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓		√
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6		✓	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry								
Course Title	BASIC INORGANI	C AND GR	EEN CHEM	ISTRY					
Type of Course	MINOR								
Semester	I								
Academic Level	100-199								
Course Details	Credit Lecture Tutorial Practical Total Hours								
		per week	per week	per week					
	4	3	-	2	75				
	Concept of atom and	molecule							
Pre-requisites	Constituents of the at	tom, Rutherfo	ord's model o	of the atom.					
	Periodic table and cla	assification o	f elements to	different bloc	ks,				
	Basic knowledge of o	qualitative an	d quantitative	e analysis					
	Titration and use of i	ndicators							
Course Summary	This course is intend	ed to provide	e basic knowl	edge in inorga	anic chemistry and				
	nanochemistry. The s	tudent gets a	n understandi	ng of the Bohr	model of the atom				
	and the modern quant	tum mechani	cal model of t	the atom throu	gh the first module				
	of this course. Differ	ent types of c	chemical bone	ding are also in	ncluded in the first				
	module. General proj	perties of the	atom and the	e variation of	these properties in				
	the periodic table are	also discusse	ed in this cou	rse. Basic prin	ciples of analytical				
	chemistry are include	ed in the thir	d module of	this course wh	nich includes acid-				
	base titration, redox	titration, con	nplexometric	titration, and	I mixture analysis.				
	This course also tries	•	-	•	• •				
	and applications. To		•		· ·				
	titration experiments	are incorpora	ated into this	course structu	re.				

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement	U	C	created exams
	of electrons in an atom.			/ Quiz
CO2	To discuss the chemical bonding,			Class test
	theories of chemical bonding and	U	F	/Assignment /
	predict molecular shapes using VSEPR			Quiz
	theory			

CO3	To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications	U	F	Class test /Assignment / Quiz
CO4	To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis	U	С	Class test /Assignment / Quiz
CO5	To Grasp the importance of green chemistry, its principles and applications, including alternative energy sources	U	F	Class test /Assignment / Quiz
CO6	To Perform different titrations and execute open-ended experiments safely and effectively	Ap	Р	Lab work

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Mark
		Atomic structure and Chemical Bonding	15	34
	1	Bohr atom model, merits and its limitations,		
		Heisenberg uncertainty principle, Louis de Broglie's	2	
		matter waves – dual nature.		
	2	Schrödinger wave equation (Mention the equation and		
		the terms in it), - Concept of orbitals, comparison of	2	
		orbit and orbital.		
	3	Quantum numbers and their significance	1	
I	4	Pauli's Exclusion principle - Hund's rule of maximum		
		multiplicity - Aufbau principle – Electronic	2	
		configuration of atoms.		
	5	Chemical Bonding: Introduction – Type of bonds.		
		Ionic bond, Covalent bond, Coordinate bond, and	2	
		hydrogen bond (Intermolecular and intramolecular		
		hydrogen bond with examples).		
	6	VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O,	2	
		PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ . NH ₄ +,		
		SO ₄ ² -		
	7	Valence Bond theory - Hybridisation involving s, p		
		and d orbitals: SP (acetylene), SP ² (ethylene), SP ³	2	
		(CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	8	Molecular Orbital theory: LCAO – Electronic		
		configuration of H ₂ , B ₂ , C ₂ , N ₂ , O ₂ and CO – Calculation	2	
		of bond order and its applications.(Bond length and		
		bond strength), Comparison of VB and MO theories		
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves, X-		
		ray studies of Henrry Mosley, Mosleys periodic law -	2	
		Modern periodic law – Long form periodic table.		
п	10	Periodicity in properties: Atomic and ionic radii,		
		Ionization enthalpy - Electron affinity (electron gain	3	
		enthalpy) – Electronegativity, valency, Oxidation number		
		(Representative element), metallic and non-metallic		
		character, inert pair effect,		
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept - Molar	2	
		volume - Oxidation and reduction – Equivalent mass.		
	12	Methods of expressing concentration: Molality,	2	
		molarity, normality, ppm, and mole fraction.		
	13	Dilution formula, Theory of volumetric analysis – Acid-	3	
		base, redox, and complexometric titrations:		
III	14	acid-base, redox, and complexometric indicators.	2	
111		Double burette method of titration: Principle and		
		advantages.		
	15	Principles in the separation of cations in qualitative	2	
		analysis		
	16	Common ion effect and solubility product and its	2	
		applications in qualitative analysis –		
	17	Microanalysis and its advantages. Accuracy &	2	
		Precision (mention only).		
		Green Chemistry	10	20
	18	Introduction- Definition of green Chemistry, need of	3	
		green chemistry, Twelve principles of Green		
		Chemistry with their explanations.		
	19	Applications of green chemistry in daily life. Green	2	
		solvents- supercritical fluids, water as a solvent for		
IV		organic reactions, ionic liquids (Brief explanation with		
		example).		
	20	Alternative sources of energy: use of microwaves and	2	
		ultrasonic energy.		
	21	Strengthening/ development of analytical techniques		
		to prevent and minimize the generation of hazardous	2	
		substances in chemical processes.		

	22	Selection of starting materials; avoidance of		
		unnecessary derivatization.	1	
		Basic Inorganic Chemistry Practical:	30	
		Acid-Base titrations and Redox titrations		
		General Instructions		
		For weighing electronic balance must be used. For		
		titrations, double burette titration method should be used.		
		Standard solution must be prepared by the student. Use a		
		safety coat, gloves, shoes and goggles in the laboratory.		
		A minimum of 7 experiments must be done. Out of the		
		seven experiments, one is to be open-ended which can be		
		selected by the teacher		
		Importance of lab safety – Burns, Eye accidents, Cuts,		
		gas poisoning, Electric shocks, Treatment of fires,		
		Precautions and preventive measures.		
		Weighing using electronic balance, Preparation of		
		standard solutions.		
		Neutralization Titrations		
	_	1. Strong acid — strong base.		
	I	 Strong acid – weak base. Weak acid – strong base. 		
		5. Weak deld strong base.		
		Redox Titrations - Permanganometry:		
		4. Estimation of oxalic acid.		
	II	5. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt		
		Redox Titrations - Dichrometry		
		6. Estimation of Fe ₂₊ /Fe _S O ₄ .7H ₂ O/Mohr's salt		
		using internal indicator.		
		7. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt using		
		external indicator.		
		Redox Titrations - Iodimetry and Iodometry:		
V		8. Estimation of iodine.		
·		9. Estimation of copper		
		Open-ended experiments - Suggestions		
		Iodometry: Estimation of chromium.		
	III	Determination of acetic acid content in vinegar by		
		titration with NaOH.		
		Determination of alkali content in antacid tablets by		
		titration with HCl.		
		Determination of available chlorine in bleaching powder.		

References

- 1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.

- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
- 5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. V. K. Ahluwaliya, Green Chemistry, Narosa Publishing House, New Delhi, 2011.
- 8. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 9. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996

Mapping of COs with PSOs and Pos

Mapp	viapping of COs with 1 5Os and 1 os												
	PSO	PSO	PSO	PSO	PSO	PSO	PO						
	1	2	3	4	5	6	1	2	3	4	5	6	7
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		√
CO2	V	V		√
CO3	V	V		V
CO4	√	V		√
CO5	V	V		√
CO6		V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	BASIC INORGANI	C CHEMIS	TRY AND N	METALLURO	GY	
Type of Course	MINOR					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
	Concept of atom and	molecule				
Pre-requisites	Constituents of the at	tom, Rutherfo	ord's model o	of the atom.		
	Periodic table and classification of elements to different blocks,					
	Basic knowledge of qualitative and quantitative analysis					
	Titration and use of i	ndicators				
Course Summary	This course is intend	ed to provide	e basic know	ledge in inorga	anic chemistry and	
	nanochemistry. The student gets an understanding of the Bohr model of the atom					
	and the modern quan	tum mechani	cal model of	the atom throu	gh the first module	
	of this course. Differ	• •		-		
	module. General pro	perties of the	atom and th	e variation of	these properties in	
	the periodic table are also discussed in this course. Basic principles of analy					
	chemistry are include					
base titration, redox titration, complexometric titration, and mixture					-	
	This course also tries to explore processes in metallurgy including extraction of					
metals and alloy formation. To master the laboratory skills acid-b						
and redox titration experiments are incorporated into this course structu				irse structure.		

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement	U	C	created exams
	of electrons in an atom.			/ Quiz
CO2	To discuss the chemical bonding,			Class test
	theories of chemical bonding and	U	F	/Assignment /
	predict molecular shapes using VSEPR			Quiz
	theory			

CO3	To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications	U	F	Class test /Assignment / Quiz
CO4	To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis	U	С	Class test /Assignment / Quiz
CO5	To Comprehend the process in metallurgy including extraction of metals and alloy formation	U	F	Class test /Assignment / Quiz
CO6	To Perform different titrations and execute open-ended experiments safely and effectively	Ap	Р	Lab work

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
		Atomic structure and Chemical Bonding	15	34
	1	Bohr atom model, merits and its limitations, Heisenberg uncertainty principle, Louis de Broglie's matter waves – dual nature.	2	
	2	Schrödinger wave equation (Mention the equation and the terms in it), - Concept of orbitals, comparison of orbit and orbital.	2	
	3	Quantum numbers and their significance	1	
I	4	Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle - Electronic configuration of atoms.	2	
	5	Chemical Bonding: Introduction – Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples).	2	
	6	VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O, PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ . NH ₄ ⁺ , SO ₄ ²⁻	2	
	7 Valence Bond theory - Hybridisation involving s, p and d orbitals: SP (acetylene), SP ² (ethylene), SP ³ (CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)			
	8	Molecular Orbital theory: LCAO – Electronic configuration of H ₂ , B ₂ , C ₂ , N ₂ , O ₂ and CO – Calculation of	2	

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law - Long form periodic table.	2	
П	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) - Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	3	
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept - Molar volume - Oxidation and reduction - Equivalent mass.	2	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	2	
	13	Dilution formula, Theory of volumetric analysis – Acidbase, redox, and complexometric titrations:	3	
Ш	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	2	
	15	Principles in the separation of cations in qualitative analysis	2	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	2	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	2	
		Metallurgy	10	20
	18	Ores and minerals, Concentration of ores – Calcination and roasting – Reduction to free metal.	2	
	19	Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, zone refining	2	
IV	20	Extractive metallurgy of Al, Fe	2	
-,	21	Alloys: Definition – Composition and uses of German silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process (brief description only)	2	
	22	Classification of steel – Composition and uses of stainless steels, and applications of industrially important stainless steel types- (AISI Grade mention only)	2	
		Basic Inorganic Chemistry Practical: Acid-Base titrations and Redox titrations	30	

		General Instructions	
		For weighing electronic balance must be used. For	
		titrations, double burette titration method should be used.	
		Standard solution must be prepared by the student. Use a	
		safety coat, gloves, shoes and goggles in the laboratory. A	
		minimum of 7 experiments must be done. Out of the seven	
		experiments, one is to be open-ended which can be	
		selected by the teacher	
		Importance of lab safety – Burns, Eye accidents, Cuts, gas	
		poisoning, Electric shocks, Treatment of fires, Precautions	
		and preventive measures.	
		Weighing using electronic balance, Preparation of	
		standard solutions.	
		Neutralization Titrations	
		1. Strong acid – strong base.	
	I	2. Strong acid – weak base.	
		3. Weak acid – strong base.	
		Redox Titrations - Permanganometry:	
		4. Estimation of oxalic acid.	
		5. Estimation of Fe ₂₊ /Fe _S O ₄ .7H ₂ O/Mohr's salt	
V	II	3. Estimation of 1 c2+/1 c504./1120/1910in 3 suit	
		Redox Titrations - Dichrometry	
		6. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt using	
		internal indicator.	
		7. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt using	
		external indicator.	
		Redox Titrations - Iodimetry and Iodometry:	
		8. Estimation of iodine.	
		9. Estimation of copper	
		Open-ended experiments - Suggestions	
		Iodometry: Estimation of chromium.	
	III	Determination of acetic acid content in vinegar by titration	
		with NaOH.	
		Determination of alkali content in antacid tablets by	
		titration with HCl.	
		Determination of available chlorine in bleaching powder.	

References

- 1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
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- 5. W. U. Malik, G. D. Tuli, R. D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. A. Cottrel, *An introduction to metallurgy*, 2nd Edn., University press, 1990.
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- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

	PSO	PSO	PSO	PSO	PSO	PSO	РО	РО	РО	РО	РО	PO	PO
	1	2	3	4	5	6	1	2	3	4	5	6	7
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		√
CO2	√	V		√
CO3	V	V		√
CO4	V	V		√
CO5	V	V		V
CO6		V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	BASIC INORGANIC	AND NUCLE	EAR CHEMIS	TRY	
Type of Course	MINOR				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours
		per week	per week	per week	
	4	3	-	2	75
	Concept of atom and	molecule			
Pre-requisites	Constituents of the at	tom, Rutherfo	ord's model o	of the atom.	
	Periodic table and cla				eks,
	Basic knowledge of o	_	d quantitativ	e analysis	
	Titration and use of i	ndicators			
Course Summary	This course is intend	ed to provide	basic know	ledge in inorg	anic chemistry and
	nanochemistry. The s	tudent gets a	n understandi	ng of the Boh	r model of the atom
	and the modern quan	tum mechani	cal model of	the atom throu	igh the first module
	of this course. Differ	ent types of c	chemical bon	ding are also i	ncluded in the first
	module. General pro	perties of the	atom and th	e variation of	these properties in
	the periodic table are	also discusse	ed in this cou	rse. Basic prin	ciples of analytical
	chemistry are include	ed in the thir	d module of	this course wl	hich includes acid-
	base titration, redox	titration, cor	nplexometric	titration, and	d mixture analysis.
	This course also tries	s to examine	e nuclear che	emistry, the I	N/P ratio, and the
	application of radio	active isotop	oes. To mast	er the laborate	ory skills acid-base
	titration, and redox ti	tration exper	iments are in	corporated in	to this course
	structure.				

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Understand the structure of atoms			Instructor-
	and rules regarding the arrangement	U	C	created exams
	of electrons in an atom.			/ Quiz
CO2	To discuss the chemical bonding,			Class test
	theories of chemical bonding and	U	F	/Assignment /
	predict molecular shapes using VSEPR			Quiz
	theory			

CO3	To Comprehend periodic properties, understand laws and the concept of the modern periodic table, and its implications	U	F	Class test /Assignment / Quiz
CO4	To Master the principle of volumetric analysis, understand the separation of cations in qualitative analysis	U	С	Class test /Assignment / Quiz
CO5	To Examine nuclear chemistry, the N/P ratio and the application of radioactive isotopes	U	F	Class test /Assignment / Quiz
CO6	To Perform different titrations and execute open-ended experiments safely and effectively	Ap	Р	Lab work

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Mark
		Atomic structure and Chemical Bonding	15	34
	1	Bohr atom model, merits and its limitations,		
	Atomic structure and Chemical Bonding 1 Bohr atom model, merits and its limitation Heisenberg uncertainty principle, Louis de Broglie matter waves – dual nature. 2 Schrödinger wave equation (Mention the equation are the terms in it), - Concept of orbitals, comparison orbit and orbital. 3 Quantum numbers and their significance 4 Pauli's Exclusion principle - Hund's rule of maximu multiplicity - Aufbau principle - Electron configuration of atoms. 5 Chemical Bonding: Introduction - Type of bonds. Ionic bond, Covalent bond, Coordinate bond, and hydrogen bond (Intermolecular and intramolecular hydrogen bond with examples). 6 VSEPR theory: Shapes of BeCl ₂ , BF ₃ , CH ₄ , NH ₃ , H ₂ O, PCl ₅ , SF ₄ , ClF ₃ , XeF ₂ , SF ₆ , IF ₅ , XeF ₄ , IF ₇ and XeF ₆ . NH ₄ + SO ₄ ² -		2	
		matter waves – dual nature.		
	2	Schrödinger wave equation (Mention the equation and		
		the terms in it), - Concept of orbitals, comparison of	2	
		orbit and orbital.		
	3	Quantum numbers and their significance	1	
I	4	Pauli's Exclusion principle - Hund's rule of maximum		
			2	
		9		
	5			
			2	
		1		
		, ,		
	6		2	
		SO_4^{2-}		
	7	Valence Bond theory - Hybridisation involving s, p		
		and d orbitals: SP (acetylene), SP ² (ethylene), SP ³	2	
		(CH ₄), SP ³ d (PCl ₅), SP ³ d ² (SF ₆)		
	8	Molecular Orbital theory: LCAO – Electronic		
		configuration of H_2 , B_2 , C_2 , N_2 , O_2 and CO – Calculation	2	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		of bond order and its applications.(Bond length and bond strength), Comparison of VB and MO theories		
		Periodic Properties	5	10
	9	Name and symbol of elements, Law of triads, octaves, X-ray studies of Henrry Mosley, Mosleys periodic law - Modern periodic law - Long form periodic table.	2	10
II	10	Periodicity in properties: Atomic and ionic radii, Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity, valency, Oxidation number (Representative element), metallic and non-metallic character, inert pair effect,	3	
		Analytical Chemistry	15	34
	11	Atomic mass - Molecular mass - Mole concept - Molar volume - Oxidation and reduction - Equivalent mass.	2	
	12	Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	2	
	13	Dilution formula, Theory of volumetric analysis – Acidbase, redox, and complexometric titrations :	3	
Ш	14	acid-base, redox, and complexometric indicators. Double burette method of titration: Principle and advantages.	2	
	15	Principles in the separation of cations in qualitative analysis	2	
	16	Common ion effect and solubility product and its applications in qualitative analysis –	2	
	17	Microanalysis and its advantages. Accuracy & Precision (mention only).	2	
		Nuclear Chemistry	10	20
	18	Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy	2	
	19	Nuclear fission - Atom bomb - Nuclear fusion - Hydrogen bomb.	1	
IV	20	Nuclear forces - Exchange theory and liquid drop model - Nuclear reactors. Decay series – group displacement law	2	
	21	Isotopes, Separation of isotopes by gaseous diffusion method and thermal diffusion method	2	
	22	Application of radioactive isotopes – ¹⁴ C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy	3	
		Basic Inorganic Chemistry Practical:	30	
		Acid-Base titrations and Redox titrations		
		General Instructions		

	1		
		For weighing electronic balance must be used. For	
		titrations, double burette titration method should be used.	
		Standard solution must be prepared by the student. Use	
		safety coat, gloves, shoes and goggles in the laboratory.	
		A minimum of 7 experiments must be done. Out of the	
		seven experiments, one is to be open-ended which can be	
		selected by the teacher	
		Importance of lab safety – Burns, Eye accidents, Cuts,	
		gas poisoning, Electric shocks, Treatment of fires,	
		Precautions and preventive measures.	
		Weighing using electronic balance, Preparation of	
		standard solutions.	
		Neutralization Titrations	
		1. Strong acid – strong base.	
	I	2. Strong acid – weak base.	
		3. Weak acid – strong base.	
		D. L. Witantin D.	
		Redox Titrations - Permanganometry:	
V		4. Estimation of oxalic acid.	
	II	5. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt	
		Redox Titrations - Dichrometry	
		6. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt	
		using internal indicator.	
		7. Estimation of Fe ₂₊ /FeSO ₄ .7H ₂ O/Mohr's salt using	
		external indicator.	
		Redox Titrations - Iodimetry and Iodometry:	
		8. Estimation of iodine.	
		9. Estimation of copper	
		Open-ended experiments - Suggestions	
		Iodometry: Estimation of chromium.	
	III	Determination of acetic acid content in vinegar by	
		titration with NaOH.	
		Determination of alkali content in antacid tablets by	
		titration with HCl.	
		Determination of available chlorine in bleaching powder.	
		·	

References

- 1. C. N. R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
- 2. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edn., Tata McGraw Hill Publishing Company, Noida, 2007.
- 3. R. Puri, L. R. Sharma K. C. Kalia, *Principles of Inorganic Chemistry*, 31st Edn., Milestone Publishers and Distributors, New Delhi, 2013.
- 4. Satya Prakash, *Advanced Inorganic Chemistry*, Vol. 1, 5th Edn., S. Chand and Sons, New Delhi, 2012.
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- and Co., New Delhi, 2010.
- 6. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Oxford University Press, New Delhi, 2008.
- 7. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, *Inorganic Chemistry*, 5th Edn., Pearson, 2009.
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- 9. New Delhi, 1995.J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 10. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edn., Prentice Hall, New Delhi, 1996.

T T	0												
	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	O6							
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	1				2		1				1		
3													
CO	1		1		2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	V	V		V
CO3	V	V		√
CO4	V	V		√
CO5	V	V		√
CO6		V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	COORDINATION CHEMISTRY					
Type of Course	MINOR					
Semester	I					
Academic Level	100-199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	ı	2	75	
Pre-requisites	Classification of elen f block elements base General idea about tr Concept of coordinat Concept of covalent l Theoretical and pract	ed on electron ansition and a e bond, valer bond, and org	nic configura inner transitioncy. ganic compou	tion. on elements, and.		
Course Summary	Theoretical and practical knowledge about volumetric analysis This course explains the characteristics of s, p, d and f block elements and familiarises some of the important compounds of main group elements. It also gives insight into coordination compounds and various theories to explain the bonding in coordination compounds. It covers the practical application of complex formation in quantitative analysis A brief discussion of Organometallic compounds, complexometric titration, preparation of complex compounds and colourimetry is also included in this course.					

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To Elucidate the trends in physical and			Instructor-
	chemical properties of s and p block	U	F	created exams
	elements			/ Quiz
CO2	To Evaluate the general properties of			Class test
	transition metals and to distinguish between	U	F	/Assignment /
	lanthanides and actinides			Quiz
CO3	To Unlock the Complexity of Coordination			Class test
	Compounds: Structures, Properties, and	U	F	/Assignment /
	Applications			Quiz
CO4	To demonstrate different theories to explain	U	С	Class test
	the formation of coordination compounds			/Assignment /
				Quiz

CO5	To explore the characteristics of	U	F	Class test
	organometallic compounds			/Assignment /
				Quiz
CO6	To Perform complexometric titrations,			
	colourimetry experiments and	Ap	P	Lab Work
	preparation of complex compounds.			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Mark
		s & p BLOCK ELEMENTS	15	33
	1	s block elements - General properties: Ionization	2	
		Energy, Flame coloration, photoelectric effect,		
		metallic character, hydration energy.		
	2	p-block elements: comparative study- halides,	2	
		sulphates, carbonates and bicarbonates (solubility		
		and thermal stability).		
	3	Oxidation number and inert pair effect, Comparison	1	
_		of Lewis acidity of boron halides.		
I	4	Preparation, properties, structure and uses of	3	
		Diborane, Boric acid, Borazine and Boron nitride.		
		Structure and bonding of oxides of N (N ₂ O, NO, NO ₂ ,		
		N ₂ O ₄) and S (SO ₂ and SO ₃)		
	5	Oxo acids of P (H ₃ PO ₂ ,H ₃ PO ₃ , H ₃ PO ₄) and Cl (HOCl,	2	
		HOCl ₂ , HOCl ₃ ,HOCl ₄) (structure and acid strength).		
	6	Colour and bond dissociation energy of halogens.	2	
		Interhalogen compounds: Preparation, properties		
		uses and structure (One example each- ClF, ClF ₃ ,		
		ClF ₅ and IF ₇), Electropositive character of iodine		
	7	Pseudo halogen: Comparison of pseudo halogen	3	
		(Cyanogen as example) and halogens. structure of		
		poly halide ions (ICl ₂ -, ICl ₄ - and I ₅ -). Noble gases:		
		Isolation of noble gases: Dewar's method-		
		Separation by charcoal adsorption method, Uses of		
		He, and Ne		
		TRANSITION AND INNER TRANSITION	8	17
	0	ELEMENTS		
	8	Transition Metals: General characteristics: Metallic	2	
		character, oxidation states, size, density, melting		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		point, boiling point. ionization energy, colour,		
		magnetic properties, catalytic properties		
II	9	non-stoichiometric compounds, complex formation	2	
		and alloy formation. Difference between first row		
		and other two rows.		
	10	Lanthanides: Electronic configuration and general	2	
		characteristics. Occurrence of lanthanides –		
		Importance of beach sands of Kerala – Isolation of		
		lanthanides from monazite sand – Separation by ion		
		exchange method.		
	11	Lanthanide contraction: Causes and consequences.	2	
		Industrial importance of lanthanides. Actinides:		
		Electronic configuration and general characteristics –		
		Comparison with lanthanides [Mention only].		
		COORDINATION COMPOUNDS	15	34
	12	Double salt and complex, ligand, type of ligands:	2	
		(mono, bi, tri, tetra, hexa, ambidentate, chelate and		
		macrocyclic ligands) coordination number,		
	13	Isomerism - structural and stereoisomerism, IUPAC	2	
		Nomenclature of complexes,		
	14	Postulates of Werner's theory, EAN rule, application	2	
		of co-ordination complexes in quantitative and		
		qualitative analysis.		
	15	Theories of bonding, VBT (valence bond theory) ,	2	
		geometry of co-ordination numbers 4 and 6,		
	16	Limitations of VBT, Crystal field Theory: CFSE of low	2	
III		spin and high spin octahedral complexes, Factors		
		affecting crystal field splitting.		
	17	Spectrochemical series, Crystal field splitting of d	2	
		orbitals in Tetragonal and Square planar Complexes.		
	18	Magnetism (spin only magnetic moment) and colour	1	
		(d-d transition),		
	19	Distorted octahedral complexes, merits and	2	
		demerits of CFT.		
		Organometallic Compounds	7	14
	20	Definition - Classification based on the nature of	2	
IV		metal-carbon bond, Zeise's salt. 18-electron rule.		
	21	Metal carbonyls - Mononuclear and Polynuclear	2	
		carbonyls of Fe, Co and Ni (structure only) – Bonding		
		in metal carbonyls.		

	22	Ferrocene: Preparation, properties and bonding (VBT only). Catalysis: Zeigler Natta catalyst in the polymerization and Wilkinson catalyst in the hydrogenation of alkene.	3	
		PRACTICAL:	30	
		Complexometric titrations and Inorganic Preparations		
		A minimum of 7 experiments must be done. Out of the seven experiments, one is to be open-ended which		
	I	 can be selected by the teacher Estimation of zinc. Estimation of magnesium. Estimation of calcium. Determination of total hardness of water. 		
	II	Preparation of complex compounds 5. Preparation of tetramminecopper(II) sulphate. 6. Preparation of Nickel (II) dimethylglyoxime 7. Preparation of trithioureacopper(I) sulphate		
V	III	Colorimetry 8. Verification of Beer-Lambert law for KMnO4 & determination of concentration of the given solution. 9. Estimation of iron. 10. Estimation of chromium.		
	IV	Open-ended experiments - Suggestions		
		 Preparation of double salt/Complex compounds. Determination of alkali content in antacid tablets by titration with HCl. 		
		3. Determination of available chlorine in bleaching powder.4. Analysis of Ores		

References

- 1. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Wiley India Pvt. Ltd., 2008.
- 2. B. R. Puri, L. R. Sharma, K. C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
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- 7. P. Powell, *Principles of Organometallic Compounds*, 2nd Edn., Chapman and Hall, London, 1988.

- 8. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
- 9. D. N. Bajpai, O. P. Pandey, S. Giri, *Practical Chemistry; For I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	O6							
CO	2				2		1				1		
1													
CO	2				2		1				1		
2													
CO	2				2		1				1		
3													
CO	2				2		1				1		
4													
CO	1				2		1				1		
5													
CO			2		1		1		1		2		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	V	V		√
CO3	V	V		V
CO4	V	V		√
CO5	V	V		V
CO6		V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	QUANTUM MEC	CHANICS, S	SOLID STA	TE AND GA	SEOUS STATE	
Type of Course	MINOR					
Semester	II					
Academic Level	100 - 199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
Pre-requisites	1. Basic idea the st	ructure of at	om			
	2. Fundamentals of	f states of ma	atter			
	3. Basic knowledge	e in analytic	al principles			
Course Summary	1. This course	e aims to in	troduce the	failures of c	lassical theories in	
	explaining	many experi	ments and th	ne emergence	of quantum theory.	
	2. This course	also aims to 1	ealise the the	eories of diffe	rent states of	
	matter and their implications.					
				• •	litative analysis	
	and to fami	liarize physi	cal chemistr	y experiments	S	

СО	CO Statement	Cognitiv e Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the importance andthe impact of quantum revolution in science.	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the properties of solids	E	С	Instructor-created exams / Quiz /Assignment
CO3	To analyse the behaviour of gases	An	С	Instructor-created exams / Quiz /Assignment
CO4	To understand the properties of gaseous state and how it links to thermodynamic systems.	U	С	Instructor-created exams / Quiz /Assignment
CO5	To perform the cation analysis on a provided mixture containing two cations.	An	P	Lab work

CO6	To enable the students to determine	Ap	P	Lab work				
	the physical properties (physical							
	constants).							
* - Remer	* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)							
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive								
Knowledge (M)								

Module	Unit Content		Hrs	Marks
Ι		Introduction to Quantum mechanics	15	32
	1	Postulates of quantum mechanics – derivation of time- independent Schrodinger equation	2	
	2	Particle in one dimensional box problem- Schrodinger	3	
		equation, derivation for expression of energy, quantisation of energy levels, HOMO-LUMO transition in 1,3-butadiene Particle in three dimensional box (no derivation)- Concept of degeneracy of energy levels		
	3	Harmonic oscillator model, Schrodinger equation and Energy levels (basic idea only, no derivation)	1	
	4	Spherical polar coordinates and Rigid rotor model (no derivation, basic idea only), Expression for energy, Spherical harmonics, Angular momentum	2	
	5	Quantum mechanics of Hydrogen-like atoms - Hamiltonian operator of H-like systems, The Schrodinger equation in spherical polar coordinates, separation of variables	3	
	6	Wave functions or atomic orbitals, radial and angular parts of atomic orbitals. Quantum numbers (n, l, m).	2	
	7	The Stern - Gerlach experiment and the concept of electron spin, spin quantum number.	2	
II		Solid state	10	22
	8	Classification of solids: Amorphous, Crystalline, Lattice points, lattice energy (general idea), unit cell, seven crystal systems.	2	
	9	Weiss and Miller indices - Bravais lattices, Close packing in crystals, examples of simple cubic, bcc and fcc lattices,	1	
	10	Explanation of electrical properties using concepts of bands, Explanation of conductors, semiconductors and insulators, Super conductors	2	
	11	Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.	3	
	12	Defects in crystals – stoichiometric and non-stoichiometric defects (Basic ideas only).	2	
III		Gaseous state - I	10	22

	13	Characteristics of gases	1	
	14	Postulates of kinetic theory of gases	2	
	15	Maxwell's distribution of molecular velocities – Root mean	3	
		square, average and most probable velocities.		
	16	Collision number – Mean free path – Collision diameter	1	
	17	Viscosity of gases, including their temperature and pressure	1	
		dependence,		
	18	Relation between mean free path and coefficient of	2	
		viscosity, calculation of σ from η ; variation of viscosity with		
		temperature and pressure.		
IV		Gaseous state -II	10	22
	19	Behaviour of real gases - Deviation from ideal behaviour –	3	
		Compressibility factor		
	20	Causes of deviation from ideal behaviour - van der Waals	4	
		equation of state (derivation not required) – Expression of	•	
		van der Waals equation in virial form and calculation of		
		Boyle temperature		
	21	PV isotherms of real gases – Continuity of states – Isotherm	1	
		of van der Waals equation	•	
	22	Critical phenomena (basic idea only) – Critical constants	2	
		and their determination (derivation not required) –	2	
		Relationship between critical constants and van der Waals		
		constants.		
V		Practical	30	
•	A minii	mum of seven experiments must be done. Out of the seven		
		nents, one is to be open-ended which can be selected by the		
	teacher	ichts, one is to be open chied which can be selected by the		
	1	Incurania Qualitativa Analysia (comi micus analysia)	25	
	1	Inorganic Qualitative Analysis (semi – micro analysis)	25	
		 Reactions of Cations: Study of the reactions of the following cations with a view of their identification 		
		and confirmation. NH ₄ ⁺ , Pb ²⁺ , Cu ²⁺ , Cd ²⁺ , Al ³⁺ ,		
		Ni ²⁺ , Co ²⁺ , Mn ²⁺ , Zn ²⁺ , Ba ²⁺ , Sr ²⁺ , Ca ²⁺ , and Mg ²⁺		
		 Systematic qualitative analysis of a solution 		
		containing any two cations from the above list.		
		(Minimum 6 mixtures)		
	2	Open ended experiments—Physical chemistry experiments.	5	
		(Any one experiment)		
		Suggestions		
		Determination of Physical Constants [Determination of		
		colligative properties, Determination of viscosity of a		
		binary liquid solution (Glycerol-water system)		
		Refractometry experiments etc]		
L	l .			

Reference Books

1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.

- 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
- 4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 5. Anthony R. West, Solid State Chemistry and its Applications, 2nd Edn., Wiley-Blackwell, 2014.
- 6. L. V. Azaroff, Introduction to Solids, Tata McGraw Hill Publishing Company, New Delhi, 1960.
- 7. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
- 8. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
- 9. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 10. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	06							
CO	2				2		1						
1													
CO	2				2		1						
2													
CO	2				2		1						
3													
CO	2				2		1						
4													
CO			2		2		1				1		
5													
CO			2		2		1				1		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	√	V		V
CO2	√	√		√
CO3	V	V		V
CO4	V	V		V
CO5	V	V	V	
CO6	V	V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry				
Course Title	LIQUID STATE,	GASEOUS	STATE AN	D ELECTRO	OCHEMISTRY
Type of Course	MINOR				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours
		per week	per week	per week	
	4	3	-	2	75
Pre-requisites	1. Fundamentals of	Gaseous an	d Liquid sta	tes of matter	
	2. Basic principles	of Electroch	nemistry		
	3. Basic knowledge	e in analytic	al principles		
Course Summary	1. This course	provides the	ne students a	thorough kno	owledge about
	gaseous and liquid states of matter and the continuity between them.				
	2. This course aims to impart an idea about electrochemistry				
	3. This course also aims to develop proficiency in qualitative analysis and				
	to familiari	ze physical o	chemistry ex	periments	

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To apply the postulates of kinetic theory of gases.	Ap	F	Instructor-created exams / Quiz /Assignment
CO2	To describe the properties of liquids.	Е	С	Instructor-created exams / Quiz /Assignment
CO3	To analyse the behaviour of gases and liquids	An	С	Instructor-created exams / Quiz /Assignment
CO4	To illustrate the basic concepts of electrochemistry and its applications	U	С	Instructor-created exams / Quiz /Assignment
CO5	To perform the cation analysis on a provided mixture containing two cations.	An	Р	Lab work

CO6	To enable the students to determine	-	P	Lab work			
	the physical properties (physical						
	constants).						
* - Re	* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)						
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive							
Knowledge (M)							

Module	Unit	Content	Hrs (75)	Marks
I		Liquid State	15	34
	1	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point, – Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	5	 Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor 	2	
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	7	Applications of liquid crystals.	1	
II		Gaseous State - I	10	20
	8	Characteristics of gases	1	
	9	Postulates of kinetic theory of gases	2	
	10	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	11	Collision number – Mean free path – Collision diameter	1	
	12	Viscosity of gases, including their temperature and pressure dependence,	1	

	13	Relation between mean free path and coefficient of viscosity, calculation of σ from η ; variation of viscosity with temperature and pressure.	2	
III		Gaseous State - II	10	22
	14	Behaviour of real gases - Deviation from ideal behaviour - Compressibility factor	3	
	15	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	16	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	17	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) – Relationship between critical constants and van der Waals constants.	2	
IV		Electrochemistry	10	22
	18	Specific conductance, equivalent conductance and molar conductance	2	
	19	Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes	2	
	20	Application of conductance measurements – Conductometric titrations.	1	
	21	Galvanic cells – emf of cell and electrode potentials - IUPAC sign convention – Reference electrodes – Standard Hydrogen electrode – Calomel electrode - Standard electrode potential - Nernst equation	2	
	22	H ₂ -O ₂ fuel cell. Ostwald's dilution law – Buffer solutions – Buffer action [acetic acid/sodium acetate & NH ₄ OH/NH ₄ Cl], applications of buffers.	3	
V		Practical	30	
		nimum of seven experiments must be done. Out of the seven iments, one is to be open-ended which can be selected by the er		
	1	 a) Inorganic Qualitative Analysis (semi – micro analysis) Reactions of Cations: Study of the reactions of the following cations with a view of their identification and 	25	

	 confirmation. NH₄⁺, Pb²⁺, Cu²⁺, Cd²⁺, Al³⁺, Ni²⁺, Co²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, and Mg²⁺ Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures) 		
2	b) Open ended experiments—Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

- 1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
- 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
- 4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 5. S. Glasstone, Introduction to Electrochemistry, East-West Press Pvt. Ltd., New Delhi, 2007.
- 6. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
- 7. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
- 8. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	01	O2	O3	O4	O5	O6							
CO	2				2		1						
1													
CO	2				2		1						
2													
CO	2				2		1						
3													
CO	2				2		1						
4													
CO			2		2		1				1		
5													
CO			2		2		1				1		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	√	√		√
CO3	V	V		V
CO4	V	V		V
CO5	V	V	V	
CO6	V	V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry	B.Sc Chemistry								
Course Title	PHYSICAL PRO	PHYSICAL PROPERTIES OF SOLUTIONS, GASES AND								
	COLLOIDS									
Type of Course	MINOR									
Semester	II									
Academic Level	100 - 199									
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours					
	4	3	-	2	75					
Pre-requisites	1. Fundamentals of	f Gases and	Liquids							
	2. Colloids – Defin	nition and cla	assification							
	3. Basic knowledge	e in analytic	al principles							
Course Summary	1. This course	provide the	students a th	orough know	ledge about various					
	properties of	of gases and	liquids							
	2. This course	e aims to dev	elop an idea	about the app	lications of					
	colloids	1								
	3. This course	also aims to c	levelop profi	ciency in qual	itative analysis and					
	to familiari	ze physical o	chemistry ex	periments						

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	To explain the characteristics of gases.	U	F	Instructor-created exams / Quiz /Assignment
CO 2	To analyse the intermolecular attractions and explain the properties of liquids	An	С	Instructor-created exams / Quiz /Assignment
CO 3	To evaluate the behaviour of solutions	Е	С	Instructor-created exams / Quiz /Assignment
CO 4	To apply the theories of different states of matter and understand their implications.	Ap	F	Instructor-created exams / Quiz /Assignment

CO	To appreciate the importance of	U	С	Instructor-created
5	colloids in chemistry			exams / Quiz
				/Assignment
CO	To perform qualitative analysis	Ap	P	Lab work
6	of cations and determine			
	physical constants			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Hrs (75)	Marks				
I		15	32				
	1 Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.						
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2				
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2				
	4 Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapour pressure – Elevation of boiling point, – Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications						
	5	 Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) –Abnormal molecular mass – Van't Hoff factor 	2				
	6	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1				
	7	Applications of liquid crystals.	1				
II		Properties of Gases	10	22			
	8	Characteristics of gases	1				
	9	Postulates of kinetic theory of gases	2				
	10	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3				

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	11	Collision number – Mean free path – Collision diameter	1	
	12	Viscosity of gases, including their temperature and pressure dependence,	1	
	13	Relation between mean free path and coefficient of viscosity, calculation of σ from η ; variation of viscosity with temperature and pressure.	2	
III		Ideal and Real Gases	10	22
	14	Behaviour of real gases - Deviation from ideal behaviour – Compressibility factor	3	
	15	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	16	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	17	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) – Relationship between critical constants and van der Waals constants.	2	
IV		Colloids	10	22
	18	True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples.	2	
	19	Purification of colloids by electrodialysis and ultrafiltration	2	
	20	Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis.	2	
	21	Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions.	2	
	22	Applications of colloids: Delta formation, medicines,	2	
		emulsification, cleaning action of detergents and soaps.		
V		emulsification, cleaning action of detergents and soaps. Practical	30	

1	 Inorganic Qualitative Analysis (semi – micro analysis) Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH₄⁺, Pb²⁺, Cu²⁺, Cd²⁺, Al³⁺, Ni²⁺, Co²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, and Mg²⁺ Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures) 	25	
2	Open ended experiments—Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5	

Reference Books

- 1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
- 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
- 4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 5. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
- 6. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
- 7. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 8. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	O6							
CO	2				2		1						
1													
CO	2				2		1						
2													
CO	2				2		1						
3													
CO	2				2		1						
4													
CO	2				2		1						
5													
CO			2		2		1				1		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	√	√		√
CO3	V	V		V
CO4	V	V		V
CO5	V	V		V
CO6	V	V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	STATES OF MA	TTER AND	NUCLEAR	CHEMIST	RY	
Type of Course	MINOR					
Semester	II					
Academic Level	100 - 199					
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per week	per week	per week		
	4	3	-	2	75	
Pre-requisites	1. Fundamentals of Gaseous and Liquid states of matter					
	2. Basic idea about nucleons					
	3. Basic knowledge in analytical principles					
Course Summary	1. This course provides the students a thorough knowledge about					
	gaseous and liquid states of matter and the continuity between them.					
	2. This course aims to introduce the applications of nuclear chemistry					
	3. This course also aims to develop proficiency in qualitative analysis and					
	to familiarize physical chemistry experiments					

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of gaseous state and how it relates to thermodynamic systems.	U	F	Instructor-created exams / Quiz /Assignment
CO2	To understand the behaviour of ideal and non-ideal solutions	Е	С	Instructor-created exams / Quiz /Assignment
CO3	To analyse the properties of gases and liquids.	An	С	Instructor-created exams / Quiz /Assignment
CO4	To apply the theories of different states of matter and understand their implications.	Ap	F	Instructor-created exams / Quiz /Assignment

CO5	To describe various processes in	U	С	Instructor-created
	nuclear chemistry			exams / Quiz
				/Assignment
CO6	To analyse cations from a given	An	P	Lab work
	mixture and enable the students to			
	determine the physical constants.			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs (75)	Marks
I		Gaseous State - I	10	22
	1	Characteristics of gases	1	
	2	Postulates of kinetic theory of gases	2	
	3	Maxwell's distribution of molecular velocities – Root mean square, average and most probable velocities.	3	
	4	Collision number – Mean free path – Collision diameter	1	
	5	Viscosity of gases, including their temperature and pressure dependence,	1	
	6	Relation between mean free path and coefficient of viscosity, calculation of σ from η ; variation of viscosity with temperature and pressure.	2	
II		Gaseous State - II	10	22
	7	Behaviour of real gases - Deviation from ideal behaviour - Compressibility factor	3	
	8	Causes of deviation from ideal behaviour - van der Waals equation of state (derivation not required) – Expression of van der Waals equation in virial form and calculation of Boyle temperature	4	
	9	PV isotherms of real gases – Continuity of states – Isotherm of van der Waals equation	1	
	10	Critical phenomena (basic idea only) – Critical constants and their determination (derivation not required) –	2	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		Relationship between critical constants and van der Waals constants.		
III		15	32	
	11	Introduction – Definition and characteristics of liquids - Vapour pressure, surface tension and viscosity - Explanation of these properties on the basis of intermolecular attraction.	4	
	12	Kinds of solutions –Solubility of gases in liquids – Henry's law and its applications	2	
	13	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	14	Colligative properties – Qualitative treatment of colligative properties – Relative lowering of vapor pressure – Elevation of boiling point, – Depression in freezing point – Osmotic pressure – Reverse osmosis and its applications	3	
	15	 Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) – Abnormal molecular mass – Van't Hoff factor 	2	
	16	Introduction to liquid crystal phases. Types of liquid crystals: nematic, smectic, cholesteric.	1	
	17	Applications of liquid crystals.	1	
IV		Nuclear Chemistry	10	22
	18	Natural radioactivity – Modes of decay – Group displacement law.	2	
	19	Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy	2	
	10	Isotopes, isobars and isotones with examples. Nuclear fission - Atom bomb - Nuclear fusion - Hydrogen bomb	1	
	21	Nuclear reactors	1	
	22	Application of radioactive isotopes – ¹⁴ C dating, Rock dating, Isotopes as tracers, Radio diagnosis, Radiotherapy. Problems	4	
V		Practical	30	

sever	A minimum of seven experiments must be done. Out of the seven experiments, one is to be open-ended which can be selected by the teacher						
1	 a) Inorganic Qualitative Analysis (semi – micro analysis) Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH₄⁺, Pb²⁺, Cu²⁺, Cd²⁺, Al³⁺, Ni²⁺, Co²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, and Mg²⁺ Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures) 	25					
2	b) Open ended experiments— Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc.]	5					

Reference Books

- 1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
- 2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017 G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 4. 1. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn., New Age International (P) Ltd., New Delhi, 1995
- 5. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
- 6. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
- 7. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 8. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
		02	U3	04		00							
CO	2				2		1						
1													
CO	2				2		1						
2													
CO	2				2		1						
3													
CO	2				2		1						
4													
CO	2				2		1						
5													
CO			2		2		1				1		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	√	√		V
CO3	√	V		V
CO4	V	V		V
CO5	V	V		V
CO6	V	V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	SOLUTIONS AND SURFACE CHEMISTRY							
Type of Course	MINOR							
Semester	II							
Academic Level	100 - 199							
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	4	3	-	2	75			
Pre-requisites	1. Basic idea of sol	lutions						
	2. Colloids – Defin	nition and cla	assification					
	3. Fundamentals of	f surface phe	enomena					
	4. Basic knowledge	e in analytic	al principles					
Course Summary	1. This course	provide the	students a th	orough know	ledge about various			
	properties of	of liquids						
	2. This course	e aims to imp	oart an idea a	bout importar	nce of colloids			
	3. This course aims to develop the concept of adsorption and							
	separation techniques							
	4. This course	also aims to o	develop profi	iciency in qua	litative analysis			
	and to fami	liarize physi	cal chemistr	y experiments	S			

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts and the properties of liquids	U	F	Instructor-created exams / Quiz /Assignment
CO2	To evaluate the importance of colligative properties.	Е	С	Instructor-created exams / Quiz /Assignment
CO3	To differentiate different types of colloids and explain their properties and applications.	U	С	Instructor-created exams / Quiz /Assignment
CO4	To appreciate the importance of surface phenomena in chemistry	U	С	Instructor-created exams / Quiz /Assignment

CO5	To perform the cation analysis on a provided mixture containing two		P	Lab work
	cations.			
CO6	To enable the students to determine the	Ap	P	Lab work
	physical properties (physical constants).			

 $^{*-}Remember\ (R),\ Understand\ (U),\ Apply\ (Ap),\ Analyse\ (An),\ Evaluate\ (E),\ Create\ (C)$

Module	Unit	Content	Hrs	Marks
Ι		Solutions	15	32
	1	Introduction – Definition and characteristics of liquids -	4	
		Vapour pressure, surface tension and viscosity - Explanation		
		of these properties on the basis of intermolecular attraction.		
	2	Kinds of solutions –Solubility of gases in liquids – Henry's law	2	
		and its applications		
	3	Raoult's law – Ideal and non-ideal solutions – Dilute solutions.	2	
	4	Colligative properties – Qualitative treatment of colligative	3	
		properties – Relative lowering of vapour pressure – Elevation		
		of boiling point, – Depression in freezing point – Osmotic		
		pressure – Reverse osmosis and its applications		
	5	- Application of colligative properties in finding molecular	2	
		weights (thermodynamic derivation not needed) – Abnormal		
		molecular mass – Van't Hoff factor		
	6	Introduction to liquid crystal phases. Types of liquid crystals:	1	
		nematic, smectic, cholesteric.	- 1	
	7	Applications of liquid crystals.	1	
II	0	Colloids	10	22
	8	True solution, colloidal solution and suspension. Classification	2	
		of colloids: Lyophilic, lyophobic, macromolecular,		
		multimolecular and associated colloids with examples.		
	9	Purification of colloids by electrodialysis and ultrafiltration	2	
	10	Properties of colloids: Brownian movement – Tyndall effect –	2	
		Electrophoresis.		
	11	Origin of charge and stability of colloids – Coagulation - Hardy	2	
		Schulze rule – Protective colloids - Gold number. Emulsions.		
	12	Applications of colloids: Delta formation, medicines,	2	
		emulsification, cleaning action of detergents and soaps.		
III		Adsorption and Catalysis	10	22
	13	Adsorption, Physical and chemical adsorption, factors affecting	2	
		adsorption.		
	14	Adsorption isotherms: Freundlich and Langmuir isotherms	2	
		(derivation not required) –		
	15	Applications of adsorption.	1	
		11		

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	16	Catalysis: Homogeneous and heterogenous catalysis – Theories of homogenous and heterogenous catalysis	3	
	17	Enzyme catalysis – Michaelis-Menten equation (derivation not required).	2	
IV		Separation Techniques	10	22
	18	Chromatography- Introduction - Adsorption and partition chromatography - Development of chromatogams: frontal, elution and displacement methods	2	
	19	Qualitative and quantitative aspects of principle and applications of column, thin layer, paper and gas chromatography	2	
	20	Rf value – Relative merits of different techniques	2	
	21	Solvent extraction: Classification, principle and efficiency of the technique.	2	
	22	Extraction of metal ions from aqueous solution,	2	
V		Practical	30	
	A min	nimum of seven experiments must be done. Out of the seven		
	experi	iments, one is to be open-ended which can be selected by the		
	teache	er		
	1	Inorganic Qualitative Analysis (semi – micro analysis)	25	
		 Reactions of Cations: Study of the reactions of the following cations with a view of their identification and confirmation. NH₄+, Pb²⁺, Cu²⁺, Cd²⁺, Al³⁺, Ni²⁺, Co²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, and Mg²⁺ Systematic qualitative analysis of a solution containing any two cations from the above list. (Minimum 6 mixtures) 		
	2	Open ended experiments—Physical chemistry experiments. (Any one experiment) Suggestions Determination of Physical Constants [Determination of colligative properties, Determination of viscosity of a binary liquid solution (Glycerol-water system) Refractometry experiments etc]	5	

Reference Books

- 1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
- 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.

- 4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 5. Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- 6. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
- 7. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- 8. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- 9. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Vogel's Textbook of Qualitative Chemical Analysis, 6th Edn., Pearson Education, Noida, 2013.
- 10. V. V. Ramanujam, Inorganic Semi Micro Qualitative Analysis, 3rd Edn., The National Publishing Company, Chennai, 1974.
- 11. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 12. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2				2		1						
CO 2	2				2		1						
CO 3	2				2		1						
CO 4	2				2		1						
CO 5			2		2		1				1		
CO 6			2		2		1				1		

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	√	√		√
CO3	√	V		√
CO4	√	V		V
CO5	√	√	V	V
CO6	√	√	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry						
Course Title	FUNDAMENTALS OF PHYSICAL CHEMISTRY						
Type of Course	MINOR						
Semester	II						
Academic Level	100 - 199						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours		
		per week	per week	per week			
	4	3	-	2	75		
Pre-requisites	1. Fundamentals of	f Thermodyr	namics				
	2. General idea abo	out state of e	quilibrium				
	3. Basic idea about	order of rea	ection				
	4. Basic knowledge	e in analytic	al principles	and structure	of molecules		
Course Summary	1. This course	aims to fan	niliarise the s	tudents with t	the concepts of		
	thermodyna	amics, kineti	cs and photo	chemistry.			
	2. This course	also aims to	impart an io	dea about ioni	ic and phase		
	equilibrium						
	3. This course	also aims to o	develop profi	iciency in ana	lytical tools and to		
	draw molec	cular structui	es using sof	twares			

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts thermodynamic processes	U	F	Instructor- created exams / Quiz /Assignment
CO2	To evaluate the importance of ionic and phase equilibrium.	E	С	Instructor- created exams / Quiz /Assignment
CO3	To analyse the order of different reactions	An	С	Instructor- created exams / Quiz /Assignment
CO4	To appreciate the importance of photochemistry	U	С	Instructor- created exams /

				Quiz /Assignment
CO5	To create structures of different molecules and calculation of different parameters	С	Р	Lab work
CO6	To enable the students to determine the physical properties (physicalconstants).	Ap	Р	Lab work

Module	Unit	Content	Hrs	Marks
I		Thermodynamics	10	22
	1	Definition of thermodynamic terms – System – Surroundings –	1	
		Types of systems,		
	2	First law of Thermodynamics – Internal energy – Significance of	2	
		internal energy change –Enthalpy		
	3	Second law of Thermodynamics – Entropy and spontaneity –	2	
		Statement of second law based on entropy.		
	4	Entropy change in phase transitions (derivation not required) –	2	
		Entropy of fusion, vaporization and sublimation.		
	5	The concept of Gibbs free energy – Physical significance of free	1	
		energy –		
	6	Conditions for equilibrium and spontaneity based on ΔG values	2	
		– Effect of temperature on spontaneity of reaction. Third law of		
		Thermodynamics.		
II		Ionic and Phase Equilibria	10	22
	7	Introduction to acid base theories – pKa, pKb and pH	1	
	8	Buffer solutions Mechanism of buffer action – Buffer index –	2	
		Henderson equation – Applications of buffers		
	9	Hydrolysis of salts of all types - Degree of hydrolysis -	1	
		Hydrolysis constant and its relation with Kw		
	10	Solubility product and common ion effect.	2	
	11	Phases, components and degrees of freedom of a system, criteria	2	
		of phase equilibrium. Gibbs phase Rule		
	12	Phase diagrams of one-component systems – e.g.: water	2	
III		Chemical Kinetics	15	32
	13	The concept of reaction rates. Effect of temperature, pressure,	3	
		catalyst and other factors on reaction rates. Order and		
		molecularity of a reaction.		

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	1.4		~	
	14	Derivation of integrated rate equations for zero, first and second	5	
		order reactions (both for equal and unequal concentrations of		
		reactants).		
	15	Half-life of a reaction. General methods for determination of	2	
		order of a reaction.		
	16	Concept of activation energy and its calculation from Arrhenius	3	
		equation (qualitative treatment only)		
	17	problems	2	
IV		Photochemistry	10	22
	18	Introduction – Difference between thermal and photochemical	3	
		processes – Characteristics of electromagnetic radiation - Beer		
		Lambert's law.		
	19	Laws of photochemistry: Grothus-Draper law and Stark-	1	
		Einstein's law of photochemical equivalence.		
	20	Quantum yield and its explanation with example – Photophysical	3	
		processes: Jablonski diagram – Fluorescence –		
		Phosphorescence.		
	21	Photosensitization, Role of photochemical reactions in	2	
		biochemical processes	_	
	22	Photostationary states – Chemiluminescence	1	
		Thotostationary states Chemitamineseenee	1	
V		Practical	30	
,	A min	nimum of seven experiments must be done. Out of the seven		
		iments, one is to be open-ended which can be selected by the		
	teache	•		
	1	Absorption (and transmittance) measurements of a colourless	25	
	1	and a coloured light absorbing substance in a solution by using	23	
		a spectrophotometer either experimentally or by simulation.		
		For simulation use		
		https://mas-iiith.vlabs.ac.in/exp/uv-visible-		
		spectroscopy/simulation/expt1/mas_expt1.html		
		• Verify Beer Law using a spectrophotometer either		
		experimentally or by simulation.		
		For simulation use		
		https://mas-iiith.vlabs.ac.in/exp/beer-		
		law/simulation/expt4/mas_expt4.html		
		https://mas-iiith.vlabs.ac.in/exp/lambert-		
		law/simulation/expt3/mas_expt3.html		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html • Draw structures of organic molecules using any chemistry		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html • Draw structures of organic molecules using any chemistry structure drawing softwares/websites (any five molecules)		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html • Draw structures of organic molecules using any chemistry structure drawing softwares/websites (any five molecules) Samples:		
		https://mas-iiith.vlabs.ac.in/exp/beer-lambert-law/simulation/expt6/mas_expt6.html • Draw structures of organic molecules using any chemistry structure drawing softwares/websites (any five molecules) Samples: https://molview.org/		

	http://www.kingdraw.cn/en/ https://www.rcsb.org/chemical-sketch • Measure the bond length and bond angle of organic molecules using softwares Samples: https://molview.org/ • Determination of heat of solution (ΔH) of oxalic acid/ benzoic acid from solubility measurement.		
2	 Open ended experiments— Physical chemistry experiments. (Any one experiment) Suggestions Determination of velocity constant for acid hydrolysis of methyl acetate. Determination of velocity constant for the saponification of ethyl acetate. Preparation of buffers and determination of pH values of fruitjuices using pH meter. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium 	5	
	acetate and their mixtures.		

Reference Books

- 1. P. W. Atkins, J. de Paula, Atkin's Physical Chemistry, 8th Edn., Oxford University Press, 2006.
- 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, 46th Edn., Vishal Publishing Company, New Delhi, 2013.
- 3. Kapoor K. L., Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017.
- 4. G. M. Barrow, Physical Chemistry, 5th Edn., Tata McGraw Hill Education, New Delhi, 2006.
- 5. J. Rajaram, J. C. Kuriacose, Chemical Thermodynamics, Pearson Education, New Delhi, 2013.
- 6. K. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004.
- 7. P. L. Soni, O. P. Dharmarha, U. N. Dash, Textbook of Physical Chemistry, 23rd Edn., Sultan Chand & Sons, New Delhi, 2011.
- 8. A. Findlay, Findlay's Practical Physical Chemistry, 9th Edn., John Wiley and Sons, New York, 1972.
- 9. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publications, Meerut, 2008.

Mapping of COs with PSOs and POs

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	06							
CO	2				2		1						
1													
CO	2				2		1						
2													
CO	2				2		1						
3													
CO	2				2		1						
4													
CO			2		2		1				1		
5													
CO			2		2		1				1		
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / Practical exam
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory / Practical Exam	Assignment / Viva	Practical Skill Evaluation	End Semester Examination
CO1	V	V		V
CO2	V	V		V
CO3	V	V		V
CO4	√	V		V
CO5	V	V	V	
CO6	√	V	V	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	BASIC ORGANIC	BASIC ORGANIC CHEMISTRY						
Type of Course	MINOR							
Semester	III							
Academic	200-299							
Level								
Course Details	Credit	Lecture	Tutorial	Practical	Total			
		per week	per week	per week	Hours			
	4	3	-	2	75			
Pre-requisites	1. Fundamental Con	cepts of orga	nic chemistry	y- Nomenclati	ure,			
	Isomerism, Fuctional	l groups, Hor	nologous seri	es				
Course	This course explores	s basics of o	rganic chemi	istry reaction	mechanism,			
Summary	Reactions and me	chanism of	important	functional	groups and			
	stereochemistry							

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	To understand the basic concepts of	U	C	Instructor-created
	reaction mechanisms			exams /
				Assignment
CO2	To realise types of organic reactions	Ap	P	Instructor-created
	and intermediates			exams Assignme
				nt / quizes
CO3	To analyse important application of	An	P	Assignment /
	functional groups			seminar/Internale
				xam
CO4	To understand how different	U	C	Assignment/Semi
	functional groups confer distinct			nar/
	properties and reactivity, influencing			
	the chemical behaviour of molecules			
CO5	To realise the imporantace of	U	С	Assignment/Grou
	stereoisomerism,optical activity and			p Discussion
	chirality/			
CO6	To enable the students to develop	Ap	P	Observation of
	analytical skills in organic qualitative			practical
	analysis.			skill/Viva voce

Module	Unit	Content	Hrs	Marks
I		15	30	
	1	Introduction- Homolysis and Heterolysis with suitable examples. Curley arrow rules. Reagents – Electrophiles, nucleophiles and free radicals	2	
	2	Electron Displacement Effects: Inductive effect, Definition - Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition – Characteristics - +E effect and -E effect - Addition of H+ to ethene and addition of CN-to acetaldehyde.	1	
	4	. Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene,nitrobenzene, Phenol and Aniline	3	
	5	Hyperconjugation effect: Definition – Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	1	
	6	Steric effect	1	
	7	Reaction intermediate: Type ,shape and stability of Carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions- Defintion and one example	2	
II		Chemistry of alkyl halides, Alcohols and phenols	10	23
	9	Akyl halides Preparation of alkyl halides from alkanes and alkenes – Wurtz reaction and Fittig's reaction. SN1 and SN2 reactions of alkyl halides-Mechanism and stereochemistry.	3	
	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only).	2	
	11	Reactions of Alcohols-Substitution, dehydration, oxidation and esterification. Haloform reaction - iodoform test – Luca's test – Chemistry of methanol poisoning, harmful effect of ethanol in human body	3	

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	12	Phenols: Preparation from chlorobenzene. Comparison of	1	
		acidity of phenol, p-nitrophenol and p-methoxyphenol –.		
	13	Preparation and uses of phenolphthalein	1	
III		Chemistry of carbonyl compounds and amines	10	22
	14	Aldehydes & Ketones: Preparation from alcohols – Comparison of reactivity of aldehydes and ketones. Nucleophilic addition reactions-addition of HCN and bisulphite. Clemmension reduction and wolff kishner reduction	3	
	15	Carboxylic Acids: Preparation from Grignard reagent – Decarboxylation – Kolbe electrolysis.	2	
	16	Amines: Preparation from nitro compounds – Hofmann's bromamide reaction – Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline	3	
	17	Diazonium salts :Preparation and synthetic application of benzene diazonium chloride.	1	
	18	Preparation and uses of methyl orange	1	
IV		Stereochemistry	10	23
	19	Stereosiomerism: definition, classification. Geometrical Isomerism: Definition, Condition, Geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid. cis and trans isomerism, E and Z configurations. Methods of distinguishing geometrical isomers using melting point and dipolemoment.	3	
	20	Conformations: Newman projection, Saw-horse projection. Conformations of ethane, n-butane, and cyclohexane. Relative stability and energy diagrams. Conformation of methyl cyclohexane.	3	
	21	Optical Isomerism - Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with one and two chiral-centres-Lactic acid and tartaric acid. Distereoisomers, meso-structures.	3	
	22	Racemic, mixture. Racemisation and resolution	1	
V	PR .	ACTICALS RELATED TO THE MODULE II and III Reactions of Organic Compounds	30 4	
	3	 II. Functional groups test for 1. Phenols -Phenol 2. Amines-Aniline 3. Aldehydes and ketones -benzaldehyde, benzophenone). 4. Carboxylic acid (benzoic acid, cinnamic acid). 5. Carbohydrates (glucose). 6. Amides (benzamide, urea III.Preparation of organic compounds- open ended 	20	

References

- 1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. Kalsi, P. S., Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015
- 4. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
- 5. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 6. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 7. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 8. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.
- 9 . Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2^{nd} Edn., Pearson Education, Noida, 2013

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	ı	1	1	2			1	2	1	
CO 2	2		2	1	ı	1	2			2	1	1	
CO 3	2	ı	2	1	1	2	2			2	1		
CO 4	2	ı	2		2	2	2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar Midterm Exam
- Practical exam (20%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	√	√				V
CO 2	√	✓		>		V
CO 3	√		V			V
CO 4		√	V			V
CO 5		√	V			V
CO 6				√	V	V

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry								
Course Title	BIOORGANIC CHEMISTRY								
Type of Course	MINOR								
Semester	III								
Academic	200-299								
Level									
Course Details	Credit Lecture Tutorial Practical Total								
		per week per week per week Hours							
	4	3	-	2	75				
Pre-requisites	1. Fundamental	-	_	•					
	Nomenclature		_						
	2. Preliminary ideas of carbohydrates and Biomolecules								
Course	This course explores basics of organic chemistry reaction mechanism,								
Summary	Reactions and mecha	anism of imp	ortant function	onal groups, C	Chemistry of				
	Carbohydrates,Biom	olecules and	natural produ	icts					

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO 1	To understand the basic concepts of reaction mechanisms	U	С	Instructor-created exams / Assignment
CO 2	To realise types of organic reactions and intermediates	Ap	Р	Instructor-created exams Assignment /quizes
CO 3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules	U	С	Assignment/Seminar
CO 4	To appreciate the importance of biomolecules in recognizing their central role in life processes	An	Р	Instructor-created exams / Assignment
CO 5	To emphasize how organic chemistry provides a framework for unravelling	U	С	Group work /Assignment/class test

	the complexities of bio molecular structures.			
CO 6	To enable the students to develop analytical skills in organic qualitative analysis	Ap	P	Observation of practical skill/Viva voce

 $^{*-} Remember\ (R),\ Understand\ (U),\ Apply\ (Ap),\ Analyse\ (An),\ Evaluate\ (E),\ Create\ (C)$

I Basic concepts of Organic Chemistry. 1 Introduction- Homolysis and Heterolysis with suitable examples. Curley arrow rules. Reagents – Electrophiles, nucleophiles and free radicals 2 Electron Displacement Effects: Inductive effect, Definition - Characteristics - +I and -I groups. Applications: Acidity of	30
Curley arrow rules. Reagents – Electrophiles, nucleophiles and free radicals 2 Electron Displacement Effects: Inductive effect, Definition - 2	
radicals 2 Electron Displacement Effects: Inductive effect, Definition - 2	
2 Electron Displacement Effects: Inductive effect, Definition - 2	
Characteristics - +I and -I groups Applications: Acidity of	
carboxylic acids-effect of substituents.	
3 Electromeric effect: Definition – Characteristics - +E effect and - 1	
E effect - Addition of H+ to ethene and addition of CN- to	
acetaldehyde.	
4 . Mesomeric effect: Definition, Characteristics - +M and -M 3	
groups. Applications: Comparison of electron density in	
benzene, nitrobenzene, Phenol and Aniline	
5 Hyperconjugation effect: Definition – Characteristics. 1	
Applications: comparison of stability of But-1-ene and But-2-ene.	
6 Steric effect 1	
7 Reaction intermediate: Type , shape and stability of Carbocations, 3	
carbanions and free radicals.	
8 Types of organic reactions: Addition, Elimination, Substitution, 2	
Rearrangement and Redox reactions-Defintion and one example	
II Chemistry of carbonyl compounds and amines 10	22
9 Aldehydes & Ketones : Preparation from alcohols –Comparison 3	
of reactivity of aldehydes and ketones. Nucleophilic addition	
reactions-addition of HCN and bisulphite.	
10 Carboxylic Acids: Preparation from Grignard reagent – 2	
Decarboxylation – Kolbe	
electrolysis	
11 Amines : Preparation from nitro compounds – Hofmann's 3	
bromamide reaction – Hofmann's carbylamines reaction.	
Basicity: Comparison of basicity of ammonia, methylamine and	
aniline	
12 Diazonium salts :Preparation and synthetic application of benzene 1	
diazonium chloride	

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	13	Preparation and uses of methyl orange	1	
III		Carbohydrates	10	23
	14	Classification- Monosaccharides, oligosaccharides, and	2	
		polysaccharides, Aldose and Ketose, reducing and nonreducing		
		sugars		
	15	Cyclic structure of Ribose, Deoxy ribose. glucose and fructose.	2	
	16	D and L forms of glyceraldehyde, Glucose - manufacture of	2	
		glucose from starch, physical properties, uses, Structure of D and		
		L glucose		
	17	Analytical test for glucose - effect of heating, effect of conc	1	
		sulphuric acid, Fehling's test, Tollens test, Molisches test.		
	18	Fructose- preparation from cane sugar, properties. Sucrose -	3	
		manufacture of sucrose from sugar cane juice. Starch and		
		cellulose - physical properties, structure (Basic ideas only)		
IV		Proteins and Nucleic acids	10	23
- 1	19	Amino acids – Classification – Structure of amino acids –	3	
		Zwitter ion formation – Isoelectric point. Peptide		
		linkage,polypeptides and proteins. Primary ,secondary and		
		tertiary structure of proteins. Denaturation of proteins. Tests for		
		proteins: Xanthoprotein test, Biuret test and Ninhydrin test.		
		proteins raminoprotein test, and a time raming dain test.		
	20	Enzymes, characteristics and examples	1	
	21	Nucleic acids: Introduction, constituents of nucleic acids –	3	
		nitrogenous bases, nucleosides and nucleotides. Double helical		
		structure of DNA. Difference between DNA & RNA – DNA		
		finger printing and its applications		
	22	Lipids: Classification-Fats and oils. Biological functions of lipids.	3	
		Steroids :classification.Structure and biological functions of		
		cholesterol,testosteroneand		
		progestron.Elementary ideaof HDL and LDL		
V		PRACTICALS RELATED TO THE MODULE II and III	30	
	1	Reactions of Organic Compounds	4	
	2	II. Functional groups test for	20	
		1. Phenols -Phenol	20	
		2. Amines-Aniline		
		3. Aldehydes and ketones -benzaldehyde, benzophenone).		
		4. Carboxylic acid (benzoic acid, cinnamic acid).		
		5. Carbohydrates (glucose).		
		6. Amides (benzamide, urea		
	3	III.Preparation of organic compounds-open ended	6	
		in.i reparation of organic compounds-open ended		

References

- 1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
- 4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 6. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 7. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.
- 8 . Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2^{nd} Edn., Pearson Education, Noida, 2013

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	ı	2	-	1	1	2			1	2	1	
CO 2	2		2	-	1	1	2			2	1	1	
CO 3	2	1	2	1	2	2	2			2	1		
CO 4	2	1			2		2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	V	V				V
CO 2	>	>		~		V
CO 3	~		V			V
CO 4		√				V
CO 5		√	V			V
CO 6				√	V	V

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	ORGANIC AND PI	HYTOCHEN	MISTRY			
Type of Course	MINOR					
Semester	III					
Academic	200-299					
Level						
Course Details	Credit	Lecture	Tutorial	Practical	Total	
		per week	per week	per week	Hours	
	4	3	-	2	75	
Pre-requisites	1. Basic concepts of	Organic Che	mistry			
	2. Basic concepts of	Biomolecule	S			
Course	This course ensure	students to	acquire a pi	rofound unde	rstanding of	
Summary	Organic Chemistry by emphasizing fundamental reactions and concepts,					
	and to explore the	importance of	of Organic C	Chemistry in	the study of	
	biomolecules.					

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts of reaction mechanisms through the step by step processes involved in chemical reactions	U	С	Instructor-created exams / Assignments
CO2	To recognize the various types of organic reactions and reaction intermediates	Ap	Р	Assignment / seminar/quizes
CO3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules.	U	C	Assignment/Seminar/Class test
CO4	To appreciate the importance of biomolecules in	Ap	Р	Group work /Assignment/class test

	recognizing their central role in life processes.			
CO5	To emphasize how organic chemistry provides a framework for unravelling the complexities of bio molecular structures.	Ap	Р	Group work /Assignment/class test
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	Р	Observation of practical skill/Viva voce

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		Basic concepts of Organic Chemistry	15	30
	1	1		
		Free radicals.		
	2	Electron Displacement Effects: Inductive effect, definition,	2	
		Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.		
	3	Electromeric effect: Definition, Characteristics - +E effect and -E	2	
		effect. Addition of H ⁺ to ethene and addition of CN ⁻ to acetaldehyde.		
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups.	2	
		Applications: Comparison of electron density in benzene,		
		nitrobenzene, phenol and aniline.		
	5	Hyperconjugation effect: Definition, Characteristics. Applications:	2	
		comparison of stability of But-1-ene and But-2-ene.		
	6	Steric effect and its importance in reactivity.	1	
	7	Reaction intermediate: Type, shape and stability of carbocations,	3	
		carbanions and free radicals.		
	8	Types of organic reactions: Addition, Elimination, Substitution,	2	
		Rearrangement and Redox reactions-Definition and example.		
II		Chemistry of Alkyl halides, Alcohols and Phenols	10	23
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes-	3	
		Wurtz		
		reaction and Fittig's reaction. SN¹ and SN² reactions of alkyl		
		halides-Mechanism and stereochemistry.		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit	2	
	wash, recurred spirit, absolute alcohol, denatured spirit, proof spirit		ı
	and namen alaskal		
	and power alcohol		
11	(mention only).	2	
11		3	
	·		
12		1	
12		1	
13		1	
13	reparation and uses of phenorphinatem.	1	
	Chemistry of Carbonyl compounds and Amines	10	22
14	Aldehydes & Ketones: Preparation from alcohols. Comparison of	1	
	reactivity of aldehydes and ketones.		
15	Nucleophilic addition reactions in aldehydes and ketone. Addition	2	
	of HCN and bisulphite. Clemmensen reduction and Wolff Kishner		
	reduction.		
16	Carboxylic Acids: Preparation from Grignard reagent-	2	
	Decarboxylation-Kolbe		
	electrolysis.		
17	Amines: Preparation from nitro compounds-Hofmann's bromamide	3	
	reaction, Hofmann's carbylamines reaction. Basicity: Comparison		
	of basicity of ammonia, methylamine and aniline.		
18	Diazonium salts: Preparation and synthetic application of benzene	2	
	diazonium chloride. Preparation and uses of methyl orange.		
			23
19	Carbohydrates: Classification with examples-cyclic structures of	2	
	glucose and fructose - Applications of carbohydrates.		
20	Proteins: Amino acids- Classification, Zwitter ion formation –	4	
	Peptide linkage – Polypeptides and proteins – Primary, secondary and		
	tertiary structure of proteins – Globular and fibrous proteins –		
	Denaturation of proteins. Enzymes: Characteristics and examples.		
21	Natural products: Alkaloids: Extraction, Classification, Source,	1	
	structure and physiological functions of nicotine, coniine and		
	piperine.		
22	11	3	
	advantages.		
	5		
	Organic Chemistry Practicals	30	
	15 16 17 18 19 20	11 Reactions of alcohols-Substitution, dehydration, oxidation and esterification. Haloform reaction - iodoform test -Luca's test-Chemistry of methanol poisoning, harmful effect of ethanol in human body. 12 Phenols: Preparation from chlorobenzene. Comparison of acidity of phenol, p-nitrophenol and p-methoxyphenol. 13 Preparation and uses of phenolphthalein. Chemistry of Carbonyl compounds and Amines 14 Aldehydes & Ketones: Preparation from alcohols. Comparison of reactivity of aldehydes and ketones. 15 Nucleophilic addition reactions in aldehydes and ketone. Addition of HCN and bisulphite. Clemmensen reduction and Wolff Kishner reduction. 16 Carboxylic Acids: Preparation from Grignard reagent-Decarboxylation-Kolbe electrolysis. 17 Amines: Preparation from nitro compounds-Hofmann's bromamide reaction, Hofmann's carbylamines reaction. Basicity: Comparison of basicity of ammonia, methylamine and aniline. 18 Diazonium salts: Preparation and synthetic application of benzene diazonium chloride. Preparation and uses of methyl orange. Biomolecules 19 Carbohydrates: Classification with examples-cyclic structures of glucose and fructose - Applications of carbohydrates. 20 Proteins: Amino acids- Classification, Zwitter ion formation - Peptide linkage - Polypeptides and proteins - Primary, secondary and tertiary structure of proteins - Globular and fibrous proteins - Denaturation of proteins. Enzymes: Characteristics and examples. 21 Natural products: Alkaloids: Extraction, Classification, Source, structure and physiological functions of nicotine, coniine and piperine. 22 Terpenes: Classification with examples, Isoprene rule - Isolation of essential oils by steam distillation - Uses of lemongrass oil, eucalyptus oil and sandalwood oil - Source, structure and uses of citral and menthol - Natural rubber - Vulcanization and its	Reactions of alcohols-Substitution, dehydration, oxidation and esterification.

24	Study of the reactions of functional groups from the following list.	20	
	1. Phenols –(phenol)		
	2. Amines-(aniline)		
	3. Aldehydes and Ketones-(benzaldehyde, benzophenone).		
	4. Carboxylic acids (benzoic acid, cinnamic acid).		
	5. Carbohydrates (glucose).		
	6. Amides (benzamide, urea)		
25	Organic Preparations- open ended	6	

References

- 1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. I. L. Finar, Organic Chemistry, Vol. I & II, 5th Edn., Pearson Education, New Delhi, 2013.
- 4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 6. O.P Agarwal, Chemistry of Organic Natural Products, 30 th Edn. Goel Publications, 2006
- 7. S.P Bhutani, Chemistry of Biomolecules, Ane Books Pvt Ltd, 2000
- 8. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 9. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.
- 10. V.K Ahluwalia, S.Dhingra. Comprehensive Practical Organic Chemistry, Universities Press, Hyderabad, 2004.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	ı	2	1	1	ı	2			1	2	1	
CO 2	2		2	ı	1	1	2			2	1	1	
CO 3	2	-	2	-	-	2	2			2	1		

CO 4	2	1	2		2	2	2		2	1	
CO 5	2		ı	1	2	ı	2		2	1	
CO 6	2	-	2		-	2	2	1		2	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	>	✓				V
CO 2	✓	✓		√		V
CO 3	√		~			V
CO 4		~	~			V
CO 5		√	√			V
CO 6				V	√	√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	ORGANIC CHEMI	ISTRY IN D	AILY LIFE			
Type of Course	MINOR					
Semester	3					
Academic	200-299					
Level						
Course Details	Credit	Lecture	Tutorial	Practical	Total	
		per week	per week	per week	Hours	
	4	3	1	2	75	
Pre-requisites	1. Basic concepts of	Organic Che	mistry			
	2. Chemistry and its	importance in	n daily life			
Course	This course ensure students to acquire a profound understanding of					
Summary	Organic Chemistry, emphasizing fundamental reactions, concepts and its					
	implication in daily l	ife.				

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts of reaction mechanisms through the step by step processes involved in chemical reactions	U	C	Instructor-created exams / Assignment
CO2	To recognize the various types of organic reactions and reaction intermediates	Ap	Р	Assignment / seminar/quizzes
CO3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules.	U	С	Assignment/Seminar/Internal exam
CO4	To understand the importance of Chemistry in Daily Life.	Ap	P	Group work /Assignment
CO5	To understand the role of Chemistry in human	Ap	Р	Group work /Assignment

	happiness index and life expectancy.			
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	Р	Observation of practical skill/Viva voce

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Hrs	Marks			
I		Basic concepts of Organic Chemistry	15	30		
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow	1			
		rules. Types of reagents -Electrophiles, Nucleophiles and Free radicals.				
	2	Electron Displacement Effects: Inductive effect, definition,	2			
	Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents. 3 Electromeric effect: Definition, Characteristics - +E effect and -E effect.					
	3	Addition of H ⁺ to ethene and addition of CN ⁻ to acetaldehyde.	_			
	4	Mesomeric effect: Definition, Characteristics - +M and -M groups.	2			
		Applications: Comparison of electron density in benzene, nitrobenzene,				
		phenol and aniline.				
	5	Hyperconjugation effect: Definition, Characteristics. Applications:	2			
		comparison of stability of But-1-ene and But-2-ene.				
	6	Steric effect and its importance in reactivity.	1			
	7	Reaction intermediate: Type, shape and stability of carbocations,	3			
		carbanions and free radicals.				
	8	Types of organic reactions: Addition, Elimination, Substitution,	2			
		Rearrangement and Redox reactions-Definition and example.				
II		Chemistry of Alkyl halides, Alcohols and Phenols	10	22		
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes-	3			
		Wurtz reaction and Fittig's reaction. SN¹ and SN² reactions of alkyl				
		halides-Mechanism and stereochemistry.				
	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol	2			
		from molasses –				
		Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit				
		and power alcohol				
		(mention only).				
	11	Reactions of alcohols-Substitution, dehydration, oxidation and esterification.	3			
		Haloform reaction - iodoform test -Luca's test-Chemistry of methanol				
		poisoning, harmful effect of ethanol in human body.				

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	12	Phenols: Preparation from chlorobenzene. Comparison of acidity of	1	
	12	phenol, p-nitrophenol and p-methoxyphenol.	-	
	13	Preparation and uses of phenolphthalein.	1	
III		Chemistry of Carbonyl compounds and Amines	10	23
	14	Aldehydes & Ketones: Preparation from alcohols. Comparison of	1	
		reactivity of aldehydes and ketones.		
	15	Nucleophilic addition reactions in aldehydes and ketone. Addition of	2	
		HCN and bisulphite. Clemmensen reduction and Wolff Kishner		
		reduction.		
	16	Carboxylic Acids: Preparation from Grignard reagent-	2	
		Decarboxylation-Kolbeelectrolysis.		
	17	Amines: Preparation from nitro compounds-Hofmann's bromamide	3	
		reaction, Hofmann's carbylamines reaction. Basicity: Comparison of		
		basicity of ammonia, methylamine and aniline.		
	18	Diazonium salts: Preparation and synthetic application of benzene	2	
		diazonium chloride. Preparation and uses of methyl orange.		
IV		Chemistry in Daily Life	10	23
	19	Petrochemicals: Name, carbon range and uses of fractions of petroleum	2	
		distillation. Octane number, Cetane number, Flash point. LPG and CNG:		
		Composition and uses.		
	20	Pharmaceuticals: Drug - Chemical name, generic name and trade names	2	
		with examples. Antipyretics, analgesics, antibiotics, antacids, antiseptics		
		(definition and examples, structure not expected).		
	21	Dyes: Definition- Requirements of a dye. Theories of colour and	3	
		chemical constitution. Structure and applications of martius yellow,		
		indigo and alizarin.		
	22	Food: Food additives: Food preservatives, artificial sweeteners and	3	
	22	antioxidants (definition and examples, structures not required)	3	
		Commonly used permitted and non-permitted food colours (structures		
V		not required).	20	
V	22	Organic Chemistry Practicals	30	
	23	General Reactions of Organic Compounds	4	
	24	Study of the reactions of functional groups from the following list.	20	
	2-7	1. Phenols –(phenol)	20	
		2. Amines-(aniline)		
		3. Aldehydes and Ketones-(benzaldehyde, benzophenone).		
		4. Carboxylic acids (benzoic acid, cinnamic acid).		
		5. Carbohydrates (glucose).		
		6. Amides (benzamide, urea)		
	25	Organic Preparations- open ended	6	1
		- 6	_	

References

- 1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
- 4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 6. Jayashree Ghosh. A textbook of Pharmaceutical Chemistry, 3 rd Edn. S Chand and Company Ltd. New Delhi,1999
- 7. B. Srilakshmi. Food Science 5th Edn. New Age publishers, New Delhi, 2010.
- 8. K. Singh. Chemistry in Daily Life. Prentice Hall of India, New Delhi
- 9. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	ı	2	-	1	1	2			1	2	1	
CO 2	2		2	-	-	1	2			2	1	1	
CO 3	2	-	2	-	-	2	2			2	1		
CO 4	2	-	2		2	2	2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Practical exam (20%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	V	√				V
CO 2	>	>		>		V
CO 3		>	V			V
CO 4		√	V			V
CO 5		√	V			√
CO 6				√	V	V

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	ORGANIC CHEMI	ORGANIC CHEMISTRY AND POLYMERS						
Type of Course	MINOR							
Semester	III							
Academic	200-299	200-299						
Level								
Course Details	Credit	Lecture	Tutorial	Practical	Total			
		per week	per week	per week	Hours			
	4	3	1	2	75			
Pre-requisites	1. Basic concepts of	Organic Che	mistry					
	2. Basic concepts of	Polymer Che	emistry					
Course	This course ensure students to acquire a profound understanding of							
Summary	Organic Chemistry a	Organic Chemistry and Polymer Chemistry by emphasizing fundamental						
	reactions and concep	ts.						

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concepts of reaction mechanisms through the step by step processes involved in chemical reactions	Ü	C	Instructor-created exams / Assignments
CO2	To recognize the various types of organic reactions and reaction intermediates	Ap	Р	Assignment / seminar/quizes
CO3	To understand how different functional groups confer distinct properties and reactivity, influencing the chemical behaviour of molecules.	U	С	Assignment/Seminar/Class test
CO4	To understand the significance of polymers in daily life by recognizing their ubiquitous presence in materials and products.	Ap	Р	Group work /Assignment

CO5	To understand the applications of different polymers.	Ap	Р	Group work /Assignment
CO6	To empower students to cultivate analytical skills in organic qualitative/quantitative analysis by emphasizing systematic approaches.	Ap	P	Observation of practical skill/Viva voce

Module	Unit	Content	Hrs	Marks
I		Basic concepts of Organic Chemistry	15	32
	1	Homolytic and heterolytic fission with suitable examples. Curly arrow rules. Types of reagents -Electrophiles,	1	
		Nucleophiles and Free radicals.		
	2	Electron Displacement Effects: Inductive effect, definition, Characteristics - +I and -I groups. Applications: Acidity of carboxylic acids-effect of substituents.	2	
	3	Electromeric effect: Definition, Characteristics - +E effect and -E effect. Addition of H ⁺ to ethene and addition of CN ⁻ to acetaldehyde.	2	
	4 Mesomeric effect: Definition, Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene, phenol and aniline.			
	5	Hyperconjugation effect: Definition, Characteristics. Applications: comparison of stability of But-1-ene and But-2-ene.	2	
	6	Steric effect and its importance in reactivity.	1	
	7	Reaction intermediate: Type, shape and stability of carbocations, carbanions and free radicals.	3	
	8	Types of organic reactions: Addition, Elimination, Substitution, Rearrangement and Redox reactions-Definition and example.	2	
II		Chemistry of Alkyl halides, Alcohols and Phenols	10	22
	9	Akyl halides- Preparation of alkyl halides from alkanes and alkenes- Wurtz reaction and Fittig's reaction. SN¹ and SN² reactions of alkyl halides-Mechanism and stereochemistry.	3	
	10	Alcohols: Preparation from Grignard reagent – Preparation of ethanol from molasses – Wash, rectified spirit, absolute alcohol, denatured spirit,	2	

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

		proof spirit and power alcohol		
		(mention only).		
	11	Reactions of alcohols-Substitution, dehydration, oxidation and esterification.	3	
		Haloform reaction - iodoform test -Luca's test-Chemistry of		
		methanol poisoning, harmful effect of ethanol in human		
		body.		
	12	Phenols: Preparation from chlorobenzene. Comparison of	1	
		acidity of phenol, p-nitrophenol and p-methoxyphenol.		
	13	Preparation and uses of phenolphthalein.	1	
III		Chemistry of Carbonyl compounds and Amines	10	22
	14	Aldehydes & Ketones: Preparation from alcohols.	1	
		Comparison of reactivity of aldehydes and ketones.		
	15	Nucleophilic addition reactions in aldehydes and ketone.	2	
		Addition of HCN and bisulphite. Clemmensen reduction and		
		Wolff Kishner reduction.		
	16	Carboxylic Acids: Preparation from Grignard reagent-	2	
		Decarboxylation-Kolbe		
		electrolysis.		
	17	Amines: Preparation from nitro compounds-Hofmann's	3	
		bromamide reaction, Hofmann's carbylamines reaction.		
		Basicity: Comparison of basicity of ammonia, methylamine		
		and aniline.		
	18	Diazonium salts: Preparation and synthetic application of	2	
		benzene diazonium chloride. Preparation and uses of methyl		
		orange.		
IV		Polymers	10	22
	19	Classification based on origin (natural, semi synthetic and	3	
		synthetic), synthesis (addition and condensation), structure		
		(linear, branched chain and cross linked) and intermolecular		
		forces (elastomers, fibres, thermoplastics and thermosetting		
		polymers).		
	20	Tacticity- Types of Polymerisation. Chain and step growth	2	
		polymerizations- Free radical, ionic and coordination		
		polymerizations.	_	
	21	Structure and applications of synthetic rubbers (Buna-S, Buna-	3	
		N and neoprene), synthetic fibres (Nylon 66, Nylon 6 and		
		dacron), thermoplastics (polyethene, polystyrene, PVC and		
	22	teflon) and thermosetting plastics (bakelite and melmac).	2	
	22	Uses of kevlar, nomex and lexan- Biodegradable polymers	2	
		(PGA, PLA and PHBV) and theirapplications.		
V		Organic Chemistry Practicals	30	
•	23	General Reactions of Organic Compounds	4	
			20	
	24	Study of the reactions of functional groups from the following list.	20	
		1. Phenols –(phenol)		
i	1	1.1 HOHOIS —(PHOHOI)		
		2. Amines-(aniline)		

	 Aldehydes and Ketones-(benzaldehyde, benzophenone). Carboxylic acids (benzoic acid, cinnamic acid). Carbohydrates (glucose). Amides (benzamide, urea) 		
25	Organic Preparations – open ended	6	

References

- 1. Morrison, R. T. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
- 4. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.
- 5. K. S. Tewari, N. K. Vishnoi, S. N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edn., Vikas Publishing House, New Delhi, 2004.
- 6. V.R Gowarikar. Polymer Chemistry, New Age International Pvt Ltd., New Delhi, 2010.
- 7. B.K. Sharma, Polymer Chemistry. Goel Publishing House, Meerut, 1989
- 8. Gowri Sankar Misra. Introductory Polymer Chemistry, New Age International, New Delhi, 1993.
- 9. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Edn., Pearson Education, Noida, 2014.
- 10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4th Edn., Pearson Education, Noida, 2011.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	2	1	1	1	2			1	2	1	
CO 2	2		2	1	ı	1	2			2	1	1	
CO 3	2	-	2	-	-	2	2			2	1		
CO 4	2	-	2		2	2	2			2	1		
CO 5	2		-	-	2	-	2			2	1		
CO 6	2	-	2		-	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar Midterm Exam
- Practical exam (20%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	>	>				V
CO 2	✓	✓		√		V
CO 3			✓			V
CO 4		>	✓			V
CO 5		>	√			√
CO 6				√	V	V

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry	B.Sc Chemistry						
Course Title	APPLIED ORGAN	IC CHEMIS	TRY					
Type of Course	MINOR							
Semester	III							
Academic	200-299							
Level								
Course Details	Credit	Lecture	Tutorial	Practical	Total			
		per week	per week	per week	Hours			
	4	3	1	2	75			
Pre-requisites	isomerism, Fu 2. Basic concept	 Fundamental Concepts of organic chemistry- Nomenclature, isomerism, Fuctional groups, Homologous series Basic concept of organic reaction mechanism, Chemistry of functional group 						
Course	This course explores organic spectroscopy, Chemistry of aromatic							
Summary	hydrocarbons, applic	hydrocarbons, applications like medicinal chemistry and separation						
	techniques							

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To understand the fundamental concept of various spectroscopic techniques	U	С	Exams/Assignment
CO2	To provide a comprehensive understanding of aromatic hydocarbons	U	С	Exams/Assignment/ Group discussion
CO3	To provide basic knowledgeof medicinal chemistry	U	С	Internal test/Seminar
CO4	To understand role of chemistry in human life	An	С	Seminar/Assignment /Qizes
CO5	To provide concepts various separation and purification techniques	U	Р	Exams/Seminar
CO6	To empower students in various separation and purification techniques	Ap	Р	Lab work/Viva

- * Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
- # Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		Organic spectroscopy	15	30
	1	Origin of spectra - Interaction of electromagnetic radiation	2	
		with matter. Different types of energy levels in molecules:		
		Rotational, vibrational and electronic levels.		
	2	Statement of Born-Oppenheimer approximation -	1	
		Fundamental laws of spectroscopy and selection rules		
		(derivations not required).		
	3	UV-Visible Spectroscopy: Basic principle- Beer-Lambert's	2	
		law - Electronic transitions in molecules $(\sigma \rightarrow \sigma^*, n \rightarrow \sigma^*,$		
		$\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$)		
	4	Chromophore and auxochrome - Red shift and blue shift.	1	
	5	λmax calculation for dienes (substituted butadienes)	2	
	6	IR spectroscopy- basic principles, factors affecting	3	
		absorption frequencies, fingerprint and functional group		
		regionCharacteristic stretching frequencies of O-H, N-H,		
		C-H, C=C, C=N and C=O functional groups		
	7	NMR Spectroscopy: Introduction - Chemical shift and spin-	2	
		spin coupling -		
	8	Application in elucidating the structure of ethanol, propanal	2	
		and acetone (detailed study not required).		
II		Chemistry of Aromatic hydrocarbons	12	27
	9	Nomenclature and isomerism in substituted benzene.	2	
		Structure and stability of benzene: Kekule, resonance and		
		molecular orbital description.		
	10	Mechanism of aromatic electrophilic substitution:	3	
		Halogenation, nitration, sulphonation and Friedel-Craft's		
		reactions		
	11	Orientating effect of common substituents in aromatic	2	
		electrophilic substitution		
	12	Aromaticity and Huckel's rule	2	
	13	Application to benzenoid (benzene, naphthalene and	3	
		anthracene) and nonbenzenoid (pyrrole, pyridine and indol)		
		aromatic compounds.		
i		-	i	

III		Medicinal Chemistry	10	23
	14	Drug: Chemical name, generic name and trade names with examples	2	
	15	Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only).	2	
	16	Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics(definition and examples).	3	
	17	tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).	2	
	18	Synthesis of aspirin and Paracetamol	1	
IV		Purification and Characterization Techniques	8	18
	19	Distillation- Simple, fractional, steam and vacuum distillations	2	
	20	recrystalisation, sublimation, solvent extraction	2	
	21	Chromatography, stationary phase, mobile phase, Rf values	2	
	22	TLC, Column chromatography, HPLC and GC (basic concepts only).		
V	PR	ACTICALS RELATED TO THE MODULE II and III	30	
	1	Introduction to organic lab	4	
	2	 Distillation of Aniline, Limonene (from orange peels) Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol Sublimation of a dicarboxylic acid/Naphthalene Chromatographic separations – (any two) Separation of a mixture of two amino acids paper chromatography. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC) TLC of Spinach 	20	
	3	Open ended 1. Drawing structures using softwares. 2. Column Chromatography 3. Teacher can select preparation of organic compound related to the topics in the theory like synthesis of aspirin, sanitizer, drugs etc	6	

References

 $1.\ .$ Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- 2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
- 3. Organic spectroscopy, William Kemp
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- 5. I. L. Finar, Organic Chemistry, Vol. I, 5th Edn., Pearson Education, New Delhi, 2013.
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- 7. Chemistry for Pharmacy Students: General, Organic and Natural Product Chemistry, Satyajit D. Sarker and Lutfun Nahar, Wiley
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- 9. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edn., Pearson Education, Noida, 2013.
- 10. An Improved Method for the Extraction and Thin-Layer W Chromatography of Chlorophyll a and b from Spinach Hao T. Quach, Robert L. Steeper, and G. William Griffin, J Chem Edn, 2004, 81, 385
- 11. Quinone Synthesis and a Visual Introduction to Column Chromatography: An Undergraduate Experiment Danielle L. Pearson* and Russell R. A. Kitson* J. Chem. Educ. 2022, 99, 3731–3734

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	ı	ı	ı	2	1	2			1	2	1	
CO 2	2		1	1	1	-	2			2	1	1	
CO 3	2	ı		ı	ı	2	2			2	1		
CO 4	2	1			2	1	2			2	1		
CO 5	2		1	1	1	-	2			2	1		
CO 6	2	-	2		1	2	2		1		2		1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / SeminarMidterm Exam
- Practical exam (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignmen t	Seminar/Gr oup Discussion	Quizes/viva	Observation Of practical Skill	End Semester Examinations
CO 1	√	√				V
CO 2	√	√	√			V
CO 3	√		✓			V
CO 4		√	>	>		V
CO 5			√			V
CO 6				V	V	V

VOCATIONAL MINOR COURSES

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	INTRODUCTION TO INDUSTRIAL CHEMISTRY				
Type of Course	VOCATIONAL MI	NOR			
Semester	I				
Academic	100 - 199				
Level					
Course Details	Credit	Lecture	Tutorial	Practical	Total
		per week	per week	per week	Hours
	4	3	-	2	75
Pre-requisites	1. Basic awareness o	n types of in	dustries		
	2. Types of redox rea	actions and ti	trations		
Course	The course explores	various indu	ustries and th	neir scope, in	dustrial
Summary	processes, IPR, and a	nalytical kno	wledge acqu	isition throug	h volumetric
	analysis.				

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Understand the elementary ideas of Cosmetics, Soaps, Detergents, Textiles, Food and Petrochemical industries	U	F	Instructor-created exams / Group Tutorial Work
CO2	Acquire knowledge on elementary concepts of Paints and coatings, Polymers, Fine chemicals and Pharmaceuticals	U	F	Instructor-created exams / Assignments
CO3	Remember the early chemical technologies leading to the Industrial Revolution	R	F	Group Tutorial Work/Seminar
CO4	Analyse various unit processes involved in industry	An	Р	Instructor-created exams / Viva
CO5	Acquire skills in various titrimetric analysis of industrial importance	Ap	Р	Practical Assignment / Observation of Practical Skills
CO6	Understand the basic concepts, and ethics of Intellectual Property Rights	U	С	Instructor-created exams/Group Tutorial Work
* - Ren	nember (R), Understand (U), Apply (Ap),	Analyse (An)), Evaluate (E),	Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		Industrial chemistry: An Overview	9	20
	1	History of industrial chemistry-Social Background: Industrial Revolution, Early Chemical Technologies.	2	
	2	Types of chemical industries – Glass, Cement, Ceramics, Metals, Steel (Elementary idea only)	1	
	3	Paints and coatings, Polymers, Agrochemicals, Fine chemicals, Pharmaceuticals (Elementary idea only)	1	
	4	Cosmetics, Soaps and Detergents, Textiles, Petrochemicals, Food, Spices, Sugar, Brewery (Elementary idea only)	1	
	5	Management of lab chemicals and equipment, Chemical waste management, fire and health safety management	2	
	6	Methods for procuring chemicals and equipment, record keeping, supply requirements, evaluation of supply trends	2	
II		12	26	
	7	Unit process, unit operations, flow diagrams, Energy balance and materials balance, fuels, calorific value	4	
	8	Fluid flow, streamline flow, turbulence flow, viscosity, Newtonian and non-Newtonian fluids	4	
	9	Heat transfer, types of heat exchangers, refrigeration cycles	4	
III		Intellectual Property Rights (IPR)	9	20
	10	Basic concepts, Purpose and Ethics of IPR	1	
	11	Seven Types including – Copyright & trademarks;	2	
	12	Patents, Geographical indications & Plant varieties	1	
	13	Industrial designs, Layout designs of ICs	2	
	14	Basics of patenting, IP filing methods.	3	
		1		

IV		15	32	
	15	Types of industries – Cottage industries, Small and Large scale industries	2	
	16	Fundamentals of entrepreneurship – Types of entrepreneurs, Entrepreneurship and economic growth	2	
	17	Process of starting a business – Search for business ideas, Sources of business idea, Idea processing, Input requirements	2	
	18	Basics of fund management, fundamentals of finance and budgeting.	2	
	19	Business proposals- Basics of product value assessment, evaluation of product quality testing, evaluation for commercialization.	2	
	20	Basics of overall project management, report preparation and presentation	2	
	21	Start-up and Financial support schemes, MSME	2	
	22	Employment Opportunities – Job positions and eligibility requirement	1	
V		Volumetric Estimation II	30	
	1	Iodimetry and Iodometry	5	
		1. Estimation of copper		
		2. Estimation of arsenious oxide		
	2	Complexometric Titrations Using EDTA	10	
		3. Estimation of Zn		
		4. Estimation of Mg		
	3	Industrial applications	15	
		 Estimation of Acetic acid content in commercial vinegar Estimation of Alkali content in Antacid Tablets Determination of hardness of water Estimation of Ascorbic acid in fruit juices 		

- 1. B.K Sharma, Industrial Chemistry, Goel Publications (1983).
- 2. R.K. Das, Industrial Chemistry, Kalyani Publications, New Delhi (1982).
- 3. W.L.Badger and J.T.Bachero, Introduction to Chemical Engineering, Tata McGraw Hill, U.S.A
- 4. W.L.McCabe and J.C.Smith, Unit operations in Chemical Engineering, Tata McGraw Hill N.Y
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Pune Vidyarthi GrihaPrakashan, Pune

- 6. K.A.Gavhane, Unit Operations-II Heat and Mass transfer, Nirali Prakashan.
- 7. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)
- 8. D.A.Skoog, D.M.West and S.R.crouch, Fundamentals of Analytical Chemistry, 8 thEdn., Brooks/Cole

Nelson

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	ı	ı	-	1	2	3	ı	2	-	3	ı	3
CO 2	-	-	-	-	1	2	3	-	2	1	3	1	3
CO 3	-	-	-	-	ı	2	3	1	2	-	3	1	3
CO 4	-	-	-	-	1	2	3	1	2	-	3	1	3
CO 5	-	1	2	-	1	2	3	1	2	1	3	1	3
CO 6	-	-	-	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignme nt	Project Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3		√		✓
CO 4	√	√		✓
CO 5		√	√	
CO 6	✓			✓

${\bf FOUR-YEAR\ UNDERGRADUATE\ PROGRAMME\ (FYUGP)}$

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry					
Course Title	INTRODUCTIO	INTRODUCTION TO POLYMER CHEMISTRY				
Type of Course	VOCATIONAL	MINOR				
Semester	I					
Academic	100-199					
Level						
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours	
		per	per	per week		
		week	week			
	4	3	-	2	75	
	Fundamental know	wledge of c	hemistry p	rinciples and	d terminology.	
Pre-requisites	Understanding of	basic organ	nic chemist	ry concepts.	Familiarity with	
	chemical bonding	and molec	ular structu	re. Proficie	ncy in stoichiometry	
	and reaction mech	nanisms.				
Course	This course provi	ides a com	prehensive	overview o	f polymer chemistry,	
Summary	covering fundam	ental conc	epts, prope	erties, synth	esis techniques, and	
	industrial applic	cations of	polymer	s. Student	s explore polymer	
	classification, pro	perties, pol	ymerizatio	n techniques	s, processing methods,	
	and the character	and the characteristics of various commercial polymers. By the course's				
	conclusion, stude	nts will ha	ave gained	essential ki	nowledge in polymer	
	chemistry and its	practical ap	oplications.			

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Understand various classification of polymers and types of polymerisation methods	U	С	Instructor- created exams / Quiz
CO2	Understand the important characteristics of polymers such as average molecular weight, glass transition temperature, viscoelasticity and degradation.	U	F	Class test /Assignment / Quiz
CO3	Appreciate the importance of processing techniques	U	F	Class test /Assignment / Quiz

CO4	Characterize different commercial			Class test
	polymers and to understand the	U	C	/Assignment
	significance of recycling			/ Quiz
CO5	Develop practical skill in analyzing	Ap	An	viva/
	properties of polymers			practical skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hours	Marks
I	Intro	duction to Polymers	15	32
	1	Polymers and macromolecules, Monomers, Homo	3	
		and hetero polymers, Copolymers.		
	2	Classification based on origin (natural, semi-	3	
		synthetic, and synthetic), Synthesis (addition and		
		condensation), Structure (linear, branched chain, and		
		cross-linked) intermolecular forces.		
	3	Elastomers, Fibers, Thermoplastics, and	3	
		Thermosetting polymers, Tacticity.		
	4	Types of Polymerization: Chain and step growth	4	
		polymerizations, Free radical, Ionic, and		
		Coordination polymerizations with mechanism, and		
		its advantages.		
	5	Ziegler-Natta polymerization (mechanism expected).	1	
	6	Ring-opening & Group transfer polymerization	1	
		(Mechanism not needed).		
II	Prop	erties of Polymers	10	22
	7	Molecular weights of polymers: Average molecular	2	
		weights, Number average, Weight average,		
		Sedimentation average (Method of determination not		
		required).		
	8	Viscosity average molecular weight, Determination of	2	
		viscosity average molecular weight.		
	9	Polydispersity index and Molecular weight	2	
		distribution, Molecular weight and Degree of		
		polymerization.		
	10	Glass transition temperature, Definition, Factors	2	
		affecting Tg, Importance of Tg.		
	11	Viscoelasticity of polymers (Basic concepts only).	1	
	12	Polymer Degradation: Basic idea of thermal, photo,	1	
		and oxidative degradation of polymers.		
III	Polyr	nerisation Techniques	10	22

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	Polymerization Techniques: Bulk, Solution,	5	
	Suspension, Emulsion, Melt, Condensation, and		
	Interfacial polycondensation polymerizations.		
	14 Polymer Processing: Calendering, Rotational	5	
	molding, Compression, Injection molding, Blow		
	molding, and Thermoforming.		
IV	Commercial Ploymers	10	22
	15 Commercial Polymers: Preparation, Structure,	1	
	Properties, and Applications of: Polyolefins (HDPE,		
	LDPE, PP, and PS).		
	16 Vinyl polymers (PVC, PVP, and EVA, Saran),	1	
	Fluoropolymers (Teflon), Acrylic polymers (PAN and		
	PMMA).		
	17 Aliphatic polyamides (nylon 66 and nylon 6),	1	
	Aromatic polyamides (kevlar).		
	18 Polyester (terylene), Polycarbonate (lexan),	2	
	Polyurethanes.		
	19 Resins, Glyptal and Formaldehyde resins (UF, MF,	1	
	and PF).		
	Rubbers (natural rubber - Vulcanization, EPDM, BR,	2	
	SBR, Nitrile rubber, Neoprene, Butyl rubber, and		
	Silicone rubber).		
	21 Conducting polymers, Doping (conduction	1	
	mechanism not required).		
	Pollution due to plastics, Recycling of plastics, Plastic	1	
	identification code.		
V	Practicals	30	
	Any Five of the following.		
	1. Identify everyday plastics by their physical properties		
	2. Determination of density of polymers		
	3. Effect of liquid on rubber		
	4. Determine glass and filler content		
	5. Determination of total solid content of latex		
	6. Determination of dry rubber content of latex		
	7. Determination of alkalinity of latex		
	8. Determination of KOH number		
1			
	Teacher can suggest determination of other properties of		

References:

1. Billmeyer Jr., F. W. (2007). Textbook of Polymer Science. John Wiley and Sons, New

- Delhi.
- 2. Gowarikar, V. R. (2010). *Polymer Chemistry*. New Age International Pvt. Ltd., New Delhi.
- 3. Sharma, B. K. (1989). Polymer Chemistry. Goel Publishing House, Meerut.
- 4. Arora, M. G., Singh, M., & Yadav, M. S. (1989). *Polymer Chemistry, 2nd Revised Edn.* Anmolpublications Private Ltd., New Delhi.
- 5. Saunders, K. J. (1988). *Organic Polymer Chemistry, 2nd Edn.* Chapman and Hall, London.
- 6. Stevens, M. P. (1998). *Polymer Chemistry: An Introduction, 3rd Edn.* Oxford University Press, USA.
- 7. Misra, G. S. (1993). *Introductory Polymer Chemistry*. New Age International, New Delhi.
- 8. Bhatnagar, M. S. (2014). *Polymer Chemistry*. S Chand and Company Pvt. Ltd., New Delhi (Reprint).

Further reading:

- 1. Seymour, R. B., & Carraher, C. E. (1981). *Polymer Chemistry: An Introduction*. Marcel Dekker, Inc. New York.
- 2. Odian, G. (2004). Principles of Polymerization, 4th Edn. Wiley.
- 3. Ghosh, P. (1991). *Polymer Science & Technology*. Tata McGraw-Hill Education.
- 4. Lenz, R. W. (1967). *Organic Chemistry of Synthetic High Polymers*. Interscience Publishers, New York.
- 5. Stevens, M. P. (1998). *Polymer Chemistry: An Introduction, 3rd Edn.* Oxford University Press.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	-	1	-	1	2	-	-	-	1	1	1
CO 2	2	1	1	1	2	2	2	1	1	ı	1	ı	2
CO 3	1	ı	1	2	2	2	2	1	1	ı	2	1	3
CO 4	2	1	1	3	2	3	3	ı	1	1	2	3	3
CO 5	1	-	2	1	-	1	2	-	2	-	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

<u>5 01 008 0</u>	O Assessment	itabiles.		
	Internal Exam	Assignme nt/seminar /viva	Practical skill Evaluation	End Semester Examinations
CO 1	√			√
CO 2	√	√		√
CO 3	√	√		√
CO 4	√	√		√
CO 5		√	✓	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry									
Course Title	PERSPECTIVES OF INDUSTRIAL CHEMISTRY									
Type of Course	VOCATIONAL MINOR									
Semester	II									
Academic	100 - 199									
Level										
Course Details	Credit	Lecture	Tutorial	Practical	Total					
		per week	per week	per week	Hours					
	4	3	-	2	75					
Pre-requisites	1. Elementary ideas	s of fuel, foo	d, fertilizers,	cleansing age	nts, dyes					
	and cosmetics.	ı: c 1								
	2. Basic understand	ling of volun	netric titration	ns						
Course	This course details	s the proce	esses involv	ed in fuel	production,					
Summary	manufacturing and	chemistry	involved in	cleansing a	gents, dyes,					
	cosmetics and variou	s fertilizers a	nd pesticide i	industries. Th	e course also					
	furnishes practical k	nowledge ab	out the prep	aration of the	e above					
	described products.									

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Learn the composition and refining	U	F	Instructor-
	processes of crude petroleum and			created exams
	petroleum products			/ Group
				Tutorial Work
CO2	Gain insight into non-petroleum fuels	R	F	Instructor-
	and clean fuels, various lubricants and			created exams
	industrial usage of coal			/ Home
				assignments
CO3	Acquire knowledge in food chemistry	U	С	Group Tutorial
	which includes an overview on various			Work/Seminar
	food additives such as food colours,			
	flavours and artificial sweeteners			
CO4	Analyse the composition and	An	P	Instructor-
	functioning of various cleansing			created exams
	agents, dyes and cosmetics			/ Viva
CO5	Analyse the different types of	An	M	Instructor-
	pesticides as insecticides, herbicides,			created exams
	rodenticides and fungicides			/ Assignments

CO6	Gain practical skills in some	Ap	P	Practical
	industrially important chemical			Assignment /
	analyses including test for food			Observation of
	adulteration, acid value, ester value			Practical Skills
	and saponification value of oils, TFM			
	of soaps and preparation of some			
	cosmetic products			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks	
I		Fuel Chemistry	9	20	
	1	Review of energy resources (renewable and non-renewable -Clean Energy). Classification of fuels and their calorific value.	2		
	2				
	3	Composition of crude petroleum, Refining and different types of petroleum products and their applications.			
	4	Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking)	1		
	5	Elementary ideas on Non-petroleum fuels (CNG, LNG, bio-gas, fuels derived from biomass), clean fuels (wind, solar, tidal)	2		
	6	Lubricants: Solid and semisolid lubricants, synthetic lubricants	2		
II		Food Chemistry	12	26	
	7	Food additives: Functional food additives, Food colours-permitted and non permitted – adulteration and Toxicology.	3		
	8	Flavours – natural and synthetic – Soft drinks – formulation. Health drinks.	3		
	9	Artificial sweeteners – Artificial ripening of fruits and its side effects.	1		
	10	Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits.	3		
	11	Spices: Introduction, (turmeric, chilli, coriander, pepper, cardamom, cloves), general extraction procedure, applications	2		
III		Cleansing agents, Dyes and Cosmetics	18	39	
	12	Cleansing Agents: Soaps – Hard and soft soaps – Alkali content – TFM – Detergents (classification) – Cleaning action – Advantages and disadvantages of soaps and detergents	3		
	13	Shaving creams-Ingredients and functions, Shampoos – Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos).	2		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

14	Tooth paste: composition and preparation.	1	
15	Dyes: Definition – Requirements of a dye – Theories of colour and	3	
	chemical constitution – Classification based on structure and mode		
	of application to the fabric . Industrial method of dyeing		
16	Cosmetics: Hair dye: Types, chemicals used and its harmful	2	
	effects.		
17	Face and skin creams: Types, ingredients and functions.	3	
	Antiperspirants, sun screen, Face and skin powders, nail polishes,		
	lipsticks, eyebrow pencils and eye liners (ingredients and		
	functions) – Harmful effects of cosmetics		
18	Perfumes: Science of smell, history of fragrance, fragrance	2	
	sources, natural products and aroma chemicals used in fragrances,		
19	Fragrance applications in personal care and household products,	2	
	effects of odours.		
	1		
	Fertilizers and Pesticides	6	13
20	Fertilizers and Pesticides Fertilizers: Essential nutrients for plants – NPK value – Natural	6 2	13
20			13
20	Fertilizers: Essential nutrients for plants – NPK value – Natural		13
	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers	2	13
	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact	2	13
21	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers.	2	13
21	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides	2	13
21	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides	2 2	13
21 22	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides Practical	2 2 30	13
21	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides	2 2	13
21 22	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides Practical	2 2 30	13
21 22 1	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides Practical Test for adulteration in selected food products (5 experiments)	2 2 2 30 15	13
21 22 1	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides Practical Test for adulteration in selected food products (5 experiments) Determination of Acid value, ester value and saponification value	2 2 2 30 15	13
21 22 1 2	Fertilizers: Essential nutrients for plants – NPK value – Natural and synthetic fertilizers Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Biofertilizers. Pesticides: Classification – Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides Practical Test for adulteration in selected food products (5 experiments) Determination of Acid value, ester value and saponification value of oils, TFM of soaps	2 2 2 30 15	13
	15 16 17	 Dyes: Definition – Requirements of a dye – Theories of colour and chemical constitution – Classification based on structure and mode of application to the fabric. Industrial method of dyeing Cosmetics: Hair dye: Types, chemicals used and its harmful effects. Face and skin creams: Types, ingredients and functions. Antiperspirants, sun screen, Face and skin powders, nail polishes, lipsticks, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics Perfumes: Science of smell, history of fragrance, fragrance sources, natural products and aroma chemicals used in fragrances, Fragrance applications in personal care and household products, safety and regulations of fragrance, emotional and psychological 	Dyes: Definition – Requirements of a dye – Theories of colour and chemical constitution – Classification based on structure and mode of application to the fabric. Industrial method of dyeing 16 Cosmetics: Hair dye: Types, chemicals used and its harmful effects. 17 Face and skin creams: Types, ingredients and functions. Antiperspirants, sun screen, Face and skin powders, nail polishes, lipsticks, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics 18 Perfumes: Science of smell, history of fragrance, fragrance sources, natural products and aroma chemicals used in fragrances, 19 Fragrance applications in personal care and household products, safety and regulations of fragrance, emotional and psychological

Books and References:

- 1. B.K. Sharma, Industrial Chemistry, Goel Publications (1983).
- 2. R.K. Das, Industrial Chemistry, Kalyani Publications, New Delhi (1982).
- 3. G. R. Chatwal, Synthetic Drugs, Himalaya Publishing House, Bombay, 1995.
- 4. J.Ghosh, A Textbook of Pharmaceutical Chemistry, S. Chand & Co Ltd., 1997
- 5. B. Sreelakshmi, Food Science, New Age International Pvt. Ltd, New Delhi, 2015
- 6. D. Swern, Bailey's Industrial Oil and Fat Products, Vol. I and II, 4th Edn., John Wiley, 1982.
- 7. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	1	-	-	-	2	3	-	2	-	3	-	3
CO 2	-	ı	1	1	1	2	3	-	2	-	3	2	3
CO 3	-	1	-	-	-	2	3	-	2	-	3	-	3
CO 4	-1	ı	1	ı	1	2	3	-	2	1	3	ı	3
CO 5	-	-	-	-	-	2	3	-	2	1	3	-	3
CO 6	-	-	2	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignme nt	Project Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3		√		√
CO 4	√	√		✓
CO 5	√	√		✓
CO 6	√		√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry								
Course Title	COMMERCIAL POLYMERS								
Type of Course	VOCATIONAL MI	NOR							
Semester	II								
Academic Level	100-199								
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours				
		per week	per week	per week					
	4	3		2	75				
	Concept of polymers	. Use of poly	mers. Knowl	edge on synth	netic polymers and				
Pre-requisites	their application.								
Course Summary	This course is intende	ed to provide	basic knowle	dge about cor	mmercial polymers.				
	It deals with types, to	echniques of	preparation	and character	rization of plastics,				
	rubber and fibre ma	terials. The	applications	of these mate	erials in daily life,				
	engineering and bio	medical field	ls have been	emphasized	. The students are				
	exposed to the prob	olems of pol	ymer waste	management	and the strategies				
	developed to minimiz	ze plastic pol	lution.						

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Understand the basic principles of polymer chemistry, including polymerization mechanisms, molecular structure, and polymer characterization techniques.	U	С	Instructor- created exams / Quiz
CO2	Students should become familiar with the major families of commercial polymers, such as polyethylene, polypropylene, polyvinyl chloride (PVC), polystyrene, polyethylene terephthalate (PET), and others.	R,U	F	Class test /Assignment / Quiz
CO3	Students should gain awareness of the environmental impact of polymers and explore sustainable practices in polymer production, usage, and disposal. They should understand concepts such as biodegradability, recycling, and the development of eco-friendly polymers.	R, U, Ap	F	Class test /Assignment / Quiz

CO4	Students should be able to correlate the molecular structure of thermoplastics with their physical, mechanical, thermal,	R, U, Ap	С	Class test /Assignment /
	electrical, and chemical properties. They			Quiz
	should understand how these properties influence the selection of thermoplastics for			
	specific applications.			
CO5				Class test
	Students should learn about the	R, U	P	/Assignment /
	synthesis methods and curing mechanisms used for thermosetting			Quiz
	polymers, including techniques such as			
	condensation polymerization, addition			
	polymerization, and crosslinking reactions.			
CO6	1000000000			Class test
	Students should be able to classify	R, U	P	/Assignment /
	elastomers based on their chemical			Quiz
	structure, polymerization mechanisms, and properties. They			
	should also learn methods for			
	identifying different types of			
	elastomers			
CO7	Develop practical skill in the preparation of	Ap	P	Viva/
	various types of polymers			Practical Skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hours	Mark
]	INTRODUCTION TO COMMERCIAL	10	22
		POLYMERS		
	1	Types of polymer (Thermoplastics,		
		Thermosetting polymers, Elastomers, Fibers).	1	
	2	Production Methods, Polymerization,		
		Extrusion, Injection Molding, Blow Molding.	4	
	3	Properties and Applications, Mechanical	3	
I		Properties, Thermal Properties, Chemical		
		Resistance, Electrical Properties, Applications.		
	4	Environmental Considerations.	2	
	THER	17 Hrs	36	
II	5	Polyolefins and allied polymers, Vinyl		
		polymers, Styrene and its copolymers.	3	

	6	Acrylics, Polyamides, Polyesters, PU, Fluoropolymers.	3	
	7	Cellulose and its derivatives, Polycarbonates,	2	
	, ,	Polyacetals.	2	
	8	PES, PEI, PEEK, Polyacrylic acid, PVA,	2	
		Polyvinyl Acetals.		
	9	Thermosetting plastics, Phenol Formaldehyde,	2	
		Melamine Formaldehyde.		
	10	Urea Formaldehyde, Epoxy resins, Unsaturated	2	
		polyester.		
	11	Vinyl esters, Cyanate esters.	1	
	12	Furan resins and Silicone polymers.	2	
		ELASTOMERS	8 Hrs	18
	13	Lignins, Cellulose and its derivatives, Chitin,		
		Chitosan, Source, Properties and Applications.	2	
	14	Reclaimed rubber, Reclaiming processes.	1	
III	15	Elastomers, Natural Rubber, Isoprene rubber,		
		Modified forms of NR- butyl rubber, Nitrile	2	
		rubber, Chloroprene Rubber.		
	16	Styrene-Butadiene Rubber, EPDM.	1	
	17	Vulcanization, Rubber chemicals,	2	
		Thermoplastic elastomers.		
		FIBERS	10 Hrs	22
	18	Classification, Sources of fibers, Essential	1	
		properties of textile fibers.		
	19	Sources of cellulose, Sources of cellulosic	2	
		fibers, Sources of synthetic fibers.		
	20	Fibers formation, Synthesis of monomer,	2	
		Polymerization and Formation of polymer,		
		Characteristics of fibers formation		
IV	21	polymers, Drawing.	3	
	21	Fibers structure: Unit cell, Arrangement of chain molecules in the crystallites,	3	
		Formation and arrangement of crystallites		
		in fibers, Chemical methods.		
		·		
	22	Vegetable fibers, Cellulose, Jute, Flax,	2	
		Hemp, Ramie, Sisal, Pineapple, Coir.		
\mathbf{v}	PRAC	TICAL	30	
, ·		Any Five preparations of the following.		
		Preparation of Glyptal resin		
		2. Preparation of phenol formaldehyde		
	1	<u> </u>	I .	1

resin
3. Preparation of urea formaldehyde resin
4. Preparation of aniline formaldehyde
resin
5. Preparation of polyaniline
6. Preparation of Nylon 6,6
7. Preparation of PMMA
8. Preparation of linear polystyrene (free
radical polymerization)
9. Preparation of crosslinked polystyrene (
suspension polymerization)
Teacher can suggest preparation of any
polymers other than mentioned above (Open
ended)

References

- 1. Introduction to Polymers" by Robert J. Young and Peter A. Lovell
- 2. "Handbook of Thermoplastics" edited by Olagoke Olabisi and Kolapo Adewale.
- 3. "Thermoplastic Materials: Properties, Manufacturing Methods, and Applications" by Christopher C. Ibeh
- 4. Thermosetting Polymers: Synthesis, Properties, and Applications" edited by Ulf W. Gedde
- 5. "Thermosets: Structure, Properties, and Applications" edited by Qipeng Guo.
- 6. Introduction to Thermosetting Plastics" by Syed Qutubuddin and Aftab Ahmed
- 7. "Elastomers: Types, Properties and Applications" edited by Aubrey Q. Stokes
- 8. "Rubber Technology Handbook" by Werner Hofmann and Walter Holzwarth
- 9. "Elastomer Technology Handbook" edited by Jiri George Drobny
- 10. Textile Fibre Structure" by M.A. Hearle, W.E. Morton, and B.S. Harwood

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	ı	ı	1	1	1	2	ı	1	ı	1	ı	1
CO 2	2	ı	1	1	2	1	2	ı	1	ı	1	1	1
CO 3	3	1	1	3	1	3	2	1	2	-	2	3	2
CO 4	2	-	1	1	1	2	2	-	2	1	2	2	1

CO 5	1	1	ı	1	1	1	1	ı	1	ı	1	1	1
CO 6	2	1	1	2	1	2	2	1	1	1	1	1	1
CO 7	2	-	2	1	1	1	2	-	1	-	-	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

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Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignm ent/ Seminar/ Viva	Practical skill Evaluation	End Semester Examinations
CO 1	>			✓
CO 2	>	>		✓
CO 3	>	>		✓
CO 4	>	>		✓
CO 5	√	√		√

CO 6	√	>		√
CO 7		✓	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry								
Course Title	INDUSTRIAL POL	INDUSTRIAL POLLUTION AND CONTROL							
Type of Course	VOCATIONAL MI	NOR							
Semester	III								
Academic	200 - 299								
Level									
Course Details	Credit	Lecture	Tutorial	Practical	Total				
		per week	per week	per week	Hours				
	4	3	-	2	75				
Pre-requisites									
Course	The course provides a comprehensive overview of basic concepts of								
Summary	industrial chemistry, Types of chemical industries, various industrial								
	processes, intellectua	ıl property rig	ght and scope	of industrial	chemistry.				

CO	CO Statement	Cognitive	Knowledge	Evaluation Tools
		Level*	Category#	used
CO1	Explain the adverse effects of emissions from chemical industries and guidelines set by	U	С	Seminar presentation /Assignment
	the environmental protection agencies.			
CO2	Understand the causes and effects of air pollution.	Ap	Р	Class test /Quiz /Assignment
CO3	To give an insight to various pollution control measures	An	Р	Seminar Presentation / Instructor created exam
CO4	To familiarise waste water treatment methods	U	С	Instructor- created exams / Home Assignments
CO5	Explain different techniques for municipal solid waste and hazardous waste management	Ap	Р	Assignment /Seminar presentation /Class test

CO6	Gain practical skills in some	Ap	P	Lab work /Viva			
	industrially important chemical			Voce			
	analyses						
* - Re	* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)						
# - Fa	# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)						
Metad	Metacognitive Knowledge (M)						

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks
I		Industrial pollution	9	20
	1	Types of pollution	1	
	2	Types of emissions from chemical industries and	2	
		effects of environment		
	3	Environment legislation	2	
	4	Effluent guidelines and standards	2	
	5	Sources and characteristics of pollutants in fertilizer,	2	
		paper and pulp industry, petroleum and petroleum industry		
II		Air pollution	12	26
	6	Definition, Air quality, standards, emission standards, source and classification of air pollutants.	2	
	7	Major air pollutants – Oxides of carbon, nitrogen and sulphur	2	
	8	Particulates – London smog and photochemical smog	2	
	9	Air pollution control measures – Gravitational settling chamber, fabric filter	2	
	10	wet scrubber, catalytic converters, stacks and chimneys,	2	
		cyclone collectors		
	11	Cottrell electrostatic precipitator, extraction ventilator,	2	
		zoning and green belt.		
III		Water pollution	12	26
	12	Water quality parameters: DO, BOD and COD – Determination of BOD and COD	2	
	13	Toxic metals in water (Pb, Cd and Hg) – Minamata disaster (a brief study). Control of water pollution – Need for the protection of water bodies.	2	
	14	Sewage Treatment: Importance of sewage treatment, broad outline of sewage treatment (preliminary treatment, primary treatment, secondary or biological treatment disinfection	3	
	15	Sewage disposal methods of sewage, natural methods (dilution and land treatment)	3	

	16	miscellaneous treatments (oxidation ponds, aerated		
		lagoons, oxidation ditch, anaerobic lagoons)		
IV		Soil pollution	12	26
	17	Soil pollution: Sources by industrial and urban wastes	2	
	18	Solid waste management - Sources and generation of solid wastes, their characterization, reduce-reuse-recycle paradigm	2	
	19	Chemical composition and classification of solid wastes	2	
	20	methods of disposal –sanitary landfill, secured land fill, incineration, pyrolysis, types of composting	2	
	21	Hospital waste and hazardous waste, rules regarding solid waste management	2	
	22	recycling of waste material, waste minimization technologies.	2	
V		 Water analysis Determination of chemical oxygen demand (COD). Determination of biological oxygen demand (BOD) Estimation of Fluoride, Phosphate, Nitrate, Nitrite and Sulphate Soil analysis Determination of TOC. Analysis of soil Sulphate. Determination of Ca2+ and Mg2+ 	30	

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- 2. Mahajan. S.P., "Pollution Control in Process Industries", Tata-McGraw Hill, New Delhi, 1985.
- 3. Narayana Rao, M. and Datta, A.K., "WasteWater Treatment", 2nd Edition, Oxford and IBH Publications, New Delhi, 2005.
- 4. Swamy, A.V.N., "Industrial Pollution Control and Engineering", Galgotia Publications, Hyderabad, 2005.
- 5. S. K. Banerjee, *Environmental Chemistry*, 2nd Edn., Prentice-Hall of India Pvt. Ltd., New Delhi, 2005.
- 6. A. K. De, Environmental Chemistry, 6th Edn., New Age International
- 7. N. P Cheremisinoff, Handbook of Air Pollution Prevention and Control, 2002.
- 8. M. Senapati, Advanced Engineering Chemistry, 2006.
- 9. K. C. Schifftner, Air Pollution Control Equipment Selection Guide, CRC Press, 2013.

10. K. B. Schnelle, C. A. Brown, *Air Pollution Control Technology Handbook*, CRC Press, 2016

11. A. I. Vogel 'A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis': (Third Ed.) (ELBS)

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	-	-	-	1	1	-	3	-	2	-	3	1	3
CO 2	-	ı	-	1	1	ı	3	-	2	1	3	1	3
CO 3	ı	ı	ı	ı	ı	1	3	ı	2	1	3	1	3
CO 4	ı	ı	ı	ı	ı	1	3	ı	2	ı	3	ı	3
CO 5	-	-	-	-	-	1	3	-	2	-	3	1	3
CO 6	-	-	2	-	-	2	3	-	2	-	3	1	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignme nt	Project Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	✓	√		✓
CO 3		√		√
CO 4	√	√		✓
CO 5		√	√	
CO 6	√			✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry					
Course Title	PLASTICS AND FIBER TECHNOLOGY					
Type of Course	VOCATIONAL MINOR					
Semester	III					
Academic	200-299					
Level						
Course Details	Credit	Lecture	Tutorial	Practical	Total	
		per week	per week	per week	Hours	
	4	3	-	2	75	
Pre-requisites	Foundation course in	polymer che	mistry			
Course	To impart the basic concepts of Mixing and compounding various					
Summary	moulding techniques. Understand about reinforced plastics and fiber					
	technology					

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basics of plastic processing and the role of additives in plastics and Describe the principles and techniques involved in mixing and compounding of plastics	U	С	Class test /Assignment / Quiz
CO2	Explain and describe the principles and processes involved in plastic injection molding	R,U	С	Class test /Assignment / Quiz
CO3	Analyze the principles of calendering, laminating, and 3D printing in plastic processing	An	С	Class test /Assignment / Quiz
CO4	Understand the principles, processes involved and equipment used in	U	С	Class test /Assignment / Quiz

	compression molding, transfer molding, blow molding, rotational molding, and reaction injection molding			
CO5	Identify different types of fibers used in industries including cellulose derivatives, polyolefinic, polyester, polyamide, aramid, carbon, and glass fibers.	A	С	Class test /Assignment / Quiz
CO6	Describe fiber spinning operations and the manufacturing process of various types of cords used in the tire industry	U	С	Class test /Assignment / Quiz
CO7	Develop practical skill in different compounding, dipping and molding techniques	Ap	P	viva/ practical skill

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks			
I			9	25			
	Mix	Mixing and compounding					
	1	1 Introduction to plastic processing, additives for plastics – Fillers,					
		Antioxidants					
	2	Stabilisers, Colourants, Flame retardants	2				
	3	Plasticisers. Mixing and compounding of plastics	2				
	4	Mixing and compounding equipments- Compounding by batch mixer	2				
	5	High speed mixer - Two roll mill - Banbury Mixer - Ribbon blender -	2				
		Planetary mixers					
II		Moulding techniques	18	25			
	6	Plastic injection moulding, different types of injection moulding	1				
		machines,					
	7	details of injection moulding machine, injection moulding of	2				
		thermosets.					

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	8	Extrusion, details of extruders, twin screw extruders, dies, post	2	
		extrusion processing		
	9	Calendaring. Laminating, 3D printing.	4	
	10	Compression moulding: hydraulic presses, press capacity and pressure	1	
		calculations, moulding process.		
	11	Transfer moulding: moulding process and advantages, Blow	4	
		moulding: extrusion and injection blow moulding.		
	12	Rotational moulding: process and equipment.	2	
	13	Reaction injection moulding: introduction, process and advantages.	2	
III		Reinforced plastics	9	24
	14	Reinforced plastics	1	
	15	Processing techniques	2	
	16	Hand lay-up, spray lay up	2	
	17	Filament winding autoclave, Bag moulding	4	
IV		Fiber technology	9	24
	18	Fibers from cellulose and its derivatives	1	
	19	Polyolefinic, polyester, polyamide, aramide	2	
	20	Carbon and glass fibers, Fiber spinning operations	2	
	21	Different types of cords used in tyre industry, definition of denier, tex,	2	
		tenacity		
	22	Different types of twisting, geo textiles	2	
V		PRACTICALS	30	
		Any Five experiments from the following can be done		
		Preparation of dispersions of solid latex compounding		
		2. preparation of emulsions of liquid compounding ingredient		
		3. preparation of latex compounding for household gloves and		
		finger caps		
		4. production of finger caps by dipping process		
		5. production of balloon by dipping process		
		6. practice production of table mat		
		7. Hands on training in production of injection moulded plastic		
		articles 8. Hands on training in production of blow moulded plactic		
		8. Hands on training in production of blow moulded plastic articles		
		9. Hands on training in production of compression moulded		
		plastic articles		

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- 1. C. J. Crawford, *Plastic Engineering*, Pergamon Press, London ,1999.
- 2. D. H. Morton, *Polymer processing*, Chapman and Hall, London, 1989.
- 3. George Mathews, *Polymer mixing technology*, Applied Science Publishers, London, 1982.
- 4. Joel Frados (Ed) *Plastic Engineering* Hand book, Van Nostrand Reinhold Company, New York, 1976.

- 5. Polymer Science and Technology,2nd Edn. Joel Fried, Prentice Hall of India Ltd.
- 6. Text Book of Polymer Science, 3rd Edn. Fred W BillMeyer, JR. Wiley
- 7. Polymer Science, 3rd Edn. VR Gowariker, NV Viswanathan, Jayadev Sreedhar, New Age International Publishers
- 8. Polymer Chemistry, Dr BK Sharma, Goel Publishing House.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3		1	2	1	2	3		2	2			3
CO 2	3		1	-	1	2	3		2	2			3
CO 3	3	1	2	-	1	3	3		3	2			3
CO 4	3	-	2		-	2	3		1	2			2
CO 5	3		2	-	-	2	2		1	1			3
CO 6	3	ı	2		1	2	3		1	2			2
CO 7	3		3			3	3		3	3		2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

ssessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignm ent	Project Evaluation	End Semester Examinations
CO 1	✓	√		✓
CO 2	√	√		✓
CO 3	√	√		√
CO 4	√	√		√
CO 5	√	√		√
CO 6	√	√		√
CO7		√	√	

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry						
Course Title	INDUSTRIAL QUALITY MANAGEMENT						
Type of Course	VOCATIONAL MINOR						
Semester	VIII						
Academic	300 - 399						
Level							
Course Details	Credit	Lecture	Tutorial	Practical	Total		
		per week	per week	per week	Hours		
	4	4	-	-	60		
Pre-requisites	1. Fundamentals of Quality Management: Familiarity with basic quality management concepts, principles, and methodologies can be beneficial. This includes knowledge of quality standards (e.g., ISO 9001), quality improvement techniques (e.g., Six Sigma, Lean), and quality assurance processes. 2. Problem-Solving Skills: Strong problem-solving and critical thinking skills are crucial for identifying quality issues, analyzing root causes, and developing effective solutions.						
Course Summary	To give the students functions and pri management, strate assistance tools, tota resource development	nciples of gic manage Il quality ma	manageme ment proces	nt, administs, quality of technic	ration and management ques, human		

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Foundational understanding of management principles, functions, theories, and organizational structures, enabling the students to apply this knowledge in practical contexts within various types of organizations.	U	С	Instructor-created exams / Quiz /Assignment
CO2	Students equipped with the knowledge and skills to analyze business environments, formulate effective strategies, evaluate strategic options, and implement strategic plans to achieve organizational success and competitive advantage.	An	С	Class test /Assignment /Quiz

CO3	Able the students to apply quality management principles, tools, and standards to improve processes, enhance product/service quality, meet customer expectations, and ensure organizational excellence.	Ap	P	Assignment/ Class test/Seminar presentation
CO4	Enable the students to apply TQM tools and techniques to improve organizational processes, enhance teamwork, foster customer-centric approaches, and understand the strategic role of HRM in achieving organizational goals and objectives.	Ap	P	Assignments /Seminar presentation
CO5	Have a solid understanding of Management Information Systems, their components, functions, and strategic importance in supporting decision-making, enhancing business processes, and enabling digital transformation in organizations.	U	С	Instructor created exams /Assignment /Quiz

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks		
I		Basic Management				
	1	Introduction, Definition and characteristics of management.	1			
	2	Functions of management - Planning, Organising, Staffing,	2			
		Directing, Coordination, Controlling, Motivating, Communication,				
		Decision Making.				
	3	Principles of management – F. W. Taylor, Henry Fayol, Elton	2			
		Mayo.				
	4	Administration and management, Nature of management, levels of	3			
		management, managerial skills, managerial roles.				
	5	Forms of Organization- Line, Line-staff etc. Forms of ownerships	3			
		- Partnership, Proprietorship, Joint stock, Co-operative society,				
		Govt. Sector etc.				
II		Strategic Management	9	18		
	6	Concept and Characteristics of strategic management –Defining	3			
		strategy – Mintzberg's 5P's of strategy – Corporate, Business and				
		Functional Levels of strategy.				
	7	Strategic Management Process.	1			

^{# -} Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	8	Preparing an Environmental Threat and Opportunity Profile (ETOP)	2	
	9	Industry Analysis - Porter's Five Forces Model of competition. BCG Matrix - GE 9 Cell Model -Balanced Scorecard, Generic	3	
		Competitive Strategies: Low cost, Differentiation, Focus.		
III		Quality Management	14	28
	10	Definition of quality, goalpost view of quality, continuous	2	1
		mprovement		
	11	Types of quality – quality of design, conformance and	3	
		performance, phases of quality management, Juran and Deming's		
		view of quality		
	12	Quality Management Assistance Tools: Ishikawa diagram – Pareto	3	
	10	Analysis – Pokka Yoke (Mistake Proofing).	2	_
	13	Quality circles, Total Quality Management (TQM), Barriers to	3	
		TQM, Kaizen, Five S (5S), Six sigma Quality Management		
		Standards – concepts, methodology, principles, applications to manufacturing		
	14	he ISO 9001:2000 Quality Management System Standard-The ISO	3	1
	1.	14001:2004 Environmental Management System Standard- ISO		
		27001:2005		
	15	Information Security Management System	2	=
IV	TQ	M Tools & Techniques and human resource development	14	28
IV	TQ	The seven traditional rules of quality, New management rules	14 2	28
IV		The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process,		28
IV	16 17	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types	2 2	28
IV	16	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements	2	28
IV	16 17 18	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal	2 2 2	28
IV	16 17	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-	2 2	28
IV	16 17 18	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer	2 2 2	28
IV	16 17 18 19	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention	2 2 4	28
IV	16 17 18	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do- Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department	2 2 2	28
IV	16 17 18 19	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention	2 2 4	28
IV	16 17 18 19	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process;	2 2 4	28
	16 17 18 19	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do- Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system.	2 2 4 4	28
V	16 17 18 19 20	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system.	2 2 4	28
	16 17 18 19 20 Open	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do- Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system. Management Information Systems Concept of data and information, characteristics of information,	2 2 4 4	28
	16 17 18 19 20	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system. Management Information Systems Concept of data and information, characteristics of information, types of information. Definition of MIS, Need, Purpose and	2 2 4 4	28
	16 17 18 19 20 Open	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system. Management Information Systems Concept of data and information, characteristics of information, types of information. Definition of MIS, Need, Purpose and Objectives, Contemporary Approaches to MIS, Components of an	2 2 4 4	28
	16 17 18 19 20 Open	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system. Management Information Systems Concept of data and information, characteristics of information, types of information. Definition of MIS, Need, Purpose and	2 2 4 4	28
	16 17 18 19 20 Open	The seven traditional rules of quality, New management rules Benchmarking, reason to bench mark, Benchmarking process, FMEA: stages and types Quality function deployment, TPM- concepts, improvements needed, cost of quality, performance measures and appraisal Team and team work, recognition and rewards, PDSA (Plan-Do-Study-Act) cycle, customer focus-customer orientation, customer satisfaction, customer complaints and customer retention Strategic importance HRM, objectives of HRM, HR department operations, Human Resource Planning - objectives and process; human resource information system. Management Information Systems Concept of data and information, characteristics of information, types of information. Definition of MIS, Need, Purpose and Objectives, Contemporary Approaches to MIS, Components of an information system, need to study information systems,	2 2 4 4	28

commerce, types – B2B, B2C, C2B, C2C etc., Business Process	
Re-engineering (BPR)	

References:

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- 2. L.C.Jhamb, Savitri Jhamb, Industrial Management I, Everest Publishing House.
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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	ı	1	1	1	1	2	3	-	2	-	3	1	3
CO 2	-	ı	-	1	ı	2	3	-	2	1	3	1	3
CO 3	-	1	1	1	1	2	3	-	2	-	3	-	3
CO 4	-	ı	-	1	ı	2	3	-	2	1	3	1	3
CO 5	-	1	-	-	-	2	3	-	2	1	3	1	3
CO 6	-	-	-	-	-	2	3	-	2	-	3	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment / Discussion / Seminar
- Internal Examination
- Practical Examination
- Final Examination (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignme nt	Project Evaluation	End Semester Examinations
CO 1	√	√		✓
CO 2	√	√		✓
CO 3		√		√
CO 4	√	√		✓
CO 5		√	√	
CO 6	√			√

${\bf FOUR-YEAR\ UNDERGRADUATE\ PROGRAMME\ (FYUGP)}$

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry									
Course Title	POLYMERS IN INDUSTRY									
Type of Course	VOCATIONAL MINOR									
Semester	VIII	VIII								
Academic Level	300-399									
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours					
		per week	per week	per week						
	4	4			60					
Pre-requisites										
Course Summary		"Polymers in Industry" offers an in-depth exploration of the wide-ranging applications of polymers across various industrial sectors								

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Students should gain insight into the diverse	R, U, Ap	С	Class test
	range of applications and uses of natural fibers			/Assignmen
	across industries such as textiles, apparel,			t / Quiz
	home furnishings, agriculture, packaging, construction, and craft industries			
CO2	Students will conduct a comparative	Ap,An, E	C,M	Class test
	environmental analysis between natural and	_		/Assignmen
	synthetic fibers and they will evaluate the life			t / Seminar
	cycle environmental impacts of both fiber			
	types			
CO3	Students will become familiar with basic	U	С	Class test
	terminology related to adhesives, including			/Assignmen
	terms such as viscosity, cure time, tack,			t / Quiz
	cohesive strength, adhesive failure, and cohesive failure			
CO4	Students will explore theories of adhesion,	U, Ap	С	Class test
	including mechanical interlocking,			/Assignmen
	electrostatic attraction, diffusion, and			t / seminar
	chemical bonding theories. They will			
	understand how these theories contribute to			

	I	1		
	the understanding of adhesive bonding at the			
	molecular level.			
CO5	Students will develop a comprehensive	U, Ap	C	Class test
	understanding of pigments and paints,			/Assignmen
	including their composition, properties, and			t / seminar
	applications in various industries such as			t / Sellillai
	1			
	coatings, plastics, printing, and cosmetics			
CO6	Develop a comprehensive understanding of	R,U	C	Class test
	food packaging materials, including			/Assignmen
	conventional materials (e.g., plastics, metals,			t / Viva
	glass) and emerging edible and biobased			
	materials. They will learn about the properties,			
	functionalities, and applications of different			
	packaging materials in the food industry			
CO7	Develop a thorough understanding of	R,U,Ap	C	Class test
	polymers used in biomedical applications,			/Assignmen
	including their chemical structures, properties,			t / seminar
	and biocompatibility and students will learn			0, 001111101
	about polymer types such as biodegradable			
	polymers, hydrogels, elastomers, and			
	nanocomposites			
CO8	Students will develop a thorough	R,U,Ap	C,M	Class test
	understanding of the properties of polymers			/Assignmen
	relevant to aerospace applications, including			U
	mechanical properties (e.g., strength, stiffness,			c, Quil
	toughness), thermal properties (e.g., heat			
	resistance, thermal expansion), chemical			
	resistance, and durability in harsh			
	environments (e.g., UV radiation, moisture,			
	space vacuum)			
	mechanical properties (e.g., strength, stiffness, toughness), thermal properties (e.g., heat resistance, thermal expansion), chemical resistance, and durability in harsh environments (e.g., UV radiation, moisture,			t / Quiz

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Mark
I		Polymers in fiber industry	12	24
	1	Harvesting, extraction, processing, and characteristics of	2	
		natural fibers (cotton, wool, silk, jute, flax).		
	2	Application and uses of natural fibers in textiles. Regenerated	2	
		cellulose fibers-viscose,tencel, cellulose acetate and triacetate		
		(Mention only)		
	3	Polyester, nylon, acrylic, polypropylene, polyethylene,	3	
		acetate, Lycra and their manufacturing processes. Properties		
		and advantages of synthetic 2 fibers.		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	4	Comparison with natural fibers in terms of properties and applications. Environmental considerations in synthetic fiber production.	2	
	5	Other fiber forming materials -glass, ceramic, carbon and metal. Innovations in fiber technology. Sustainable practices in textile fibers.	3	
		Polymers in adhesives coating	15	30
	6	Adhesives-adhesive bonding, advantages-adhesive classification basic terminology, theories of adhesion-wettability	2	
	7	Performance of adhesives - shear, peel and cleavage properties, factors affecting adhesive performance	2	
	8	Design of adhesive joints, selection of adhesives. Structural adhesive, types - epoxy, urethane, acrylic, phenolic and high temperature and PVC plastisol types	2	
п	9	Advantages and disadvantages, anaerobic adhesives, cyanoacrylates, hot melt adhesive, pressure sensitive adhesives, silicone adhesives, water based adhesives, inorganic adhesives	2	
	10	Pigments and paints, inorganic pigments & organic pigments, extenders paint preparation factors affecting dispersion, preparation of pigment dispersion	2	
	11	Surface preparation and paint application techniques. Paint properties and their evaluation, mechanism of film formation factors affecting coating properties, methods used for film preparation	3	
	12	Carrier properties, optical properties, ageing properties, rheological properties and adhesion properties of coatings.	2	
		PACKAGING APPLICATIONS	10	22
	13	Edible and biobased food packaging materials, Edible film and coating,	2	
	14	Polysaccharide based coatings, Lipid based coatings, Protein based coating, First, Second and Third biobased packaging materials.	2	
Ш	15	Permeability of thermoplastic polymers, Multilayer films, Processing, Deteriorative reaction in foods, Enzyme reactions, Chemical reactions,	2	
	16	Physical change, Biological change, shelf life of foods, Factors controlling 2 shelf life.	2	
	17	Packaging of dairy products, Packaging of cereals, snack foods and confectionary, Packaging of beverages, Comparison of polymer packaging with paper, metal and glass materials	2	
IV		POLYMERS IN BIOMEDICAL APPLICATION	11	22

	18	Definition of biomedical Polymers and its classification,	2	
		Criteria for the Selection of Biomedical Polymers		
	19	Properties of biomedical Polymers, : Polymers for biomedical applications—Polymers in dentistry	2	
	20	polymers in Tissue adhesives , Dialysis Membrane	2	
	21	Polymers in Blood oxygenators, Bone cement, Prostheses	2	
	22	polymers in Biodegradable sutures, Control drug delivery systems	3	
		POLYMERS IN AEROSPACE APPLICATION	12	
	24	Requirement of polymer characteristics for in space usage, polymers in aerospace applications: thermal blanket, helmet,	4	
v	25	polymers in aerospace applications: Adhesive, Space Suits	3	
	polymers in aerospace applications: Eelectronic applications, structural applications		2	
		Important plastics used in Aerospace industry (Thermosetting polyimide, Polyetheretherketone, Polyamide-imide, Polycholrotrifloroethylene, PTFE	3	

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- 2. Billmeyer, F.W., Textbook of polymer science, Wiley, New Delhi, India, 2007.
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- 5. Cook, J.G., *Handbook of textile fibers natural fibers*, p. 240, Woodhead Publishing, Cambridge, UK, 1984.
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- 7. Yosomiya R, Morimoto K, Nakajima A, Ikada Y, Suzuki T. Adhesionand bonding in composites. 1st ed. New York: Marcel Dekker Inc.;1989.
- 8. R. Sinha, outlines Polymer Technology, Prentice Hall India, 2000.
- 9. P. M Ajayan, L.S Schadler and P. V Braun, nanocomposite Science and Technology, Wiley-VCH GmbH Co.
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11. Thomas D K. Uses of rubber and composites in aerospace. Plast Rubber Int, vol 8, no 2, April 1983, pp 53-57

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	1	2	3	3		2	1	2	2	3
CO 2	2		2	2	1	1	3	1	2	1	2	3	2
CO 3	3	1	2	1	-	-	3					2	2
CO 4	3	1	2	1	-	-	3					1	1
CO 5	3		1	2	ı	ı	3		1		1	2	2
CO 6	3	1	1	2	1	1	3		1		2	2	2
CO 7	3			2	2	3	3		2		2	3	3
CO 8	3			3	2	3	3		2		2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignm ent	Project Evaluation	End Semester Examinations
CO 1	√	√		~
CO 2	√	✓		✓
CO 3	√	√		√
CO 4	√	√		✓
CO 5	√	√		√
CO 6	√	√		√
CO7	√	√		√
CO8	√	√		

SKILL ENHANCEMENT COURSES

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemist	B. Sc. Chemistry								
Course Title	CHEMISTRY	CHEMISTRY IN EVERYDAY LIFE								
Type of Course	SEC									
Semester	V									
Academic	100 - 199									
Level										
Course Details	Credit	Lecture per	Tutorial	Practical	Total Hours					
		week	per week	per week						
	3	3	-	-	45					
Pre-requisites	1. Fundam	ental Chemisti	ry							
	1. Polymer	rs- Natural and	synthetic							
Course	This course ope	ens the the vas	t domain of ap	oplied Chemist	ry for all					
Summary										

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To understand the composition of	U	F	Instructed
	products used in everyday life			created
				exams, quiz
CO2	To create awareness on the safety	An	С	Seminars
	regulations of food products			
CO3	To gain knowledge on beverages	U	С	Assignment
CO4	To develop environmentally friendly	An	P	Observation
	polymers			of practical
				skill
CO5	To apply eco-friendly plastic disposal	Е	P	Exams
	methods			
CO6	To demonstrate efficient energy storage	U	F	Assignment/p
	systems			pt
				presentations

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

[#] - Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	1 Syllabus Unit		IIma	Monka	
Module	Unit	Content	Hrs	Marks	
I	Diary P	10	20		
	1	2			
	2	Analysis of fat content, minerals in milk and butter.	2		
	3	Estimation of added water in milk.	1		
	4	Beverages: Analysis of caffeine in coffee and tea,	2		
	5	Detection of chicory in coffee	1		
	6	Chloral hydrate in toddy,	1		
	7	Determination of methyl alcohol in alcoholic beverages	1		
II		Food additives	10	20	
	8	Food additives – definitions, classification, and function	1		
	9	Antioxidants, Preservatives, Emulsifiers, Stabilizers, sweeteners, thickening agents, chelating agents, curing agents, leavening agents, anti-caking agents, colouring agents	2		
	10	Flavouring agents, stimulants. Functional rule of food additives	2		
	11	Safety and regulations of food additives.	2		
	12	Food allergy and intolerance	2		
	13	Benefits of additives- Side effects of food additives	1		
III		Polymers	10	20	
	14	Basic concept of polymer- classification and characteristics of polymers	2		
	15	Applications of polymers as plastics in electronics, automobile components, medical fields and aerospace materials.	3		
	16	Problems of plastic waste management.	2		
	17	3			
IV		Chemical and Renewable Energy Sources:	6	10	
	18	Principles and applications of primary & secondary batteries and fuel Cells	3		
		I	1	L	

	19	Basics of solar energy	3	
V		Open Ended: (Practical experience may be offered)	9	
		Analysis of milk, beverages		
		Synthesis of a polymer		
		A project on Food labels and the actual contents		
		Review project on solar cells and batteries		

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	-	-	-	-	-	3	-	1	-	1	-
CO 2	2	3	1	1	ı	1	2	1	1	1	ı	2
CO 3	-	-	1	-	-	-	2	-	-	-	-	-
CO 4	-	-	2	3	-	-	2	-	2	-	-	2
CO 5	-	1	-	-	-	-	-	-	-	-	-	2
CO 6	-	-	-	3	-	-	2	-	1	-	-	2

Correlation Levels:

Level	Correlation
1	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignm ent	Project Evaluation	End Semester Examinations	
CO 1	√			✓	
CO 2	√			✓	
CO 3	√			✓	
CO 4		>		✓	
CO 5		√		✓	
CO 6			√		

References

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- 2. Ashtoush Kar. Medicinal Chemistry (Two Colour Edition), New Age International Pvt Ltd, 2022
- 3. Edward Cox Henry, The Chemical analysis of Foods, Hardcover, Hassell Street Press, 2021
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FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemist	B. Sc. Chemistry								
Course Title	CHEMISTRY	CHEMISTRY OF COSMETICS								
Type of Course	SEC									
Semester	V									
Academic	100 - 199									
Level										
Course Details	Credit	Lecture per	Tutorial	Practical	Total Hours					
		week	per week	per week						
	3	3	-	-	45					
Pre-requisites	1. Nomenclatu	re of organic co	ompounds							
	2. Properties of	f emulsifiers, s	urfactants etc							
Course	This course ex	plores applicat	ion of Chemi	stry in the synt	hesis of cosmetic					
Summary	products									

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the importance of Chemistry in the preparation of cosmetics	U	С	Instructor-exams
CO2	Familiarise the chemical ingredients in cosmetics.	U	С	Assignment /Presentation/Quiz
CO3	Recognise the essential oils and its extraction	Ap	С	Seminar Presentation / Group Tutorial Work
CO4	Evaluate the synthesis methods of cosmetic products	Ap	Р	Practical-Synthesis

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Module	Unit	Content	Hrs	Marks
I		Introduction to Cosmetic Chemistry	10	20
	1	Overview of Cosmetic Chemistry- Role of Chemistry in	2	
		Cosmetics-		

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

	2	Cosmetic ingredients-Classification and properties of	2	
		cosmetic ingredients		
	3	Natural and synthetic ingredients-	2	
	4	Active and inactive ingredients is cosmetics	2	
	5	Nomenclature of cosmetic ingredients	4	
II		Cosemetic Ingrediants	10	20
	6	Colours in Cosmetics	2	
	7	Perfumes and fragrance	2	
	8	Surfactants	2	
	10	Polymers and thickners	2	
	11	Cosmetic emulsions	1	
	12	Microbilogical control and preservation of cosmetics	1	
III		Perfumes and fragrance in Cosmetics	8	15
	13	Essential oils and their importance in cosmetic industries	3	
		with reference to Eugenol, Geranial, sandalwood oil,		
		eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmine, Civet		
		one, Mascon		
	14	Essential oils -Peppermint oil, Spearmint oil, Lavender oil,	3	
		Rosemary oil, Lemon oil, Clove oil		
	15	Extraction of essential oils- Distillation, Solvent extraction,	2	
		enfleurage Method		
IV		Preparation of Cosmetic products	8	15
	16	Preparation and uses of – lipsticks and lipbalm	2	
	17	Preparation and uses of shampoo and talcum powder	2	
	18	Preparation and uses of creams-shaving cream, Cold creams,	2	
		creams for dry skin		
	19	Safety Assessment of Ingredients- Regulatory guidelines-	2	
		Ethics and sustainability in cosmetic Chemistry		
V	Op	en Ended Module: Mastering Hashing for Efficient Data	9	
		Handling		
	1	1. Data Collection- of ingredients from labels, different		
		brands		
		2.Preparation of Cosmetic Products- shampoo, lipstick-		
		Evaluating the quality of the synthesised product		
		3. Visiting a cosmetic Industry- Group Activity		

References

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- 3. Handbook Industrial Chemistry by Mohammad Farhat Ali Khan, First edition
- 4. Industrial Chemistry, E. Stocchi: Vol -I, Ellis Horwood Ltd. UK.
- 5. Engineering Chemistry P.C. Jain, M. Jain: Dhanpat Rai & Sons, Delhi

Mapping of COs with PSOs and POs:

••	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	ı	ı	ı	1						
CO 2	2	3	ı	1	ı	1						
CO 3	-	-	1	1	1	-						
CO 4	-	-	2	3	1	-						
CO 5	-	1	-	-	-	-						
CO 6	-	-	-	3	-	-						

Correlation Levels:

Level	Correlation
1	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	√			√
CO 2		√		√
CO 3	√			√
CO 4			√	√

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	ANALYTICAL TECHNIQUES IN WATER QUALITY ASSESSMENT				
Type of Course	SEC				
Semester	VI				
Academic	100-199				
Level					
Course Details	Credit	Lecture	Tutorial	Practical	Total
		per week	per week	per week	Hours
	3	2	-	1	45
Pre-requisites	1. Basic idea on volu	metric Analy	sis		
	2. Knowledge on Wa	ater distributi	on and water	resources	
Course	1. To enable the stud	ents to becor	ne aware of the	he water quali	ty standards
Summary	and to familiarize the methods for analysing water qualities.				
	2. To make them aware of the impact of water pollution and hence reduce				
	water pollution.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the analytical techniques used in chemistry for water quality monitoring	U	C	Instructor-created exams / problem solving
CO2	Demonstrate the instrumental methods used in water quality monitoring	U	P	Instructor- Created exams/assignment
CO3	Enhancing the knowledge on water purification methods	U	С	Presentation- Peer Teaching
CO4	Demonstrate the procedures for the determination of water quality	Ap	Р	Problem solving- Home Assignments
CO5	Acquire skill on the analytical techniques used in water Analysis	Ap	P	Doing practicals

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

^{# -} Factual Knowledge(F) Conceptual Knowledge(C) Procedural Knowledge(P) Metacognitive Knowledge(M)

Module	Unit	Content	Hrs	Marks
I		Analytical techniques in Chemistry	8	15
	1	An introduction to analytical methods in chemistry-concentration terms- Molarity, Molality, Normality, v/v, w/v, ppm and ppb, Dilution of solutions, standard solutions	4	
	2	Principles of Volumetric methods in water Analysis- Acidbase titrations, Redox titrations,	2	
	3	complexometric titration and precipitation titrations	2	
II		Instrumental Methods of Water Analysis	9	18
	4	pH meter, Conductivity meter, Turbibity meter, Flame photometer, Colourimeter,	2	
	5	Atomic absorption spectrophotometer (AAS), GCMS	2	
	6	Ion-selective electrodes, Isotopic analysis	1	
III		Water Purification	9	18
	7	Water resources: ground water and surface water, Importance of water, Water quality- water cycle,	1	
	8	Distribution of water -Water scarcity, Common water quality problems	1	
	9	Potable Water: Pre-treatment, coagulation, filtration, disinfection,	2	
	10	Water storage supply, Demineralization & desalination		
	11	Water softening methods-Lime soda process- Zeolite process, Ion exchange method	2	
	12	Sewage waste water treatment-Primary, Secondary and tertiary treatment & sewage water treatment plants in Kerala	2	
	13	Desalination of brackish water-Electrodialysis-Reverse Osmosis	1	
IV		Determination of Water quality parameters	10	19
	14	Water quality monitoring	1	
	15	Water Quality parameters- Odour, Temperature, Colour, Turbidity, pH, Total Dissolved Solids (TDS), Conductivity-	2	
	16	Experimental methods for the estimation of Alakalinity, Hardness of water	2	
	17	Estimation of anions and cations from dissolved minerals	1	
	18	Experimental methods for the estimation of Biological parameters- DO, BOD, COD, Microbiological parameters,	2	
	19	Water quality standards: drinking water- WHO guidelines- Water quality standards by BIS, IS-10500-2012 on drinking water specification,17482-2020-on drinking water supply management system	2	
IV	Wate	r Quality Assessment (Open Ended)	9	
		ollowing water quality assessment may be through hands on		

1	Determination of -temperature, pH, conductivity-Instrumental Methods		
2	Determination of turbidity using Turbidity meter		
3	Determination of total dissolved solids (TDS)- Gravimetric/Instrumental method		
4	Determination of carbonate and bicarbonate using titration method (Acidimetry & Alkalimetry),		
5	Determination of Ca, Mg, Total hardness -Complexometry		
6	Determination of Ammonia and iron-Colorimetry		
7 Determination of Dissolved Oxygen (DO)- Winkler's Method-Iodometry			
8	Determination of Chloride- Argentometry		

References:

- 1. R. Ramesh & M. Anbu, Chemical methods for Environmental Analysis: Water and Sediment, Madras Macmillan.
- 2. B.K. Sharma, Instrumental methods of chemical analysis, Krishna Publication Media (P) Ltd. Meerut.
- 3. S.S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edition, S. Chand and Sons, New Delhi
- 4. B.K. Sharma and H. Kaur, Environmental Chemistry, Goel Publishing House, Meerut
- 5. Water Pollution- causes, effects and control- P K Goel, New age International

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	ı	ı	ı	1						
CO 2	2	3	1	-	-	-						
CO 3	-	-	1	-	-	-						
CO 4	-	-	2	3	-	-						
CO 5	-	1	-	-	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Assignmenents(20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

•	1 000		it itubiles	<i>y</i>	
		Internal Exam	Assignm ent	Project Evaluation	End Semester Examinations
	CO 1		√		✓
	CO 2	>			√
	CO 3	√			√
	CO 4		√		✓
	CO 5			√	✓

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemistry				
Course Title	SCIENTIFIC COMMUNICATION, PUBLIC OUTREACH AND				
	ENTREPRENEUR	IAL SKILLS	S		
Type of Course	SEC				
Semester	VI				
Academic	100 - 199				
Level					
Course Details	Credit	Lecture	Tutorial	Practical	Total
		per week	per week	per week	Hours
	3	2	-	1	45
Pre-requisites	1. Foundational know	vledge in che	mistry: Fund	amental of ch	emical
	bonding and geometr	y of molecul	es, Concept of	of isomerism,	Elements of
	symmetry of molecul	les 2. Proficie	ency in Engli	sh to compreh	end and
	engage in scientific writing and communication.				
Course	This course equips participants with advanced technical writing skills,				
Summary	effective science con	nmunication	strategies, an	d entrepreneu	rial insights,
	preparing them for di	verse career	pathways in	the field of ch	emistry.

Course Outcomes (CO):

СО	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Recognize the importance of effective scientific communication in academia and in the society.	U	F	Instructor- created exams / Quiz
CO2	Acquire practical skills for the data presentation using 2D and 3D chemical structures and animations.	Ap	Р	Practical Assignment / Observation of Practical Skills
CO3	Create scientific illustrations, diagrams, and video stories for science communication to the public audience.	С	М	Seminar Presentation
CO4	Comprehend the basics of entrepreneurship in science and identify opportunities in chemistry	Ap	С	Instructor- created exams / Assignments / Presentation
CO5	Apply entrepreneurial thinking in the development of research proposals	An	P	Writing assignments
* - Re	emember (R), Understand (U), Apply (A	Ap), Analyse (A	An), Evaluate (E),	Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs	Marks
I		Science Communication to Public	8	15
	1	Importance of effective communication in academia and beyond and different forms of scientific communication	2	
	2	Tailoring Science for Public Audiences and adapting scientific language for non-experts,	2	
	3 Social media strategies for scientists, Science Journalism, Content Writing.			
	4	Interactive Public Presentations	1	
	5	Techniques for effective public speaking	1	
II		Technical skills for Academic Writing	9	18
	6	Structure and organization of scientific articles,	2	
	7	Paper formatting using MS Office, writing chemical equations and formulas, Understanding citation styles, reference management software	3	
	8	AI tools for literature review, content development, editing and data analysis.	2	
	9	Issues in scientific writing (plagiarism, authorship, ghostwriting, reproducible research).	2	
III		Entrepreneurial Skills for Scientists	9	18
	10	Introduction to Entrepreneurship in Science, identifying opportunities for entrepreneurship in chemistry	2	
	11	Basics of intellectual property rights, Understanding the patenting process	4	
	12	Overview of funding sources for entrepreneurial ventures, strategies for successful grant applications	3	
IV		Practical: Technical skills for Academic Writing	10	19
	13	Presentation of data in tables, figures and plots using excel / google sheet and using equations and functions in excel	1	
	14	Drawing 2D chemical structures using ChemSketch or Chemdraw	1	
	15	Creating 3D models of chemical structures for presentations and publications using Avogadro and JMOL; designing 3D molecular structures, measurement of bond length, bond angles and dihedral angles,	2	
	16	Visualizing atomic and molecular orbitals and analyse geometric and conformational isomers using JMOL	2	
	17	Exploring crystal structures, unit cell and symmetry operations in molecules using JMOL	1	
	18	Exploring the structure of protein and nucleic acid using JMOL	1	

	19	Creating scientific illustrations and diagrams (Inkscape, canva), video stories to communicate scientific information (Openshot, Kdenlive),	2	
V		Open Ended: Practical Application and Project Work	9	
	1	Case studies of successful scientific entrepreneurs	3	
	2	Public Communication Simulation: Role-playing scenarios for engaging with the public and media	2	
	3	Entrepreneurial Pitch Practice: Crafting and presenting a pitch for a scientific entrepreneurial idea	2	
	4	Writing and Presenting a Mock Research Proposal: Students develop a proposal integrating academic writing and entrepreneurial concepts	2	

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- 6. Jmol Tutorial: https://wiki.jmol.org/index.php/Jmol_Tutorials
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- 8. Janet R. Morrow, Should You Become a Chemist Entrepreneur? Inorg. Chem. 2021, 60, 23, 17415–17418
- 9. Law Relating to Intellectual Property Rights, V K Ahuja, Lexis Nexis, 2017

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1				2				3				3	3
CO 2				2				3				3	3
CO 3				1				3				2	3
CO 4				2				3				3	3
CO 5				2				3				3	3
CO 6				1				3				3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Assignment (20%)
- Presentation (20%)
- Final Exam (40%)

Mapping of COs to Assessment Rubrics :

COSIC	COS to Assessment Rubi les.								
	Internal Exam	Assignm ent	Presentati on	End Semester Examinations					
CO 1	√			✓					
CO 2		√	✓						
CO 3		√	√						
CO 4	√			✓					
CO 5		√	✓						

VALUE ADDED COURSES

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry							
Course Title	CHEMISTRY OF CONSUMER PRODUCTS							
Type of Course	VALUE ADDED COURSE (VAC)							
Semester	III							
Academic Level	100-199							
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours			
		per week	per week	per week				
	3	3	-	1	45			
	Fundamentals of orga	anic chemistr	y					
Pre-requisites	Foundations of analy	tical chemist	ry					
	This course delves into the scientific principles behind everyday items such as							
	soaps, detergents, shampoos, and cosmetics. Students learn about the chemistry							
Course Summary	of manufacturing, formulation techniques, and quality control procedures.							
Course Building	Topics include how ingredients like linear alkyl benzene and sodium lauryl							
	sulfate are synthesized, as well as the creation of specialized products like anti-							
	dandruff shampoos	and herbal s	oaps. Enviro	onmental imp	act and regulatory			
	compliance are also covered. Through theory and practical lab work, students							
	gain a solid understanding of the chemistry driving these commonly used							
	consumer goods.							

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	Understand the process of making soaps			Instructor-
	from oils and fats, including the	U	C	created exams
	formulation of different types like herbal			/ Quiz
	and medicated soaps.			
CO2	Identify the ingredients and functions used			Class test
	in detergent production, comparing their	U	F	/Assignment /
	effectiveness with traditional soap.			Quiz
CO3	Understand the components in anti-			Class test
	dandruff and herbal shampoo, and their	U	F	/Assignment /
	safety standards.			Quiz

CO4	Analyze cosmetic preparation ingredients			Class test
	and functions to ensure the production of	An	С	/Assignment /
	safe and effective products like face creams			Quiz
	and nail polishes.			
CO5	Evaluate the environmental impact of			Class test
	consumer products, proposing sustainable	Е	С	/Assignment /
	practices to minimize harm.			Quiz
CO6	Analyze the need for innovative solutions			Class test
	to challenges in consumer product	An	F	/Assignment /
	chemistry, fostering creativity and			Quiz
	improvement in the industry.			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs (45)	Marks
		Soaps	9	18
	1	Saponification of oils and fats. Manufacture of soaps.	1	
	2	Formulation of toilet soaps. Different ingredients used and their functions.	2	
	3	Medicated soaps. Herbal soaps. Mechanism of action of soap.	2	
	4	Soft soaps. Shaving soaps and creams.	2	
I	5	ISI specifications of soaps and creams. Testing procedures/limits.	2	
		Detergents	9	18
	6	Types of Detergents. Anionic detergents: Manufacture of LAB (linear alkyl benzene). Sulphonation of LAB – preparation of acid slurry.	1	
II	7	Different ingredients in the formulation of detergent powders and soaps. Liquid detergents. Foam boosters. AOS (Alpha Olefin Sulphonates)	2	
11	8	Cationic detergents: examples. Manufacture and application. Non-ionic detergents: examples. Manufacture of ethylene oxide condensater.	2	
	9	Mechanism of action of detergents. Comparison of soaps and detergents.	2	
	10	Biodegradation – environmental effects. ISI specifications / limits for detergents.	2	
		Shampoos	8	15
Ш	11	Manufacture of SLS and SLES. Ingredients. Functions.	2	
	12	Different kinds of shampoos – anti-dandruff, anti-lice, herbal and baby shampoos.	2	

	13	Hair dye. Manufacture of conditioners. Coco betaines or coco diethanolamides	2	
	14	ISI specifications for shampoos. Testing procedures and limits.	2	
		Cosmetic Preparations	10	19
	15	Face and skin powders. Ingredients, functions. Different types.	2	
	16	Snows and face creams. Chemical ingredients used. Anti perspirants. Sun screen preparations.	2	
IV	17	UV absorbers. Skin bleaching agents. Depilatories. Turmeric and Neem preparations. Vitamin oil.	2	
	18	Nail polishes: nail polish preparation, nail polish removers. Article removers.	2	
	19	Lipsticks, roughes, eyebrow pencils. Ingredients and functions. Hazards of cosmetic preparations. ISI specifications.	2	
		Open Ended: Leading firms, brand names, choosing	9	
	UNI	the right product. Packing regulations. Marketing.		
IV	T- V	Licensing – drug license – legal aspects. GMP – ISO		
		9000/12000 – consumer education. Evaluation of the		
		product – advertisements. Visit to a cosmetic production facility		

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- 2. Kafaro, Wasteless chemical processing, Mir publishers, 1995.
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- 4. Ayaz Mahmood Dar, Cosmetic Chemistry: An Instant Approach. Educreation Publishing, 2011.
- 5. P. K. Chattopadhyay, Modern Technology of Soaps, Detergents & Toiletries (with Formulae & Project Profiles) 4th Revised Edition, NIIR Board publication.

Mapping of COs with PSOs and Pos

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	O6							
CO	1		1			2	1					1	2
1													
CO	1		1			2	1					1	2
2													
CO	1		1			2	1					1	2
3													
CO	1		2			2	1					1	2
4													
CO	1		1			2	1					2	2

5									
CO	1	2	1	2	1			2	2
6									

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory	Assignment / Viva	End Semester Examination
CO1	V	V	V
CO2	V	V	V
CO3	V	V	V
CO4	V	V	V
CO5	V	V	V
CO6	V	V	V

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B.Sc Chemistry	B.Sc Chemistry							
Course Title	SOLID WASTE MAN	SOLID WASTE MANAGEMENT							
Type of Course	VALUE ADDED COURSE (VAC)								
Semester	IV								
Academic Level	100-199								
Course Details	Credit	Lecture	Tutorial	Practical	Total Hours				
		per week	per week	per week					
	3	3	-	-	45				
	Fundamental knowle	dge of chemi	stry						
Pre-requisites	Chemical processes t	hat occur in	the environm	ent, including	those related to				
	pollution								
	Basic understanding	of environme	ental chemisti	ry and the imp	act of solid waste				
	on ecosystems and h	uman health							
	This course provide	es an overvi	ew of solid	waste manag	gement principles,				
	practices, and policies. It covers the generation, collection, transportation, and								
Course Summary	disposal of solid w	aste, with a	a focus on	sustainable w	vaste management				
	strategies. The course includes a discussion of waste management strategies for								
	promoting waste reduction, reuse, and recycling. Through this course, the								
	students can explore	best practices	s for sustainal	ole waste mana	agement, including				
	waste minimization,	source sepa	ration, and th	e global stand	dards for waste				
	management.								

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation
		Level*	Category#	Tools used
CO1	To describe the concept of solid waste and			Instructor-
	its various components.	U	C	created exams
				/ Quiz
CO2	To Explore Solid Waste Collection			Class test
	Systems and to compare different methods	U	F	/Assignment /
	of solid waste collection			Quiz

CO3	To Comprehend waste reduction principles and waste management standards	U	F	Class test /Assignment /
	and waste management standards	ð	1	Quiz
CO4	1 &			Class test
	techniques of solid waste	U	С	/Assignment /
				Quiz
CO5	To understand the basic principles involved			Class test
	in the Land disposal of Solid waste, and its	U	C	/Assignment /
	merits and drawbacks.			Quiz
CO6	To familiarize common solid waste			Lab work
	treatment technologies like composting,	U	F	
	recycling, and incineration			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module	Unit	Content	Hrs	Mark
		Solid waste	9	18
	1	Solid waste: Definition, overview of solid waste		
		management, types of solid wastes	2	
	2	sources of solid wastes, properties of solid wastes,		
		Factors affecting the type and quality of waste	2	
	3	causes of solid waste generation, associated risks of	2	
		solid wastes		
I	4	Physical and chemical composition of municipal solid waste,	2	
	5	hierarchy of waste management options.	1	
		Collection, Transportation, and Processing of Solid	12	23
		waste		
	6	Key components of solid waste management:		
		Generation, storage (containers), collection	1	
	7	Specialized collection programs (hazardous waste, bulky waste) and transportation (human powered, animal powered and motorized)	2	
II	8	Recycling and resource recovery, layout of routes	1	
	9	Methods of handling and processing of solid wastes: separation, screening,	1	
	10	size reduction, densification, baling, cubing, compaction, and pelleting	3	
	11	Waste reduction hierarchy (3R Principle - reduce, reuse, recycle).	2	

	12	Compliance assessment and certification processes, Overview of waste management standards - ISO 14001,	2					
		OHSAS 18001						
		Unit-3: Land disposal of Solid waste	7	14				
	13	Landfilling: Site selection criteria, landfill layout,	2					
		landfill sections,						
	14	2						
III	15	composition and characteristics, generation factors, initial adjustment phase, transition	2					
		phase, acid formation phase, methane formation phase, maturation phase of gases and leachate,						
	16 advantages and disadvantages of Land disposal of							
		Solid waste						
	Unit-	Composting and Thermal treatment	8	15				
	4							
	17	Composting: definition, types, process description,						
		design and operational consideration of aerobic	2					
		composting;						
IV	18	process. Description, design and operational	3					
		consideration of anaerobiccomposting;						
	19	Vermicomposting; Thermal conversion methods:	3					
	19	incineration/combustion, pyrolysis and gasification,	3					
		energy recovery system						
		Open-ended experiments - Suggestions	9					
V	Open	Biomedical and E-waste management, Case study						
	Ended	etc.						

- 1. Gupta O.P, Elements of Solid Hazardous Waste Management, Khanna Book Publishing Co., Delhi Ed. 2018
- 2. Bhide, A. D., Solid Waste Management, Indian National Scientific Documentation Centre, New Delhi.
- 3. George Techobanoglous, Kreith, Frank., Solid Waste, McGraw Hill Publication, New Delhi.
- 4. Sasikumar, K., Solid Waste Management, PHI learning, Delhi.
- 5. Hosetti, B.B., Prospect and Perspectives of Solid Waste Management, New Age International Publisher.

Mapping of COs with PSOs and POs

	PS	PS	PS	PS	PS	PS	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	O1	O2	O3	O4	O5	O6							
CO	1					2	1				2	2	
1													
CO	1					2	1				2	2	
2													
CO	1					2	1				2	2	
3													
CO	1					2	1				2	2	
4													
CO	1					2	1				2	2	
5													
CO	1					2	1				2	2	
6													

Correlation Levels:

Level	Correlation
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory
- Assignments / Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory	Assignment / Viva	End Semester Examination
CO1	V	V	V
CO2	V	V	V
CO3	V	V	V
CO4	V	V	V
CO5	V	V	V
CO6	V	V	V

MULTI-DISCIPLINARY COURSES

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemist	ry					
Course Title	ENVIRONME	ENTAL CHEN	MISTRY				
Type of Course	MDC						
Semester	I						
Academic	100-199						
Level							
Course Details	Credit	Lecture per	Tutorial	Practical	Total Hours		
		week	per week	per week			
	3	3	-	-	45		
Pre-requisites	What is Enviro	nment.					
	Basic idea of e	nvironmental p	ollution.				
Course	This course en	sures that the s	tudents acqui	re a profound	knowledge and		
Summary	understanding of	understanding on environmental pollution and the necessity of controlling					
	environmental	pollution.					

Course Outcomes (CO):

CO	CO Statement	Cognitive	Knowledge	Evaluation
CO1	Acquire the knowledge on	Level* U	Category# C	Tools used Instructor-
	ecosystem.			created exams / Quiz
CO2	Recall the technical/scientific terms involved in pollution.	U	С	Instructor- created exams / Quiz
CO3	Recognize different types of toxic substances that cause environmental pollution.	U	С	Instructor- created exams / Assignment
CO4	Understand the effects of environmental pollution.	U	С	Seminar Presentation / Viva
CO5	Understand various pollution control measures.	U	С	Instructor- created exams / Quiz
CO6	Discuss and report local and global environmental issues based on the knowledge gained throughout the course.	Ap	Р	Group discussion and Seminar presentation/Viv a

- * Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
- # Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs	Mark
		Introduction to Environmental Chemistry	9	18
I	1	Environmental segments-Atmosphere, Hydrosphere, Lithosphere,	2	
		Biosphere		
	2	Interaction between different environmental spheres Concept of	2	
		ecosystem, abiotic and biotic components		
	3	Composition of Air, Water and Soil	2	
	4	Environmental pollution – Concepts and definition – Pollutant,	1	
		contaminant, receptor and sink		
	5	Classification of pollutants – Global, regional, local, persistent and non-	1	
		persistent pollutants.		
	6	Types of pollution	1	
II		Air Pollution	9	18
	7	Tropospheric pollution – Gaseous air pollutants – Hydrocarbons,	2	
		oxides of sulphur, nitrogen and carbon (Elementary idea only)		
	8	Global warming, green house effect, acid rain	1	
	9	Particulates – Smog: London smog and photochemical smog –	2	
	10	stratospheric pollution - depletion of ozone layer, chlorofluorocarbons -	2	
		Automobile pollution.		
	11	Control of air pollution	2	
III		Water Pollution	10	20
	12		1	
		Impurities in water – cause of pollution – natural and anthropogenic –		
		Marine water pollution – Underground water pollution.		
			_	
	13	Source of water pollution – Industrial waste, Municipal waste,	2	
		Agricultural waste, Radioactive waste, Petroleum, Pharmaceutical,		
		heavy metal, pesticides, soaps and detergents.		
		neavy metal, pesticides, soups and detergents.		
	14	Types of water pollutants: Biological agents, physical agents and	2	
	1.	chemical agents – Eutrophication- biomagnification and		
		bioaccumulation.		
	15		3	
		Water quality parameters: DO, BOD, COD, alkalianity, hardness,		
		chloride, fluoride and nitrate. Toxic metals in water and their effects:		
		Cadmium, lead and oil pollution in water.		
	1.0		2	
	16	Water pollution control methods	2	

IV		Soil, Thermal, and Radioactive Pollutions					
	18	Soil pollution: Sources by industrial and urban wastes. Non-degradable, degradable and biodegradable wastes. Hazardous waste.	2				
	19	Pollution due to plastics, pesticides, biomedical waste and <i>e-waste</i> (source, effects and control measures) – Control of soil pollution - Solid waste Management – Open dumping, Landfilling, Incineration, Reuse, reclamation, recycle, composting.	3				
	20	Thermal pollution – definition, sources, harmful effects and prevention.	1				
	21	Radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study).	2				
V		Open Ended Module: Environmental issues	9				
	1	Demonstration of determination of pH, conductivity and TDS, Test for acidity and alkalinity, Test for total hardness, Test for carbonate, bicarbonate, calcium and magnesium.					
	2	Volumetric estimation of the acidity of water sample using virtual lab.					

- 1. A. K. De, *Environmental Chemistry*, 6thEdn., New Age International.
- 2. A. K. Ahluwalia, *Environmental Chemistry*, The Energy and Resources Institute, 2017.
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- 13. D. S. Poornananda (2022), Environmental Journalism: Reporting on Environmental Concerns and Climate Change in India, SAGE Publishing India'
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Mapping of COs with PSOs and POs:

111up	viapping of Cos with 1 Sos and 1 Os.												
	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	-	-	-	1	1	1			2	1		
CO 2	1		1	-	1	1	1			1	1	1	1
CO 3	1	-		1	2	2	1			2	2	1	
CO 4	-	-			1	2	1			1	1	1	1
CO 5	ı		ı	1	2	2	1			1		1	1
CO 6	-	-	-	1	2	2	1			1	1	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate /
	Medium
3	Substantial /
	High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignm ent/viva	Quiz/seminar/ Goupdiscussio n	End Semester Examinations
CO 1	√		√	✓
CO 2	√		√	✓
CO 3	√	√		✓
CO 4		√	√	√
CO 5	√		√	✓
CO 6		√	√	

PROVIDENCE WOMEN'S COLLEGE (AUTONOMOUS)

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

B. Sc. CHEMISTRY

Programme	B. Sc. Chemist	B. Sc. Chemistry					
Course Title	CHEMISTRY	IN DAILY L	IFE				
Type of Course	MDC						
Semester	II						
Academic	100-199						
Level							
Course Details	Credit	Lecture per	Tutorial	Practical	Total Hours		
		week	per week	per week			
	3	3	-	-	45		
Pre-requisites	Role of chemic	als in our life.					
	Basic idea of en	Basic idea of environmental pollution.					
Course	This course ensures that the students acquire a profound knowledge and						
Summary	understanding	on chemicals the	hat are used in	daily life.			

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Know the different chemicals that sustain our life	U	С	Instructor-created exams / Quiz
CO2	Understand the role of chemistry in forensic analysis.	U	С	Instructor-created exams / Seminar
CO3	Understand the application of chemistry in agriculture and need of green methods	U	С	Instructor-created exams /Assignment
CO4	Understand the chemistry of soaps, synthetic detergents and their environmental effects.	U	С	Instructor-created exams / Seminar
CO5	Understand the chemistry of cosmetics and the effect on health.	U	С	Instructor-created exams / Quiz

CO6	Understand the	U	С	Seminar/Viva
	chemistry of drugs, food			
	additives their action and possible side			
	effects			

^{* -} Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

Detailed Syllabus:

Module	Unit	Content	Hrs	Marks		
I		Chemistry in Biological Systems & Forensic Chemistry				
	1	Vitamins and Minerals: Name, source, function and deficiency	2			
		diseases.				
	2	Enzymes - Classifications, characteristics, examples.	1			
	3	Hormones - Sex hormones - example, function. Pheromones.	2			
	4	Brain chemicals and human mood variations	1			
	5	General discussion of poisons with special reference to mode of action	2			
		of cyanide, organophosphates and snake venom.				
	6	Detection of finger print, blood stain, semen, Breath analyzer	2			
	7	Sport doping-Steroids-Anabolic agents, Stimulants, Diuretics	2			
II		Chemistry and Agriculture	6	12		
	8	Essential nutrients for plants – NPK value	1			
		Chemical composition of soil, Soil enrichment				
	9	Fertilizers- natural, synthetic, mixed, NPK fertilizers. Excessive use	2			
		of fertilizers and its impact on the environment. Bio fertilizers.				
	10	Pesticides: Classification – Insecticides, herbicides, rodenticides and	2			
		fungicides (definition and examples only) – Non-degradable pesticides				
	11	Pesticide pollution and its impact on	1			
		environment – Endosulfan disaster in Kerala (brief study).				
III		Cleansing agents and cosmetics	9	18		
	12	Soaps – Hard and soft soaps – Alkali content – TFM – Detergents	3			
		(classification) – Cleaning action – Advantages and disadvantages of				
		soaps and detergents –				
	13	Shampoos: Ingredients and functions – Different kinds of shampoos	1			
		(Antidandruff, anti-lice, herbal and baby shampoos).				
	14	Tooth paste: Composition and health effects.	1			
		Hair dye: Chemicals used and its harmful effects.				
	15	Face and skin powders:	2			
	13	*				
		Types, ingredients and functions. Cleansing creams: Cold creams,				
		vanishing creams and bleach creams.				

^{# -} Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

16	Perfumes, antiperspirants, sun screen preparations, nail	2			
	polishes, lipsticks, rouges, eyebrow pencils and eye liners				
	(ingredients and				
	functions) – Harmful effects of cosmetics.				
Pharmaceuticals and Dyes					
17	Drug: Chemical name, generic name and trade names with examples.	1			
18	Terminology: Prodrug, pharmacy, pharmacology,	2			
	pharmacophore, pharmacognosy, pharmacodynamics and				
	pharmacokinetics				
	(elementary idea only).				
19	Antipyretics, analgesics, antacids, antihistamines,	2			
	antibiotics, antiseptics, disinfectants, anaesthetics,				
	tranquilizers, narcotics,				
	antidepressants and psychedelic drugs (definition and examples).				
20	Dyes: classification based on constitution, application, examples, uses.	2			
21	Dyes: Requirements of a dye – Classification based on mode of	1			
	application to the fabric –				
22	Applications of dyes (general study). Ancient and modern colours –	1			
	Mention of indigo and alizarin.				
	Food Chemistry (OPEN ENDED)	9			
23	Demonstration of the determination of food adulterants and				
	preparation of soap and cosmetics.				
24	Visit to Regional Analytical Laboratory, Kozhikode				
	17 18 19 20 21 22	polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics. Pharmaceuticals and Dyes 17 Drug: Chemical name, generic name and trade names with examples. 18 Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). 19 Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples). 20 Dyes: classification based on constitution, application, examples, uses. 21 Dyes: Requirements of a dye – Classification based on mode of application to the fabric – 22 Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin. Food Chemistry (OPEN ENDED) 23 Demonstration of the determination of food adulterants and preparation of soap and cosmetics.	polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics. Pharmaceuticals and Dyes 17 Drug: Chemical name, generic name and trade names with examples. 18 Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). 19 Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples). 20 Dyes: classification based on constitution, application, examples, uses. 21 Dyes: Requirements of a dye – Classification based on mode of application to the fabric – 22 Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin. Food Chemistry (OPEN ENDED) 9 23 Demonstration of the determination of food adulterants and preparation of soap and cosmetics.		

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Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	-	1	1	1	1			2	1		
CO2	1		-	-	1	1	1			1	1		1
CO3	-	-		1	2	2	1			2	2		1
CO4	-	-			1	2	1			1	1	1	1
CO5	-		-	1	2	2	1			2	2	1	1
CO6	-	-	-	1	2	2	1			2	2	1	1

Correlation Levels:

Level	Correlation		
-	Nil		
1	Slightly / Low		
2	Moderate /		
	Medium		
3	Substantial /		
	High		

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignm ent/viva	Quiz/seminar/ Goupdiscussio n	End Semester Examinations	
CO1	√		✓	√	
CO2	√		√	√	
CO3	✓	√		✓	
CO4	√		√	√	
CO5	√		√	√	
CO6		√	✓		