KANNUR UNIVERSITY

(Abstract)

FYUGP -Modified Scheme and Syllabus (All Semesters) of B.Sc. Polymer Chemistry Programme - Approved & Implemented w. e. f. 2024 Admission- Orders Issued

---

ACADEMIC C SECTION

ACAD C/ACAD C3/21560/2024 Dated: 30.11.2024

Read:-1. U.O. No ACAD/FYSC-III/16859/2024 dated 29/08/2024

2. The Minutes of the online meeting of the BoS in Chemistry (UG) dated 11/11/2024

3. E-mail dtd. 13.11.2024 from the Chairperson, Board of Studies in Chemistry (UG)

4.. The Orders of Vice Chancellor dtd.26.11.2024

ORDER

1.Vide paper read as (1) above, the Scheme & Syllabus of the B. Sc Polymer Chemistry (FYUGP) Programme was approved and implemented in the Affiliated Colleges w.e.f. 2024 admission.

2.Meanwhile, as per the paper read (2) above, the Meeting of the Board of Studies (BoS) in Chemistry (UG) recommended certain corrections and modifications in the already approved Scheme & Syllabus of the B.Sc.Polymer Chemistry (FYUGP) Programme.

3.Subsequently, the Chairperson, BoS in Chemistry (UG) vide paper read (3) above, forwarded the Scheme & Syllabus (of all Semesters) of the B.Sc. Polymer Chemistry (FYUGP) Programme, incorporating necessary modifications and corrections, as suggested by the Meeting of the BoS.

4.Considering the matter, the ***Vice Chancellor, in exercising the powers of the Academic Council conferred under Section 11(1), Chapter III of Kannur University Act, 1996, approved the Corrections and Modifications made in the already approved Scheme and Syllabus of the B. Sc. Polymer Chemistry (FYUGP) Programme and accorded sanction to implement the same in the Affiliated Colleges under the University, w.e.f. 2024 admission.***

5.The Scheme and Syllabus (of all Semesters) of the B. Sc. Polymer Chemistry (FYUGP) Programme to be implemented in the Affiliated Colleges w.e.f. 2024 admission are appended with this U.O. and uploaded in the official website of the University.

Orders are issued accordingly.

Sd/-

ANIL CHANDRAN R

DEPUTY REGISTRAR (ACADEMIC)

For REGISTRAR

To: 1. The Principals of affiliated colleges offering the B.Sc. Polymer Chemistry programme

2. The Chairperson, Board of Studies in Chemistry (UG)

Copy To: 1. PA to CE (to circulate the same among the sections concerned under Examination Branch)

2. PS to VC/PA to R

3. JR II (Exam)

4. DR/AR (Academic)

5. IT Cell (to uploading on the website)

6. Computer Programmer

7. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

BOARD OF STUDIES AND ADHOC COMMITTEE, CHEMISTRY /POLYMER CHEMISTRY(UG)

SYLLABUS FOR BSc POLYMER CHEMISTRY, BSc POLYMER CHEMISTRY HONOURS AND BSc POLYMER CHEMISTRY HONOURS WITH RESEARCH

FOUR YEAR UG PROGRAMME

(2024 ADMISSION ONWARDS)

KANNUR UNIVERSITY

VISION AND MISSION

Vision:

To establish a teaching, residential and affiliating University and to provide equitable and just access to quality higher education involving the generation, dissemination, and a critical application of knowledge with special focus on the development of higher education in Kasargod and Kannur Revenue Districts and the Mananthavady Taluk of Wayanad Revenue District.

Mission:

➢ To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.

➢ To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.

➢ To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice, and merit in all educational endeavours.

➢ To affiliate colleges and other institutions of higher learning and to monitor academic ethical, administrative, and infrastructural standards in such institutions.

➢ To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.

➢ To associate with the local self-governing bodies and other statutory as well as nongovernmental organizations for continuing education and for building public awareness on important social, cultural, and other policy issues.

KANNUR UNIVERSITY

PROGRAM OUTCOMES

PO1: Critical Thinking and Problem-Solving-Apply critical thinking skills to analyse information and develop effective problem-solving strategies for tackling complex challenges.

PO2: Effective Communication and Social Interaction-Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.

PO3: Holistic Understanding-Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.

PO4: Citizenship and Leadership-Exhibit a sense of responsibility, actively contribute to the community, and showcase leadership qualities to shape a just and inclusive society.

PO5: Global Perspective-Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.

PO6: Ethics, Integrity and Environmental Sustainability-Uphold high ethical standards in academic and professional endeavours, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.

PO7: Lifelong Learning and Adaptability-Cultivate a commitment to continuous self-directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

PREFACE

The extensive curriculum of Kannur University's four-year undergraduate Polymer Chemistry program is intended to give students exposure to a wide range of specialized fields and interdisciplinary applications, as well as a strong foundation in the fundamentals of chemistry. Our curriculum ensures that graduates are well-prepared for a variety of job possibilities and advanced studies by combining demanding academic coursework with real-world laboratory experience.

The program follows the Choice Based Credit and Semester System as per the regulations of Kannur University's Four-Year Undergraduate Programme (KU-FYUGP). Three, degree programs are offered by the syllabus: a) a three-year undergraduate program; b) a four-year honours program; and c) a four-year honours program with research. The foundational topics of chemistry are covered in our core curriculum, guaranteeing a solid foundation in this field of study

Our core curriculum encompasses the fundamental areas of Chemistry and Polymer Chemistry ensuring a well-bound education in this arena of science. Our key topics in Chemistry help to explore the building blocks of matter, delving into the composition and behaviour of atoms, understanding the bonding aspects in molecules. Topics help in understanding the different phases of matter and the thermodynamics of their transitions. A keen focus has been created on the branch of organic chemistry, polymer chemistry and their subtopics to get a good insight into the structure and synthesis of natural and synthetic organic compounds as well as polymers. Syllabi delve deeply into different principles and aspects of physical chemistry to implement it in real world experiments. Quantum chemistry helps to get theoretical knowledge on the atomic and molecular structure providing a deep understanding of the existence of matter. The syllabus stringently focuses on improving student skills in qualitative and quantitative analysis of chemical substances.

To enhance employability and interdisciplinary knowledge, our program includes a variety of vocational and multidisciplinary courses. These courses aim to equip students with practical skills and a broader perspective on the applications of chemistry and polymer chemistry in various fields. Recognizing the importance of well-rounded professional development, our curriculum includes skill enhancement courses designed to foster critical thinking, problem-solving, and practical skills. The courses ensure that students are not only proficient in theoretical knowledge but also capable of applying their expertise in real-world scenarios.

The proposed KU-FYUGP is intended to make curriculum and courses more student-centric and industry-centric. It proposes the adoption of flexible curricular structures to enable creative combinations of disciplinary areas for study in multidisciplinary contexts that would also allow flexibility in course options that would be on offer to students, in addition to rigorous specialization in a subject or subjects. It provides self-paced learning and options for multiple entry, exit and re-entry points. The curriculum and syllabus of the restructured KU-FYUGP emphasises an outcome-based approach, centred around the needs and capabilities of students. This approach, rooted in Outcome Based Education (OBE), focuses on defining what students should be able to do, setting predetermined achievement outcomes

The four-year undergraduate program in Polymer Chemistry at Kannur University, is a carefully crafted journey through the diverse and fascinating world of Chemistry. With a balance of core subjects, electives, vocational, multidisciplinary, and skill enhancement opportunities, our program prepares students for a wide range of careers in academia, industry, research, and beyond. We are committed to provide a stimulating and supportive learning environment that nurtures curiosity, innovation, and a lifelong passion for chemistry. We look forward to guide you through this exciting and rewarding academic endeavour

There are many personalities whose support and guidance made this restructured FYUGP syllabus a reality. I express my profound gratitude to the members of the Board of Studies and Adhoc committee in UG Chemistry who provided me extensive personal and professional support during the work of restructuring the syllabus. With immense pleasure and gratitude, I remember the untiring support rendered by the faculty members of Chemistry from various Colleges of Kannur University, academic community and all other stake holders who worked for preparing this restructured syllabus and curriculum.

Chairperson

Board of Studies, (UG) Chemistry/Polymer Chemistry, Kannur University

KANNUR UNIVERSITY

BSC CHEMISTRY PROGRAMME

PROGRAMME SPECIFIC OUTCOMES (PSOs)

The following are the expected specific outcomes of a competent Chemistry graduate, which ensures a strong foundation in Chemistry and the skills necessary to contribute to scientific advancements, industry, and societal well-being. It's important to note that specific outcomes may vary between institutions and their unique program structures.

PSO1 Demonstrate a comprehensive understanding of the fundamental principles and theories in various domains of chemistry.

PSO2 Develop proficient laboratory skills to use laboratory techniques, equipment, perform experiments, analyse data, and interpret the results in chemistry including Polymer Chemistry

PSO3 Cultivate critical thinking skills and the ability to apply scientific principles and wisdom to solve complex problems in chemistry and related fields.

PSO4 Recognize and appreciate the interdisciplinary nature of chemistry with biological-physical science, environmental science and materials science.

PSO5 Gain proficiency in advanced concepts, modern technologies and software tools relevant to chemistry and polymer chemistry, including computational chemistry software, laboratory instrumentation and data analysis tools.

PSO6 Develop awareness on environmental and social impact of polymers and chemical processes to recognise the importance of biodegradable polymers, sustainable methods and green chemistry in various contexts.

PSO7 Develop the ability to conduct independent research and introduce a culture of scientific collaboration with peers in projects and laboratory work along with fostering teamwork and interpersonal skills.

.

KU-FYUGP:

The three broad pathways of KU-FYUGP are (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and (c) 4-year UG Degree (Honours with Research). Students who choose to exit after 3 years shall be awarded a UG Degree in their respective Major Discipline after the successful completion of the required minimum of Courses of 133 credits (133). A four-year UG Honours Degree with Research in the Major Discipline shall be awarded to those who complete the KU-FYUGP with a specific number of Courses of 177 credits including 12 credits from a graduate project/Dissertation in their major discipline. Students who aspire to pursue research as a career may opt for Honours with a research stream in the fourth year. A 4-year UG Honours Degree in the Discipline/ Disciplines shall be awarded to those who complete the KU-FYUGP with a specific number of Courses with 177 credits including an optional graduate project/ dissertation of 8credits in their major discipline. Course structure of the KU-FYUG Degree Programmes - The KU-FYUG Programmes shall consist of the following categories of courses

1) General foundation Courses 2) Discipline Specific Foundation and Pathway courses for 3-year Degree, 3) Discipline Specific foundation and pathway courses for four-year Honours Degree

Minimum credit requirements of the different pathways in the three-year programme in KUFYUGP, course structure for pathways a) Single Major, b) Major with multiple Disciplines, c) Major with Minor and d) Major with vocational minor, list of Major courses, elective courses, minor courses and other foundation courses offered in KUYUGP chemistry programme are listed in the following pages.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THETHREE-YEAR PROGRAMME IN KUFYUGP

Sl. No.	**Academic Pathway**	**Major**	**Minor/ Other Disciplines**	**Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3**	**Intern-ship**	**Total Credits**	**Example**
		Each course has 4 credits		Each course has 3 credits			
1	Single Major (A)	68	24	39	2	133	Major: Chemistry+a set of six courses in different subjects
2	Major (A) with Multiple Disciplines (B, C)	68	12 + 12	39	2	133	Major: Chemistry+ Minor B and C
3	Major (A) with Minor (B)	68	24	39	2	133	Major: Chemistry Minor: B
4	Major (A) with Minor (C)	68	24	39	2	133	Major: Chemistry Minor: C
5	Double Major (A, B)	A:48 (12 courses) B:44 (11 courses)	-	12+18+9	2	133	Chemistry and B double major
			The 24 credits in the Minor stream are distributed between the two Majors. 2 MDC, 2 SEC, 2 VAC and the internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133) 1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)				

Exit with UG degree/Proceed to fourth year with 133 credits

BSc POLYMER CHEMISTRY (HONOURS) PROGRAMME

(2024 ADMISSION ONWARDS)

COURSE STRUCTURE FOR PATHWAYS 1-4

1.Single Major
2. Major with multiple Disciplines
3.Major with Minor
4. Major with vocational minor

SEMESTER 1

No	Course code	Course Title	Hours/ week	Credit	CE	ESE	Total marks
1		AEC 1 (English)	4	3	25	50	75
2		AEC 2 (Additional Language)	3	3	25	50	75
3		MDC 1	3	3	25	50	75
4	KU1DSCCHE101	Major course -1 Fundamentals of Chemistry-1	5	4	35	65	100
5		DSC B1(Minor 1)	4/5	4	30	70	100
6		DSC C1 (Minor 2)	4/5	4	30	70	100
		Total credits	23/25	21			525

SEMESTER II

No		Title	Hours /week	Credit	CE	ESE	Total marks
1		AEC 3 (English)	4	3	25	50	75
2		AEC 4 (Additional Language)	3	3	25	50	75
3		MDC2	3	3	25	50	75
4	KU2DSCCHE101	Major course -2 Fundamentals of Chemistry - II	5	4	35	65	100
5		DSC B2 (Minor 1)	4/5	4	30	70	100
6		DSC C2 (Minor 2)	4/5	4	30	70	100
		Total credits	23-25	21			525

SEMESTER III

No	Course code	Course Title	Hours/ week	Credit	CE	ESE	Total marks
1		MDC 3 (KS)	3	3	25	50	75
2		VAC 1	3	3	25	50	75
3	KU3DSCCHE201	Major course -3 Inorganic Chemistry – I	5	4	35	65	100
4	KU3DSCCHE202	Major course -4 Organic Chemistry – I	4	4	30	70	100
5		DSC B 3 (Minor 1)	4/5	4	30	70	100
6		DSC C 3 (Minor 2)	4/5	4	30	70	100
		Total credits	23-25	22			550

SEMESTER IV

No	Course Code	Course Title	Hours/ week	Credit	CE	ESE	Total marks
1		SEC 1	3	3	25	50	75
2		VAC 2	3	3	25	50	75
3		VAC 3	3	3	25	50	75
4	KU4DSCCHE201	Major course -5 Inorganic Chemistry – II	5	4	35	65	100
5	KU4DSCCHE202	Major course -6 Organic Chemistry - II	5	4	35	65	100
6	KU4DSCCHE203	Major course -7 Physical Chemistry – I	5	4	35	65	100
		Total credits	21-24	21			525

SEMESTER V

No	Course code	Course Title	Hours/ week	Credit	CE	ESE	Total marks
1		SEC 2	3	3	25	50	75
2	KU5DSCCHE301	Major course -8 Physical Chemistry – II	5	4	35	65	100
3	KU5DSCCHE302	Major course -9 Inorganic Chemistry-III	5	4	35	65	100
4	KU5DSCCHE303	Major course-10 Theoretical Chemistry-I	4	4	30	70	100
5	KU5DSEPCH 305	Elective course 1 Polymer Chemistry I	4	4	30	70	100
6	KU5DSECHE301-304	Elective course II	4	4	30	70	100
		Total credits	23-25	23			575

SEMESTER VI

No		Title	Hours/ week	Credit	CE	ESE	Total marks
1		SEC 3	3	3	25	50	75
2	KU6DSCCHE301	Major course-11 Organic Chemistry – III	5	4	35	65	100
3	KU6DSCCHE302	Major course-12 Physical Chemistry – III	4	4	30	70	100
4	KU6DSCCHE303	Major course-13 Physical Chemistry – IV	5	4	35	65	100
5	KU6DSEPCH 305	Elective Course III Polymer Chemistry II	4	4	30	70	100
6	KU6DSECHE301-304	Elective Course IV	4	4	30	70	100
7	KU6INTPCH301	INTERNSHIP	2	2	50		50
		Total credits	25-27	25			625

EXIT WITH UG DEGREE/PROCEED TO FOURTH YEAR WITH 133 CREDITS

17 Major courses17 x 4 = **68** 6 minors 6 x 4 = **24**

13 foundation courses (AEC, SEC, VAC, MDC) 13 x 3 = **39**

1 Internship 2 x1 = **2** **Total :133**

SEMESTER VII

No	Title		Hours/ week	Credit	CE	ESE	Total marks
1	KU7DSCCHE401	Major course-14 Theoretical Chemistry-II	5	4	35	65	100
2	KU7DSCCHE402	Major course-15 Inorganic Chemistry-IV	6	4	35	65	100
3	KU7DSCCHE403	Major course-16 Organic Chemistry-IV	5	4	35	65	100
4	KU7DSCCHE404	Major course-17 Physical Chemistry-V	5	4	35	65	100
5	KU7DSECHE405	Major course-18 Physical Chemistry-VI	4	4	30	70	100
	Total credits		25	20			500

SEMESTER VIII

No	Course code	Course Title	Hours/ week	Credit	CE	ESE	Total marks
1	KU8DSCCHE401	Major course-19 Inorganic Chemistry-V	4	4	30	70	100
2	KU8DSCCHE402	Major course-20 Organic Chemistry-V	4	4	30	70	100
3	KU8DSCCHE403	Major course-21 Physical Chemistry-VII	5	4	35	65	100
		OR (Instead of any two Major courses from19to 21)					
4	KU8CIPCHE400	**PROJECT** (In honours programme)		8	60	140	200
		OR (Instead of all Major courses 19 to 21)					
5	KU8CIPCHE401	**PROJECT** (In honours Programme		12	90	210	300
6	KU8RPHCHE400	**RESEARCH PROJECT** (For honours with Research programme)		12	90	210	300
	ELECTIVE PAPERS (Three elective papers are compulsory for both Honours and Honours with Research Programme. For Honours with Research programme, one must be KU8DSECHE406)						
7	KU8DSECHE401-406	Elective V	4	4	30	70	100
8	KU8DSECHE401-406	Elective VI	4	4	30	70	100
9	KU8DSECHE401-406	Elective VII	4	4	30	70	100
		Total		**24**			**600**

CREDIT DISTRIBUTION FOR PATHWAYS 1-4

1.Single Major 2. Major with multiple Disciplines
3.Major with Minor 4. Major with vocational minor

Semester	Major courses	Minor courses	General Foundation Courses	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 years	**68**	**24**	**39**	**2**	**133**
7	4+4+4+4+4				20
8	4+4+4	4+4+4		8*/12**	24
*Instead of two major courses; ** Instead of three major courses					
Total for Four years	**88+12=100**	**36**	**39**	**2**	**177**

BSc POLYMER CHEMISTRY MAJOR COURSES

Sl No	Course Code	Course Title	Practical Component	Semester	Credit		Hours
1	KU1DSCCHE101	Fundamentals of Chemistry – I	Volumetric analysis – I	I	4	3L+1 P	75
2	KU2DSCCHE101	Fundamentals of Chemistry – II	Volumetric analysis - II	II	4	3L+1 P	75
3	KU3DSCCHE201	Inorganic Chemistry – I	Qualitative Analysis (Anion)	III	4	3L+1 P	75
4	KU3DSCCHE202	Organic Chemistry – I	---	III	4	4L	60
5	KU4DSCCHE201	Inorganic Chemistry – II	Qualitative Analysis (Mixture)	IV	4	3L+1 P	75
6	KU4DSCCHE202	Organic Chemistry – II	Qualitative Analysis (Organic compounds)	IV	4	3L+1 P	75
7	KU4DSCCHE203	Physical Chemistry – I	Physical Chemistry (Lab) – I	IV	4	3L+1 P	75
8	KU5DSCCHE301	Physical Chemistry – II	Physical Chemistry (Lab) – II	V	4	3L+1 P	75
9	KU5DSCCHE302	Inorganic Chemistry III	Gravimetry	V	4	3L+1 P	75
10	KU5DSCCHE303	Theoretical Chemistry – I	---	V	4	4L	60
11	KU5DSEPCH 305	Elective – I	---	V	4	4L	60
12	KU5DSECHE (301-304)	Elective – II	---	V	4	4L	60
13	KU6DSCCHE301	Organic Chemistry – III	Preparation& Quantitative Analysis	VI	4	3L+1 P	75
14	KU6DSCCHE302	Physical Chemistry – III	---	VI	4	4L	60
15	KU6DSCCHE303	Physical Chemistry IV	Physical Chemistry (Lab) – III	VI	4	3L+1 P	75
16	KU6DSEPCH 305	Elective -III	---	VI	4	4L	60
17	KU6DSECHE (301-304)	Elective – IV	---	VI	4	4L	60
18	KU7DSCCHE401	Theoretical Chemistry – II	Molecular Modelling Lab	VII	4	3L+1 P	75

19	KU7DSCCHE402	Inorganic Chemistry – IV	Inorganic Mixture Analysis	VII	4	2L+2P	90
20	KU7DSCCHE403	Organic Chemistry – IV	Organic Mixture Analysis	VII	4	3L+1P	75
21	KU7DSCCHE404	Physical Chemistry – V	Physical Chemistry (Lab) – IV	VII	4	3L+1P	75
22	KU7DSCCHE 405	Physical Chemistry – VI	---	VII	4	4L	60
23	KU8DSCCHE401	Inorganic Chemistry – V	---	VIII	4	4L	60
24	KU8DSCCHE402	Organic Chemistry – V	---	VIII	4	4L	60
25	KU8DSCCHE403	Physical Chemistry – VII	Physical Chemistry (Lab) – V	VIII	4	3L+1P	75
26	KU8DSECHE (401-406)	Elective V	---	VIII	4	4L	60
27	KU8DSECHE ()401-406	Elective – VI	---	VIII	4	4L	60
28	KU8DSECHE (401-406)	Elective – VII	---	VIII	4	4L	60

ELECTIVE COURSES IN CHEMISTRY

Sl No	Course code	Title	Semester	Hours/ week	Credit	Marks		
						Internal	External	Total
1	KU5DSECHE301	Industrial Chemistry	V	4	4	30	70	100
2	KU5DSECHE302	Green and Sustainable Chemistry	V	4	4	30	70	100
3	KU5DSECHE303	Environmental Chemistry	V	4	4	30	70	100
4	KU5DSECHE304	Biomaterials	V	4	4	30	70	100
5	KU5DSEPCH305	Polymer Chemistry-I	V	4	4	30	70	100
6	KU6DSECHE301	Applied Chemistry	VI	4	4	30	70	100
7	KU6DSECHE302	Pharmaceutical Chemistry	VI	4	4	30	70	100
8	KU6DSECHE303	Nano Chemistry	VI	4	4	30	70	100
9	KU6DSECHE304	Medicinal Chemistry	VI	4	4	30	70	100
10	KU6DSECHE305	Polymer Chemistry-II	VI	4	4	30	70	100
11	KU8DSECHE401	Forensic Chemistry and toxicology	VIII	4	4	30	70	100
12	KU8DSECHE402	Computational Chemistry	VIII	4	4	30	70	100
13	KU8DSECHE403	Ceramics, Composites and Inorganic polymers	VIII	4	4	30	70	100
14	KU8DSECHE404	Advanced Nano Material Synthesis	VIII	4	4	30	70	100
15	KU8DSECHE405	Theoretical Aspects of Advanced Chemistry	VIII	4	4	30	70	100
16	KU8DSECHE406	Research Methodology	VIII	4	4	30	70	100

CHEMISTRY MINOR COURSES

Group I

Sl No	Course Code	Course Title	Practical Component	Semester	Credit		Hours
1	KU1DSCCHE111	Fundamentals of Theoretical &Nuclear Chemistry	Volumetric analysis - I	I	4	3L+1P	75
2	KU1DSCCHE112	Fundamentals of Theoretical &Geochemistry	Volumetric analysis - I	I	4	3L+1P	75
3	KU1DSCCHE113	General Chemistry-I	Quantitative analysis I	I	4	3L+1P	75
4	KU2DSCCHE111	Basic Physical Chemistry &Forensic Chemistry	Volumetric analysis - II	2	4	3L+1P	75
5	KU2DSCCHE112	Principles of Physical Chemistry & Environmental Chemistry	Volumetric analysis - II	2	4	3L+1P	75
6	KU2DSCCHE113	General Chemistry-II	Quantitative analysis-II	2	4	3L+1P	75
7	KU2DSCCHE121	Essential concepts in Chemistry	---	2	4	4L	60
8	KU3DSCCHE211	Properties of Matter & Electrochemistry	Analysis of Cation mixtures	3	4	3L+1P	75
9	KU3DSCCHE212	Physical Chemistry & Metallurgy	Analysis of Cation mixtures	3	4	3L+1P	75
10	KU3DSCCHE213	General Chemistry-III	Salt analysis	3	4	3L+1P	75

Group II

Sl No	Course Code	Course Title	Practical Component	Semester	Credit		Hours
1	KU1DSCCHE114	Basic concepts in Theoretical and Environmental Chemistry	Volumetric analysis – I	1	4	3L+1P	75
2	KU1DSCCHE115	Basics of Structural &Analytical Chemistry	Volumetric analysis – I	1	4	3L+1P	75
3	KU1DSCCHE116	Principles of Basic Chemistry-I	Quantitative analysis – I	1	4	3L+1P	75
4.	KU1DSCCHE117	Foundation Course in Chemistry -I	Quantitative analysis – I	1	4	3L+1P	75
5	KU1DSCCHE124	Essentials of structural & analytical chemistry	---	1	4	4L	60
6	KU1DSCCHE126	Fundamentals of structural & analytical Chemistry	---	1	4	4L	60
7	KU2DSCCHE114	Foundations in Physical & Organic Chemistry	Volumetric analysis – II	2	4	3L+1P	75
8	KU2DSCCHE115	Foundation in Physical, Organic & Bioinorganic Chemistry	Volumetric analysis – II	2	4	3L+1P	75
9	KU2DSCCHE116	Principles of Basic Chemistry-II	Quantitative analysis-II	2	4	3L+1P	75
10	KU2DSCCHE117	Foundation Course in Chemistry -II	Quantitative analysis-II	2	4	3L+1P	75
11	KU2DSCCHE125	Concepts in coordination &Organic chemistry	---	2	4	4L	60
12	KU3DSCCHE214	Reaction Kinetics &Biomolecular Chemistry	Mixture analysis(Cation)	3	4	3L+1P	75
13	KU3DSCCHE215	Chemistry of Biomolecules	Mixture analysis(Cation)	3	4	3L+1P	75
14	KU3DSCCHE216	Bioorganic Chemistry	Mixture analysis(Cation)	3	4	3L+1P	75
15	KU3DSCCHE217	Physical and Medicinal Chemistry	Salt analysis	3	4	3L+1P	75
16	KU3DSCCHE218	Chemistry of bioorganic molecules	Mixture analysis(Cation)	3	4	3L+1P	75

CHEMISTRY FOUNDATION COURSES

Sl No	Course Code	Course Title	Semester	Credit		Hours
1	KUIMDCCHE101	Chemistry in service to man	I	3	3L	45
2	KUIMDCCHE102	Environmental studies	I	3	3L	45
3	KU2MDCCHE101	Chemistry of cosmetics	II	3	3L	45
4	KU2MDCCHE 102	Chemistry in everyday life	II	3	3L	45
5	KU2MDCPCH103	Plastic Waste Management and Biodegradable Polymers	II	3	3L	45
6	KU3MDCCHE 101	Nanomaterials	III	3	3L	45
7	KU3MDCCHE 102	Drugs- use and abuse	III	3	3L	45
8	KU4SECCHE101	Green Methods in Chemistry	IV	3	2L+1	60
9	KU4SECCHE102	Fuel Chemistry	IV	3	2L+1	60
10	KU4SECPCH103	Polymer Science and Latex Technology	IV		2L+1	60
11	KU5SECCHE101	Cosmetics and personal care products	IV	3	3L	45
12	KU6SECCHE101	Scientific Writing and Communication in Chemistry	V	3	3L	45
13	KU6SECCHE102	Spectroscopic Techniques in Chemistry	V	3	2L+1	60
14	KU3VACCHE101	Safe laboratory practices in Chemistry	III	3	3L	45
15	KU3VACPCH102	Polymers & Polymer Composites	III	3	3L	45
16	KU4VACCHE101	Food additives, Contamination, and safety	IV	3	3L	45
17	KU4VACCHE102	Water Quality Analysis	VI	3	3L	45

EVALUATION

The evaluation of each course shall contain two parts: The

(i) Internal Assessment(ii)External Assessment

(3T+1P) credit courses

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

(4T+0P) credit courses

Evaluation Type		Marks
1. End Semester Evaluation		70
2. Continuous Evaluation		30
Continuous Evaluation		
Theory	Method of Assessment	Marks
a)	Test paper*	12
b)	Viva-Voce	6
c)	Assignment	6
d)	Seminar	6
		Total – 30 marks

(2T+2P) credit courses

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (35T+30P)**
Continuous Evaluation (CCA)		**35 (15T+20P)**
Theory		**15**
a)	Test Paper*	6
b)	Assignment	3
c)	Viva-Voce	3
d)	Seminar	3
Practical20		
a)	Skill	8
b)	Record	8
c)	Punctuality	4

(3 T+0P) credit courses

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

(2T+1P) credit courses

Evaluation Type		Marks
End Semester Evaluation (ESE)		**45 (35T+10P)**
Continuous Evaluation (CCA)		**30 (15T+15P)**
Theory		**15**
a)	Test Paper*	9
b)	Assignment	3
c)	Viva-Voce	3
Practical15		
a)	Record	5
b)	Viva-Voce	5
c)	Skill	5
Total		**75**

Abbreviations: T-Theory
P-Practical

The external theory examination of all odd semesters will be conducted by the college itself and the even semesters by the University at the end of each semester.

The end-semester practical examination, viva-voce and the evaluation of practical records shall be conducted by the course 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 beginning of end-semester examination.

Those who have completed the continuous evaluation alone will be permitted to appear for the end semester (practical) viva-voce.

Scheme of Practical Examinations

Time	3hrs	4hrs
Total marks	45	60
Experiment	30	45
Record	5	5
Viva	10	10

SEMESTER - I

KU1DSCCHE101: FUNDAMENTALS OF CHEMISTRY- I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE101	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This comprehensive course offers an enriching exploration of fundamental concepts of atomic structure, periodicity in properties of elements, theories of quantitative analysis, organic chemistry, and organic reaction mechanism. The practical component will enhance skill in preparing solutions, volumetric estimation and familiarise the use of online resources to understand Chemistry in a better way.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Demonstrate a good understanding of the various theories on atomic structure and periodicity in the properties of elements.	U
2	Apply the acquired knowledge about periodicity to predict and explain the properties of elements.	A
3	Analyse and apply the rules in representing organic compounds with structural formulae and naming organic compounds	A
4	Develop skill in solving problems involving stoichiometric calculations	E

5	Develop skills in practical Chemistry and in using online resources	A
6	Demonstrate good laboratory practices.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	2	1	2	2	2
CO 2	3	1	2	1	2	2	2
CO 3	3	1	2	1	2	2	2
CO 4	3	1	2	1	2	2	2
CO 5	3	1	2	1	2	2	2
CO6	3	1	2	1	2	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ATOMIC STRUCTURE AND PERIODICITY**		**15**
	1	Atomic structure-Classical mechanics – concept- Bohr theory of atom Calculation of Bohr radius, velocity, and energy of an electron- Atomic spectra of hydrogen- Limitations of Bohr theory- failure of classical mechanics- Black body radiation (concept only, no derivation required)- Planck's law of radiation- Photoelectric effect	

	2	Heisenberg's uncertainty principle and its significance- dual nature of electrons- Davisson and Germer's experiment- de Broglie hypothesis- Quantum numbers- Shapes of orbitals – Aufbau principle-Pauli's exclusion principle and Hund's rule - Electronic configuration of atoms	
	3	Periodic table-Evolution of modern periodic table-Modern periodic law- Periodicity in properties – Atomic, ionic, covalent radii- Ionisation Potential- Electron Affinity -Electronegativity – Pauling's scale–-Allred Rochow's scale and Mulliken Scale of electronegativity	
	4	Effective nuclear charge –Screening effect – Slater rules (problems required)	

2	**THEORETICAL BASIS OF QUANTITATIVE ANALYSIS& GOOD LABORATORY PRACTICES**		**10**
	1	Fundamental concepts of quantitative analysis– mole, molarity, normality, molality, ppm, ppb, mole fraction–percentage (by mass and volume)	
	2	Primary standard – secondary standard -standard solutions – quantitative dilution from stock solutions by serial dilution method–numerical problems- Theory of titrations involving acids and bases-indicators used in acid base titrations- Redox titration with Permanganometry as example	
	3	Safe laboratory practices and Lab safety signs-Personal protective equipment (PPE) in Chemical laboratory- Awareness of Material Safety Data Sheet (MSDS).	
	4	Hazard Symbols and Signs (Physical, Chemical, Environmental and Health)- Lab accidents and safety measures Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases	

3	**INTRODUCTION TO ORGANIC CHEMISTRY**		**10**
	1	Classification of Organic compounds-homologous series	
	2	IUPAC system of nomenclature of aliphatic, alicyclic and aromatic compounds: hydrocarbons (alkane, alkene and alkynes), halo compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid halides, anhydrides, esters, amides, amines, nitriles, nitro-compounds and cycloalkanes.	
	3	Familiarise structural formula of at least 3 lower members of each homologous series	

4	**INTRODUCTION TO ORGANIC REACTION MECHANISM**		**10**
	1	Bonding notations- drawing electron movements with arrows-curved arrow notations-half headed and double headed arrows- electronegativity - polarity in bonds- homolytic and heterolytic bond fission	
	2	Reaction intermediates- carbocations, carbanions- generation and structure	
	3	Reaction intermediates-free radicals, carbenes, and nitrenes – generation and structure	
	4	Types of reactions: addition, substitution, elimination and rearrangement with simple examples-Electrophiles and nucleophiles with examples	

<table>
<tr><td rowspan="6">5</td><td>TEACHER SPECIFIC MODULE-PRACTICAL CHEMISTRY -I</td><td>30</td></tr>
<tr><td>Minimum one experiment for the preparation of solutions of each type, two experiments in acidimetry -alkalimetry, and two in permanganometry must be done. Familiarise soft skill development virtual lab experiments and simple organic compounds as per teacher’s choice.</td><td></td></tr>
<tr><td>1)Preparation of solutions
a) Standard solutions (normal, molar) b) percentage by mass
c) percentage by volume d) ppm
e) dilute solutions from stock solutions by serial dilution method</td><td></td></tr>
<tr><td>2)Volumetric experiments
Acidimetry and Alkalimetry Acidimetry, alkalimetry and permanganometry (two burette method may be used)
a) Estimation of NaOH/KOH using standard Na_2CO_3/K_2CO_3
b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.
Permanganometry
a. Estimation of oxalic acid.
b. Estimation of Fe^{2+}
c. Estimation of nitrite</td><td></td></tr>
<tr><td>3)Open ended experiments
(Familiarise the use of any two online simulation software)-suggestions
Use of Online simulation software PhET to construct.
a. Atoms of different elements (till atomic number 20)
b. Build a molecule (HCl, H_2O, NH_3, CH_4, Benzene)
c. Rutherford scattering simulation.</td><td></td></tr>
<tr><td>4. Familiarise a few organic compounds
Any 10 simple organic compounds they learn</td><td></td></tr>
</table>

Essential Readings:

1. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.
2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
4. G D Christian, Analytical Chemistry, John Wiley and Sons.
5. G H Jeffery, J Bassett, J Mendham, R C Denny
6. Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.
7. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986
8. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry' 3rd Edition, Visal Publishing Company Co.
9. K. S. Tewari and N. K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House
10. B. S. Bahl 'Advanced organic Chemistry', S. Chand.
11. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India.
12. I. L. Finar 'Organic Chemistry', Vol.- 1, Pearson Education
13. P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers
14. Peter Sykes, 'A Guidebook to Mechanism in Organic Chemistry', Pearson Education

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU1DSCCHE111 - FUNDAMENTALS OF THEORETICAL AND NUCLEAR CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE111	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on atomic structure, periodic properties, chemical bonding, nuclear chemistry, analytical techniques, and quantitative analysis. Completing the course will develop a deep understanding of molecular behaviour, nuclear chemistry, laboratory practices, and quantitative analysis skills essential for a career in chemistry and related fields.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop basic idea regarding atomic structure and atom models.	U
2	Analyse the periodicity and predict the properties of elements	An
3	Describe various theories of chemical bonding and explain the structure of simple molecules based on the theories.	A
4	Understand the concept of nuclear chemistry	U
5	Acquire the knowledge to follow efficient and safe operating procedures skilfully in the laboratory and to prevent health and environment hazards in using chemicals.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	2	0	2	2	2
CO 2	3	1	2	0	2	2	2
CO 3	3	1	2	0	2	2	2
CO 4	3	1	2	1	2	2	2
CO 5	3	1	2	0	3	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ATOMIC STRUCTURE AND PERIODICITY OF ELEMENTS**		**10**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations – wave mechanical concept of atom	
	2	Heisenberg's Uncertainty Principle – Dual nature of electrons – de Broglie equation – quantum numbers- Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept- Periodic trends – atomic radii, ionic radii & covalent radii	
	4	Ionization potential – electro negativity and electron gain enthalpy-– effective nuclear charge and screening effect	

2	**CHEMICAL BONDING**		**10**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds. Lattice energy of ionic compounds- VSEPR theory and its applications-Shape of molecules CO_2, BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, PCl_5, SF_6, ClF_3	
	2	Orbital overlapping – Hybridization: sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization -Shapes of organic molecules like methane, ethane, ethylene and acetylene.	
	3	Valence bond theory- Explain with examples H_2, N_2, CH_4, $CH_2{=}CH_2$ MO theory- Formation of B_2, C_2, N_2 and O_2 molecules-	

	4	Hydrogen bonding-types of hydrogen bonding – examples	

3		**NUCLEAR CHEMISTRY**	**10**
	1	Concept of nuclides – representation of nuclides – isobars, isotopes and isotones with examples -Detection of isotopes using Aston's mass spectrograph	
	2	Separation of isotopes by diffusion methods – stability of nucleus – n/p ratio- Liquid drop model	
	3	Radioactivity – natural and artificial- Decay constant and half-life period-Radioactive series – Group displacement law- Radio isotopes and their applications in structural elucidation, in agriculture and in industry –Radiocarbon dating	
	4	Nuclear fission and nuclear fusion-Problems associated with the nuclear waste disposal- Derivation of decay constant – Atom bomb and hydrogen bomb-Mass defect- nuclear binding energy	

4		**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**	**15**
	1	Accuracy and precision-Errors-classification- Concept of molarity, normality, molality (numerical problems expected)	
	2	Principle of volumetric analysis – Acidimetry and alkalimetry- Theory of acid-base indicators.	
	3	Types of analytical methods –Qualitative and Quantitative analysis	
	4	**Good Laboratory Practices**	
		a) Safe laboratory practices and Lab safety signs- Personal Protective Equipment (PPE) in Chemical laboratory- Awareness of Material Safety Data Sheet (MSDS)	

		b) Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures	
		c) Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases	

	TEACHER SPECIFIC MODULE	**30**
	PRACTICALS - QUANTITATIVE ANALYSIS I*	
	*A minimum of eight experiments to be conducted Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of eight experiments one is virtual lab experiment and is subjected to teacher's choice.	
5	1)Preparation of standard solutions (minimum 2) 2)Dilute solutions from Stock solutions in lab (minimum 2)	
	3)Acidimetry and Alkalimetry (minimum 3) a) Estimation of NaOH/KOH using standard Na_2CO_3. b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.	
	5. Use of Online Educational Resources (OER's) like Phet Colarado.edu as a learning tool for "Build a molecule", "Chemical Bonding" and "Virtual titration tool"	

Essential Readings:

1. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.
2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
5. Shriver and Atkins, Inorganic Chemistry, W. H Freeman and Company, 2006.
6. G D Christian, Analytical Chemistry, John Wiley and Sons.
7. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.
8. Vogel's Textbook of Quantitative Chemical Analysis
9. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU1DSCCHE112 -FUNDAMENTALS OF THEORETICALCHEMISTRY AND GEOCHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE112	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course covers modules on atomic structure, periodic properties, chemical bonding, Chemistry of earths, analytical techniques, and quantitative analysis. Completing the course will develop a deep understanding of molecular behaviour, nuclear chemistry, laboratory practices, and quantitative analysis skills essential for a career in chemistry and related fields.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop basic idea regarding atomic structure and atom models.	U
2	Analyse the periodicity and predict properties of elements.	An
3	Describe various theories of chemical bonding and explain the structure of simple molecules based on these theories.	U
4	Understand the concept of chemistry of Earth	U
5	Acquire the knowledge to follow efficient and safe operating procedures skilfully in the laboratory and to prevent health and environment hazards in using chemicals.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	2	0	3	2	2
CO 2	3	1	2	0	3	2	2
CO 3	3	1	2	0	3	2	2
CO 4	3	1	2	1	2	2	2
CO 5	3	1	2	1	3	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ATOMIC STRUCTURE AND PERIODICITY OF ELEMENTS**	**10**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations – wave mechanical concept of atom	
	2	Heisenberg's Uncertainty Principle – Dual nature of electrons – De Broglie equation – quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept	
	4	Periodic trends – atomic radii, ionic radii & covalent radii – effective nuclear charge and screening effect	
	5	Ionization potential – electro negativity and electron gain enthalpy.	
2		**CHEMICAL BONDING**	**10**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds. Lattice energy of ionic compounds	
	2	VSEPR theory and its applications. Shape of molecules CO_2, BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, PCl_5, SF_6, ClF_3.	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization -Shapes of organic molecules like methane, ethane, ethylene and acetylene.	
	4	Valence bond theory- Explain with examples H_2, N_2, CH_4, $CH_2{=}CH_2$	
	5	MO theory-Formation of B_2, C_2, N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples.	

3		**CHEMISTRY OF EARTH**	**10**
	1	The earth as a physico-chemical system-Crust as a separate system Geochemical cycle	
	2	Fundamentals of Radioactive and Radiogenic Isotope Geochemistry.	
	3	Geochronology: long-lived radioactive decay systems. Radiogenic Isotopic tracers: evolution of Mantle, Crust and Sediments.	
	4	pH and Eh Oxidation potentials- Oxidation and reduction, electrode reactions, standard potentials, use of the table of oxidation potentials;	
	5	Redox potential, Ionic potential, Hydrogen ion concentration, Limits of pH and Eh in nature, Eh and pH diagrams.	
4		**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**	**15**
	1	Accuracy and precision- Errors-classification-Concept of molarity, Normality, Molality (numerical problems expected).	
	2	Principle of volumetric analysis – Acidimetry and alkalimetry- Theory of acid-base indicators.	
	3	Types of analytical methods –Qualitative and Quantitative analysis	
	4	**Good Laboratory Practices**	
		a) Safe laboratory practices and Lab safety signs- Personal protective equipment (PPE) in Chemical laboratory. Awareness of Material Safety Data Sheet (MSDS).	
		b) Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health)-Lab accidents and safety measures	
		c) Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	

5	**TEACHER SPECIFIC MODULE**	**30**
	PRACTICALS - QUANTITATIVE ANALYSIS -I*	
	*A minimum of eight experiments to be conducted Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of eight experiments one virtual lab experiment is open-ended and is subjected to teacher's choice.	
	1)Preparation of standard solutions (minimum 2) 2)Dilute solutions from Stock solutions in lab (minimum 2)	
	3)Acidimetry and Alkalimetry (minimum 3) a) Estimation of NaOH/KOH using standard Na_2CO_3. b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.	
	5. Use of Online Educational Resources (OER's) like Phet.Colarado.edu as a learning tool for "Build a molecule", "Chemical Bonding" and "Virtual titration tool"	

Essential Readings:

1.B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.

2.J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.

3.F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.

4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.

5. Shriver and Atkins, Inorganic Chemistry, W. H Freeman and Company, 2006.

6.Brain Mason and C.B. Moore- Principles of Geochemistry

7.G D Christian, Analytical Chemistry, John Wiley and Sons.

8 G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.

9.Vogel's Textbook of Quantitative Chemical Analysis

10. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average mark of the best two written tests may be considered for internal mark

KU1DSCCHE113: GENERAL CHEMISTRY-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE113	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description:

The course covers modules on liquid state, solutions, polymers, analytical techniques, and quantitative analysis. Completing the course successfully will develop a deep understanding of molecular behaviour, nuclear chemistry, laboratory practices, and quantitative analysis skills essential for a career in chemistry and related fields.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	A comprehensive understanding about the theories of bonding in coordination compounds to explain geometry of complexes	U
2	Explain the properties of liquids based on molecular interactions	U
3	Solve numerical problems to calculate concentration of solutions	A
4	Able to distinguish different types of liquid crystals	U
5	Acquire skill in preparing standard solutions and get practical exposure in chromatography and solvent extraction experiments	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**BASICS OF COORDINATION CHEMISTRY**	**10**
	1	Introduction-Double salts and Coordination compounds	
	2	Werner's coordination theory- Classification of coordination compounds and various types of ligands	
	3	Nomenclature of coordination compounds- Application of coordination compounds in qualitative and quantitative analysis	
	4	VBT- Square planar and octahedral complexes	

2	**LIQUID STATE AND SOLUTIONS**		**14**
	1	Liquid State: Introduction - Vapour pressure – Raoult's law- surface tension and viscosity –Explanation of these properties based on intermolecular attraction	
	2	Solutions: Kinds of solutions – Ways of expressing concentration of mole fraction, molarity, normality, molality, percentage by mass, ppm, ppb (numerical problems expected).	
	3	Solubility of gases in liquids – Henry's law and its applications	
	4	Colligative properties - Determination of molecular mass using colligative properties	
	5	Introduction to liquid crystals-classification and properties	
3	**INTRODUCTION TO POLYMER CHEMISTRY**		**10**
	1	Types of polymerizations: Chain polymerization, step polymerization	
	2	Homopolymers and copolymers -Phenol formaldehyde, urea formaldehyde polymers	
	3	Natural rubber and synthetic rubbers – Synthetic fibres	
	4	Thermoplastics and Thermosetting plastics	
	5	Pollution due to plastics– Biodegradable plastic	

4	**CHROMATOGRAPHY& SOLVENT EXTRACTION**		**11**
	1	Introduction - Adsorption and partition chromatography	
	2	Principle and applications of column, thin layer, paper, Liquid and gas chromatography, HPLC, Ion Exchange chromatography (IEC)	
	3	Rf value – Relative merits of different techniques	
	4	**Solvent extraction:** Classification, principle, and efficiency of the technique-Mechanism of extraction: extraction by solvation and chelation	

5	**TEACHER SPECIFIC MODULE**	**30**
	PRACTICALS	
	Minimum 10 experiments must be done. 4 from preparation of solutions section (a) 2 from section (b) and any 2 two complexes from section 2. Remaining 2 experiments is of teacher's choice and may be from chromatography and virtual lab titration sections.	
	1.Preparation of solutions-(a) Normal, Molar, ppm, percentage by mass **b) B**y serial dilution method **2.Preparation of inorganic complexes-**Potash alum, Mohr salt, tetraammine copper (II) sulphate Teacher's choice(suggestions) **3.Chromatography Experiments**. 1. Setting up a thin layer plate, Iodine chamber for chromatographic separation 2. Setting up paper (both horizontal and vertical) chromatography 3. Column packing and elution in Column chromatography. 4. Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques 5. Separation of plant pigments using TLC, Paper and Column Chromatography	5
	4. Use of Online Educational Resources (OER's) like Phet.Colarado.edu as a learning tool for chromatography and solvent extraction methods	

Essential Readings:

1. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone
   Publishers, New Delhi.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York.
3. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
4. Jonathan Clayden, Nick Greeves, and Stuart Warren, "Organic Chemistry," Oxford University Press
5. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
6. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
7. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick Woodward, "Chemistry: The Central Science," Pearson
8. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
9. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.
10. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
11. V.R. Gowariker, N.V. Viswanathan and Sreedhar, Polymer Science, Wiley Easern Ltd.
12. F.W. Billmeyar, A textbook of polymer science, John Wiley & Sons, 1971

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU1DSCCHE114: BASIC CONCEPTS IN THEORETICAL AND ENVIRONMENTAL CHEMISTRY-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE114	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course deals with the fundamental principles of chemistry. The topics covered include atomic structure, chemical bonding, Environmental chemistry, analytical techniques, and quantitative analysis.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop basic idea regarding atomic structure and atom models.	U
2	Analyse the periodicity and predict properties of elements.	An
3	Describe various theories of chemical bonding and explain the structure of simple molecules based on these theories.	U
4	Comprehensive understanding on the various pollutants causing atmospheric pollution to minimise the global warming and carbon footprint.	A
5	Acquire proficiency in analytical chemistry techniques and adhere to good laboratory practices, ensuring safety and precision in experimental procedures.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	2	2	0	1	0	0
CO 2	2	2	2	0	1	0	0
CO 3	2	2	2	0	1	0	0
CO 4	0	0	0	3	2	2	2
CO 5	0	0	0	3	2	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ATOMIC STRUCTURE**	**10**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations – wave mechanical concept of atom	
	2	Heisenberg's Uncertainty Principle – Dual nature of electrons – de Broglie equation – quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept	
	4	Periodic trends – atomic radii, ionic radii & covalent radii – effective nuclear charge and screening effect	
		Ionization potential – electro negativity and electron gain enthalpy.	
2		**CHEMICAL BONDING**	**10**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds. Lattice energy of ionic compounds	
	2	VSEPR theory and its applications. Shape of molecules CO_2, BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, PCl_5, SF_6, ClF_3.	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization Shapes of organic molecules like methane, ethane, ethylene and acetylene.	
	4	V.B Theory-Explain with examples H_2,N_2,CH_4,CH_2=CH_2	
	5	MO theory. Formation of B_2, C_2, N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples	
3		**ENVIRONMENTAL CHEMISTRY**	**10**

	1	Introduction-environment and segments- Pollutants of water: sewage, industrial effluents, soap and detergents, pesticides, fertilizers, heavy metals-biological magnification bioaccumulation	
	2	Toxic effect of pollutants, Water quality parameters – DO, BOD and COD, Water purification- sedimentation, coagulation, filtration, disinfection, ion exchange, desalination,	
	3	Air pollution – major regions of atmosphere, pollution by oxides of N, S, C, hydrocarbons and other organic chemicals, automobile exhausts, their physiological effects on vegetation and living organisms	
	4	Ozone layer – importance – depletion of ozone – consequences,	
	5	Greenhouse effect – global warming – acid rain, Toxicity and environmental hazards of pesticides, Radiation pollution and noise pollution	
4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**		**10**
	1	Accuracy and precision. Errors-classification. Concept of molarity, Normality, Molality (numerical problems expected).	
		Principle of volumetric analysis – Acidimetry and alkalimetry. Theory of acid-base indicators.	
	2	Types of analytical methods –Qualitative and Quantitative analysis Inorganic Qualitative analysis	
	3	**Good Laboratory Practices**	**5**
		a) Safe laboratory practices and Lab safety signs; Personal protective equipment (PPE) in Chemical laboratory, Awareness of Material Safety Data Sheet (MSDS).	
		b) Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures	
		c) Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	
5	**TEACHER SPECIFIC MODULE- - PRACTICALS QUANTITATIVE ANALYSIS I**		**30**

	*A minimum of eight experiments to be conducted Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of eight experiments one virtual lab experiment is open-ended and is subjected to teacher's choice.	
	1)Preparation of standard solutions (minimum 2) 2)Dilute solutions from Stock solutions in lab (minimum 2)	
	3)Acidimetry and Alkalimetry (minimum 3) a) Estimation of NaOH/KOH using standard Na_2CO_3. b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.	
	5. Use of Online Educational Resources (OER's) like Phet.Colarado.edu as a learning tool for "Build a molecule", "Chemical Bonding" and "Virtual titration tool"	

Essential Readings:

1. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.
2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
5. Shriver and Atkins, Inorganic Chemistry, W. H Freeman and Company, 2006.
6. G D Christian, Analytical Chemistry, John Wiley and Sons
7. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of
8. Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.
9. Vogel's Textbook of Quantitative Chemical Analysis
10. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU1DSCCHE115: BASICS OF STRUCTURAL & ANALYTICAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE115	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: Foundation course on atomic structure and chemical bonding. Course includes modules on atomic structure, periodic properties, chemical bonding, basics of coordination chemistry, analytical techniques, and quantitative analysis

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Attain basic information on atomic structure and theories associated with it and understand the periodic properties of elements	U
2	Get insight about the concept of chemical bonding and theories to explain bonding in various molecules	A
3	Get awareness about various types of molecules including coordination compounds and organic molecules.	U
4	Acquire proficiency in analytical chemistry techniques, they will also demonstrate knowledge of qualitative and quantitative analysis methods and be able to apply them in practical scenarios	U
5	To provide practical experience on various titrimetric analysis	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**ATOMIC STRUCTURE AND PERIODIC PROPERTIES OF ELEMENTS**	**10**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations	
	2	Wave mechanical concept of atom – Heisenberg's Uncertainty Principle – Dual nature of electrons – de Broglie equation, quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept – periodic trends – atomic radii, ionic radii & covalent radii – effective nuclear charge and screening effect – Ionization potential – electro negativity and electron gain enthalpy	

2		**CHEMICAL BONDING**	**10**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds (Definitions and example)-Lattice energy of ionic compounds.	
	2	VSEPR theory and its applications- Shape of molecules BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, SF_6	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization.	
	4	Valence bond theory- Explain with examples H_2, N_2, CH_4, $CH_2=CH_2$	
	5	MO theory- Formation of N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples.	

3	**BASICS OF COORDINATION CHEMISTRY**		**10**
	1	Introduction-Double salts and Coordination compounds	
	2	Werner's coordination theory- Classification of coordination compounds and various types of ligands	
	3	Nomenclature of coordination compounds- Application of coordination compounds in qualitative and quantitative analysis.	
	4	VBT- Square planar and octahedral complexes	

4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES-1**		**15**
		Accuracy and precision. Errors-classification. Concept of molarity, Normality, Molality (numerical problems expected). Principle of volumetric analysis – Acidimetry and alkalimetry. Theory of acid-base indicators.	
		Types of analytical methods –Qualitative and Quantitative analysis Inorganic Qualitative analysis	
		Safe laboratory practices and Lab safety signs; Personal protective equipment (PPE) in Chemical laboratory, Awareness of Material Safety Data Sheet (MSDS). Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures.	
		Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	

5	**TEACHER SPECIFIC MODULE-QUANTITATIVE ANALYSIS I-PRACTICALS**		**30**
	1	*A minimum of eight experiments to be conducted Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of eight experiments one virtual lab experiment is open-ended and is subjected to teacher's choice.	
	2	1)Preparation of standard solutions (minimum 2) 2)Dilute solutions from Stock solutions in lab (minimum 2)	
	3	3)Acidimetry and Alkalimetry (minimum 3) a) Estimation of NaOH/KOH using standard Na_2CO_3. b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.	
	4	4)Use of Online Educational Resources (OER's) like Phet.Colarado.edu as a learning tool for "Build a molecule", "Chemical Bonding" and "Virtual titration tool"	

Essential Readings:

1. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
2. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
3. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
4. Shriver and Atkins, Inorganic Chemistry, W. H Freeman, and Company, 2006.
5. G D Christian, Analytical Chemistry, John Wiley, and Sons.
6. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of Quantitative Chemical Analysis
7. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of the best two test papers

KU1CHEDSC116: PRINCIPLES OF BASIC CHEMISTRY-I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	**KU1CHEDSC116**	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	30	70	100	2

Course Description: Explore the fundamental principles of chemistry through an engaging course covering atomic structure, chemical bonding, colloids, analytical techniques, and quantitative analysis. Through theoretical learning and practical applications, develop a deep understanding of molecular behaviour, laboratory practices, and quantitative analysis skills essential for a career in chemistry and related fields.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of atomic structure and periodicity in properties of elements.	U
2	Develop a good understanding of the concepts and the theories of chemical bonding and be able to apply them in predicting the shapes of molecules.	A

3	Understand the classification, preparation, properties of colloids and their applications in life.	U
4	Exhibit good laboratory practices and apply knowledge of quantitative analysis methods in practical scenarios.	A
5	Develop skills in virtual lab experiments and quantitative analysis skills through practical laboratory exercises.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	0	0	0	0	0
CO 2	3	3	0	0	0	0	0
CO 3	0	0	2	1	0	0	0
CO 4	0	0	0	2	2	1	1
CO 5	0	0	0	0	1	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**ATOMIC STRUCTURE**	**10**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations – wave mechanical concept of atom	

	2	Heisenberg's Uncertainty Principle – Dual nature of electrons – de Broglie equation – quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept	
	4	Periodic trends – atomic radii, ionic radii & covalent radii – effective nuclear charge and screening effect	
		Ionization potential – electro negativity and electron gain enthalpy	
2	**CHEMICAL BONDING**		**10**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds. Lattice energy of ionic compounds	
	2	VSEPR theory and its applications. Shape of molecules CO_2, BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, PCl_5, SF_6, ClF_3.	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization Shapes of organic molecules like methane, ethane, ethylene and acetylene.	
	4	Valence bond theory	
	5	MO theory-Formation of B_2, C_2, N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples.	
3	**COLLOIDS**		**10**
	1	Classification – preparation – structure and stability -Properties of Colloids – Tyndall effect – Brownian movement	
	2	Coagulation of colloidal solution – Hardy-Schultz rule – Flocculation value – protective colloids – Gold number	
		Emulsions – oil in water and water in oil type emulsions – Emulsifying agents – Gels – imbibition – syneresis	
	3	Applications of colloids in food, medicine and industry	

4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**		**15**
	1	Accuracy and precision. Errors-classification-Concept of molarity, normality, molality (numerical problems expected)	
		Principle of volumetric analysis – Acidimetry and alkalimetry-theory of acid-base indicators.	
	2	Types of analytical methods –Qualitative and Quantitative analysis Inorganic Qualitative analysis	
	3	Good Laboratory Practices	
		a) Safe laboratory practices and Lab safety signs; Personal protective equipment (PPE) in Chemical laboratory, Awareness of Material Safety Data Sheet (MSDS).	
		b) Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures	
		c) Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	

5	**TEACHER SPECIFIC MODULE- PRACTICALS** **QUANTITATIVE ANALYSIS -I**	**30**
	*A minimum of eight experiments to be conducted Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of eight experiments one virtual lab experiment is open-ended and is subjected to teacher's choice.	
	1)Preparation of standard solutions (minimum 2) 2)Dilute solutions from Stock solutions in lab (minimum 2)	

	3)Acidimetry and Alkalimetry (minimum 3) a) Estimation of NaOH/KOH using standard Na_2CO_3. b) Estimation of $HCl/H_2SO_4/HNO_3$ using standard oxalic acid.	
	4) Use of Online Educational Resources (OER's) like Phet.Colarado.edu as a learning tool for "Build a molecule", "Chemical Bonding" and "Virtual titration tool"	

Essential Readings:

1. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.
2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
5. Shriver and Atkins, Inorganic Chemistry, W. H Freeman, and Company, 2006.
6. G D Christian, Analytical Chemistry, John Wiley and Sons.
7. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of
8. Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.
9. Vogel's Textbook of Quantitative Chemical Analysis
10. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two Test Papers

Employability of the Course: Completion of this course enhances employability by equipping graduates with essential knowledge and practical skills in chemistry. Graduates are prepared for roles in industries such as pharmaceuticals, food, research, and quality control, with proficiency in laboratory techniques, analytical methods, and a strong foundation in chemical principles.

KU1DSCCHE117: FOUNDATION COURSE IN CHEMISTRY -I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	100	**KU1DSCCHE117**	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises modules on states of matter, solutions, nuclear chemistry, colloids and one on quantitative analysis.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	A comprehensive understanding about the characteristics and properties of gaseous and liquid states of matter	U
2	Explain the properties of solutions and solve numerical problems to calculate concentrations of solutions	A
3	Comprehensive understanding about the constructive and destructive nature of nuclear reactions	U
4	A good understanding about the characteristics and properties of different types of colloids and their application in daily life.	U

5	Learners will develop quantitative analysis skills through practical laboratory exercises.	A
6	Demonstrate the building of molecules and virtual lab titrations using online resources.	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	2	0	0	1	0	1
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	2	1	0
CO 5	0	0	0	0	1	2	2
CO 6	0	1	0	0	0	2	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**STATES OF MATTER**	**13**
	1	Gaseous State: Introduction - Kinetic molecular model of gases	

	2	Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required)	
	3	Collision diameter, Collision number, Collision frequency, Mean free path	
	4	Boyle's law – Charles's law – Ideal gas equation- Behaviour of real gases –Deviation from ideal behaviour - Van der Waals equation (derivation not required).	
	5	Joule-Thomson effect and Liquefaction of gases -critical temperature	
	6	Liquid state-properties of liquids-vapour pressure, surface tension, viscosity	
2	**SOLUTIONS**		**12**
	1	Types of solutions- concentration of solutions-mole fraction-molarity, normality- percentage by mass	
	2	Vapour pressure of solutions-Raoult's Law-Ideal and non-ideal solutions-Types of non-ideal solutions	
	3	Colligative properties-relative lowering of vapour pressure-elevation of boiling point, depression in freezing point, osmotic pressure	
	4	Abnormal molecular mass	
3	**NUCLEAR CHEMISTRY**		**10**
	1	Concept of nuclides – representation of nuclides – isobars, isotopes, and isotones with examples –Detection of isotopes using Aston's mass spectrograph	
	2	Separation of isotopes by diffusion methods – stability of nucleus – n/p ratio- Liquid drop model	
	3	Radioactivity – natural and artificial-Decay constant and half-life period-Radioactive series – Group displacement law	

	4	Radio isotopes and their applications in structural elucidation, in agriculture and in industry –Radiocarbon dating	
	5	Nuclear fission and nuclear fusion-Problems associated with nuclear waste disposal-Derivation of decay constant – Atom bomb and hydrogen bomb-Mass defect- nuclear binding energy	
4	**COLLOIDS**		**10**
	1	Classification – preparation – structure and stability -Properties of Colloids – Tyndall effect – Brownian movement	
	2	Coagulation of colloidal solution – Hardy-Schultz rule – Flocculation value – protective colloids – Gold number	
	3	Emulsions – oil in water and water in oil type emulsions – Emulsifying agents – Gels – imbibition – syneresis	
	4	Applications of colloids in food, medicine and industry	
5	**TEACHER SPECIFIC MODULE- PRACTICALS**		**30**
	Preparation of standard solutions 4 experiments, 1 cryoscopy experiment and use of online resource for build a molecule must be done. In open ended experiments one experiment from a and b can be done as per teacher's choice.		
	1.Preparation of standard solutions (normal, molar, percentage by mass, percentage by volume, ppm, ppb) **2.** Cryoscopy Using Solid Solvent a) Cryoscopic constant of solid solvent using a solute of known molar mass (cooling curve method) Solid solvents/solutes given: Naphthalene, Biphenyl, diphenyl amine. b) Molar mass of the given solute, using solvent of known K_f. Solid solvents/solutes given: Naphthalene, Biphenyl, diphenyl amine.		

	3.Use of Online Educational Resources (OER's) like PhET.Colarado.edu as a learning tool for "Build a molecule*",* **4.Open ended.** ***a)*** Preparation of bathing soap/washing soap *b) "Chemical Bonding", "Virtual titration tool"*	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
3. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
4. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
5. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
6. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of the best two test papers

KU1DSCCHE124: ESSENTIALS OF STRUCTURAL & ANALYTICAL - CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE124	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

Course Description: Foundation course on atomic structure and chemical bonding. The course also will introduce the basics of coordination chemistry and chemical kinetics. Apart from these, the course intended to deliver fundamental concepts of laboratory techniques as well.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Attain basic information on atomic structure and theories associated with it.	U
2	Understand the periodic properties of elements	U
3	Get insight about the concept of chemical bonding and theories to explain bonding in various molecules	A
4	Get awareness about various types of molecules including coordination compounds and organic molecules.	U

5	Attain basic knowledge in kinetics of chemical reactions	U
6	Acquire proficiency in analytical chemistry techniques, they will also demonstrate knowledge of qualitative and quantitative analysis methods and be able to apply them in practical scenarios	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	1	0	0	0	0
CO 2	3	0	1	0	0	0	0
CO 3	3	0	1	0	0	0	0
CO 4	3	0	0	0	0	0	0
CO 5	3	0	1	0	0	0	0
CO6	2	3	1	0	0	0	0

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**ATOMIC STRUCTURE AND PERIODIC PROPERTIES OF ELEMENTS**		**11**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations	

	2	wave mechanical concept of atom – Heisenberg's Uncertainty Principle – Dual nature of electrons – De Broglie equation, quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept – periodic trends – atomic radii, ionic radii & covalent radii – effective nuclear charge and screening effect – Ionization potential – electro negativity and electron gain enthalpy	

2	**CHEMICAL BONDING**		**12**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds (Definitions and example). Lattice energy of ionic compounds.	
	2	VSEPR theory and its applications. Shape of molecules BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, SF_6	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization.	
	4	Valence bond theory- Shapes of organic molecules like ethane and ethylene	
	5	MO theory. Formation of N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples.	

3	**BASICS OF COORDINATION CHEMISTRY**		**10**
	1	Introduction-Double salts and Coordination compounds	
	2	Werner's coordination theory- Classification of coordination compounds and various types of ligands	
	3	Nomenclature of coordination compounds- Application of coordination compounds in qualitative and quantitative analysis.	
	4	VBT- Square planar and octahedral complexes	
4	**CHEMICAL KINETICS AND CATALYSIS**		**15**

	1	Definition – reaction rate – factors affecting the rate of a chemical reaction – units.	
	2	Zero order reactions – Order versus molecularity. Pseudo order reactions.	
	3	Integrated rate equation for first order reaction – half life – Ester hydrolysis – equation.	
	4	Collision theory (qualitative) Effect of temperature on reaction rate.	
	5	Transition state theory and theory of catalysis using transition state theory.	
	TEACHER SPECIFIC MODULE-ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES-1		**12**
5	1	**Directions:** Accuracy and precision. Errors-classification. Concept of molarity, Normality, Molality (numerical problems expected). Principle of volumetric analysis – Acidimetry and alkalimetry. Theory of acid-base indicators.	
	2	Types of analytical methods –Qualitative and Quantitative analysis Inorganic Qualitative analysis	
	3	Safe laboratory practices and Lab safety signs; Personal protective equipment (PPE) in Chemical laboratory, Awareness of Material Safety Data Sheet (MSDS). Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures.	
	4	Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	

Essential Readings:

1. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
2. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
3. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
4. Shriver and Atkins, Inorganic Chemistry, W. H Freeman, and Company, 2006.

5. G D Christian, Analytical Chemistry, John Wiley, and Sons.
6. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of Quantitative Chemical Analysis
7. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		100

KU1DSCCHE126: FUNDEMENTALS OF STRUCTURAL & ANALYTICAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
I	DSC	100	KU1DSCCHE126	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0	-	30	70	100	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ATOMIC STRUCTURE AND PERIODIC PROPERTIES OF ELEMENTS**		**11**
	1	Bohr atom Model (No derivation) – Atomic Spectra of Hydrogen – limitations	
	2	wave mechanical concept of atom – Heisenberg's Uncertainty Principle – Dual nature of electrons – De Broglie equation, quantum numbers. Orbit and orbitals.	
	3	The periodic table – periods and groups-s, p, d and f block elements – modern concept – periodic trends – atomic radii, ionic radii & covalent	

		radii – effective nuclear charge and screening effect – Ionization potential – electro negativity and electron gain enthalpy	
2	**CHEMICAL BONDING**		**12**
	1	Types of chemical bonds-Ionic, covalent and co-ordinate bonds (Definitions and example). Lattice energy of ionic compounds.	
	2	VSEPR theory and its applications. Shape of molecules BeF_2, BF_3, CH_4, NH_3, H_2O, NH_4^+, SF_6	
	3	Orbital overlapping – Hybridization sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3 and dsp^2 hybridization.	
	4	Valence bond theory- Shapes of organic molecules like ethane and ethylene	
	5	MO theory. Formation of N_2 and O_2 molecules	
	6	Hydrogen bonding, types of hydrogen bonding – examples.	
3	**BASICS OF COORDINATION CHEMISTRY**		**10**
	1	Introduction-Double salts and Coordination compounds	
	2	Werner's coordination theory- Classification of coordination compounds and various types of ligands	
	3	Nomenclature of coordination compounds- Application of coordination compounds in qualitative and quantitative analysis.	
	4	VBT- Square planar and octahedral complexes	
4	**ENVIRONMENTAL CHEMISTRY**		**15**
		Introduction-environment and segments- Pollutants of water – sewage, industrial effluents, soap and detergents, pesticides, fertilizers, heavy metals, biological magnification bioaccumulation	
		Toxic effect of pollutants, Water quality parameters – DO, BOD and COD, Water purification- sedimentation, coagulation, filtration, disinfection, ion exchange, desalination,	
		Air pollution – major regions of atmosphere, pollution by oxides of N, S, C, hydrocarbons and other organic chemicals, automobile exhausts, their physiological effects on vegetation and living organisms Ozone layer – importance – depletion of ozone – consequences,	

5	**TEACHER SPECIFIC MODULE-ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES-1**		**12**
		Directions: Accuracy and precision. Errors-classification. Concept of molarity, Normality, Molality (numerical problems expected). Principle of volumetric analysis – Acidimetry and alkalimetry. Theory of acid-base indicators.	
		Types of analytical methods –Qualitative and Quantitative analysis Inorganic Qualitative analysis	
		Safe laboratory practices and Lab safety signs; Personal protective equipment (PPE) in Chemical laboratory, Awareness of Material Safety Data Sheet (MSDS). Hazardous Symbols and Signs (Physical, Chemical, Environmental and Health), Lab accidents and safety measures.	
		Simple first aids: Electric shocks, fire accidents, burn by chemicals, cut by glass and inhalation of poisonous gases.	

Essential Readings:

2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.
3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.
4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
5. Shriver and Atkins, Inorganic Chemistry, W. H Freeman, and Company, 2006.
6. G D Christian, Analytical Chemistry, John Wiley, and Sons.
7. G H Jeffery, J Bassett, J Mendham, R C Denny, Vogel's Textbook of Quantitative Chemical Analysis
8. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		100

SEMESTER - II

KU2DSCCHE101: FUNDAMENTALS OF CHEMISTRY- II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE101	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course covers modules on chemical bonding, acids and bases, fundamentals of coordination chemistry, introduction to solid state, organic reaction mechanism and quantitative analysis involving redox titrations and complexometry.

Course Pre-requisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the principles of chemical bonding, coordination compounds and acid base concepts.	U
2	Apply the concept of hybridisation and VSEPR theory in predicting the shape of molecules	A
3	Develop basic knowledge about reaction intermediates and aromaticity of molecules	K

4	Analyse the electron displacement and structural effects on the reactions of organic compounds and explain the properties	A
5	Understand the types of packing and imperfections in solids and their role in determining the properties of solids and solve problems for calculating number of atoms per unit cell and packing efficiency.	A
6	Develop advanced practical skills in volumetric analysis, interpreting and communicating results effectively in a laboratory setting.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	0	0	0	0	0
CO 2	3	3	0	0	0	0	1
CO 3	0	0	2	0	0	0	0
CO 4	0	0	0	3	0	1	1
CO 5	0	0	0	0	3	0	1
CO6	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**CHEMICAL BONDING**		**12**
	1	General characteristics, types of ions-Factors affecting the formation of ionic compound	
		Lattice energy – Born- Lande equation with derivation - Madelung constant	
		Born Haber cycle and its application -	
		Covalent bond - Valance bond theory and its limitations	
	2	Hybridization and shapes of simple molecules (BeF_2, PCl_3, SF_6, CH_4, CH_3- CH_3, CH_2=CH_2, CH≡CH)	
	4	VSEPR theory – Shape of molecules and ions (NH_3, XeF_6, ClF_3, NH_4^+, H_3O^+)	
		Molecular orbital theory- homodiatomic molecules and heterodiatomic molecules (HCl and NO)- LCAO method- Bond strength and bond energy - Polarisation and Fajan's rule	

2	**ACIDS AND BASES & FUNDAMENTALS OF COORDINATION CHEMISTRY**		**14**
	1	Concepts of Lowry and Bronsted – Lux – Arrhenius concept, flood concept – The solvent system concept – The Lewis concept	

	2	Relative strength of Acids and Bases – Effect of solvent – Levelling effect –Effect of polarity and substituents	
	3	Hard and soft acids and bases – Pearson's concept –Bonding in hard–hard and soft–soft combinations – HSAB principle and its applications –Basis for hard- hard and soft–soft interactions.	
	4	Classification of solvents – characteristic properties of a solvent – study of liquid ammonia	
	5	Introduction-Double salts and Coordination compounds-Werners coordination theory- Classification of coordination compounds-.	
	6	Types of ligands. Chelates-Nomenclature of coordination compounds-	
	7	Stereochemistry of coordination compounds with coordination number 2 to 6-Isomerism -Application of coordination compounds in qualitative and quantitative analysis	
3	**INTRODUCTION TO SOLID STATE**		**6**
	1	General characteristics of solids- amorphous and crystalline solids- classification of crystalline solids- crystal lattices and unit cells	
	2	Number of atoms in unit cell- close packed structures- packing efficiency- calculations involving unit cell dimensions-	
	3	Imperfections in solids- point defects-stoichiometric -impurity and non-stoichiometric (Explain different types of each)	
4	**ORGANIC REACTION MECHANISM**		**12**
	1	Electron displacement in organic molecules- inductive effect, Electromeric effect, Resonance or Mesomeric effect and Hyper conjugation	
	2	Steric effect- Tautomerism Applications of electron displacement effect in the order of acidity of Carboxylic acids, Phenol and Basicity of amines-	

	3	Comparative basic strength of Ammonia, methyl amine, dimethyl amine, trimethyl amine. - comparative basic strength of aniline, N-methylaniline and N, N-dimethyl aniline (in aqueous and non- aqueous medium), steric effects and substituent effects- Application of steric effect in the basicity of substituted aromatic amines	
	4	Effect of hyperconjugation in the stability of isomeric alkenes- Explanation of Order of stability of carbonium ions, carbanions, and free radicals.	

5	**PRACTICAL -VOLUMETRIC ANALYSIS II**	**30**
	Minimum 6 experiments must be done. Of the 6 experiments 2 are open ended.	
	Redox titrations-Dichrometry 1.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using internal indicator 2.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using external indicator **Iodometry And Iodimetry** 1.Estimation of Cu^{2+} / $CuSO_4.\ 5H_2O$. 2. Estimation of potassium dichromate. **Complexometry** Estimation of Mg^{2+}, $Zn^{2+}$and hardness of water **Open ended (Familiarise the use of PhET in any two volumetric experiments)** **Suggestions** 1.Estimation of Fe^{3+} - reduction by SnCl2 - internal indicator (Dichrometry) 2.Estimation of As_2O_3/As^{3+}(Iodometry) 3.Estimation of chloride in neutral medium (Precipitation titration-using adsorption indicators	

Essential readings

1. J E Huheey, E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, Pearson.
2. B R Puri, L R Sharma, K C Ka.lia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi.
3. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York.
4. J. D. Lee, Concise Inorganic Chemistry 5th edn, Blackwell Science, London
5. 1 P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers
6. Peter Sykes, 'A Guidebook to Mechanism in Organic Chemistry', Pearson Education
7. P. Y. Bruice, 'Organic Chemistry', Pearson Education.
8. Introduction to solids Leonid V Azaroff
9. Solid state chemistry by Lesley E. Smart and Elaine A. Morre
10. Solid state chemistry and its applications-Antony. R. West
11. D A Skoog, D M West, Analytical Chemistry, An Introduction, 4th Edn., CBS Publishing Japan Ltd., 1986
12. G D Christian, Analytical Chemistry, John Wiley, and Sons.
13. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denny, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., ELBS, 1989.
14. R. Gopal, Inorganic Chemistry for undergraduates, Universities press, India Pvt.Ltd, 2009.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

KU2DSCCHE111: BASIC PHYSICAL CHEMISTRY AND FORENSIC CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE111	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This discipline specific course offers an enriching exploration of fundamental physical chemistry and forensic chemistry concepts in the first four modules. Practical chemistry provides knowledge regarding the analytical tools like redox titration and colorimetry.

Course Prerequisite: Elementary knowledge in PUC level Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand thermodynamic principles and analyse the spontaneity of a particular reaction.	U
2	Classify the compounds based on their acidic and basic properties and calculate the pH of a solution	A
3	Understand the surface phenomenon and properties and applications of colloids.	U
4	Familiarise the principles of redox titration and investigate the principles of colorimetry	An
5	Understand the basic tools used in forensic analysis	U
6	Employ the applications of redox titrations and colorimetric estimations in practice.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	1
CO 3	0	0	3	0	0	0	0
CO 4	0	1	0	3	0	0	1
CO 5	0	0	0	0	3	1	0
CO 6	0	0	0	0	1	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**THERMODYNAMICS AND IONIC EQUILIBRIUM**	**15**
	1	**Thermodynamics -** Basic concepts– System – surroundings – open, closed and isolated systems -Process- Isothermal – isochoric and isobaric process – work – heat – energy – internal energy	
	2	Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv- First law of thermodynamics – The second law of thermodynamics – Enthalpy-Entropy-and Free energy	
	3	Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes	
	4	**Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts- **Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry- Bronsted and Lewis concepts	
	5	Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant	
2		**CHEMICAL KINETICS**	**10**
	1	Definition – reaction rate – factors affecting the rate of a chemical reaction – units – Zero order reactions - Order versus molecularity-Pseudo order reactions	
	2	Integrated rate equation for first order reaction – half life- Determination of the order – Half-life method and Graphical method- Ester hydrolysis – rate equation	

	3	Collision theory (qualitative) Effect of temperature on reaction rate Calculation of Ea from the values of k at two temperatures. Transition state theory (qualitative).	
3	**SURFACE CHEMISTRY AND COLLOIDS**		**10**
	1	Physical and chemical adsorption – Adsorption isotherms – – use and limitation. B.E.T. equations (B.E.T. no derivation) - Freundlich adsorption isotherm – effect of temperature on adsorption	
	2	Langmuir adsorption isotherm -thermodynamic derivation- Gibbs adsorption equation (no derivation)-Surface films - Determination of surface area using Langmuir equations	
	3	**COLLOIDS-**Classification – preparation – structure and stability – The electrical double layer – zeta potential– Properties of Colloids – Tyndall effect – Brownian Movement-Coagulation of colloidal solution – Hardy-Schultz rule – Flocculation value.	
	4	Protective colloids – Gold number –Emulsions – oil in water and water in oil type emulsions – Emulsifying agents – Gels –imbibition – syneresis – applications of colloids in food, medicine and industry	
4	**ANALYTICAL CHEMISTRY AND FORENSIC CHEMISTRY**		**10**
	1	**Redox titrations –** Permanganometry and Dichrometry- redox indicators. Iodometry and Iodimetry -Indicators – theory of adsorption indicators.	
	2	**Introduction to Forensic Science**- Chemical analysis- atoms, elements, molecules and compounds	
	3	Blood analysis- spatter-antibodies and timing- Estimation of time of death (mention the tools)	
	4	Ballistic and bullet analysis	
	5	Fingerprint analysis	

5	**TEACHER SPECIFIC MODULE- PRACTICALS- QUANTITATIVE ANALYSIS -II**	**30**
	A minimum of six experiments must be conducted Two burette method (As per Green Chemistry Protocol) is preferred for the above titrations. Out of the six experiments one is to be open-ended and is subjected to teacher's choice.	
	Quantitative Analysis- Redox Titrations **1 Permanganometry** a. Estimation of oxalic acid. b. Estimation of Fe^{2+} c. Estimation of Nitrite **2. Dichrometry** a. Estimation of Fe^{2+} -using internal and external indicator b. Estimation of Fe^{3+} - reduction by $SnCl_2$ - internal indicator(lab or virtual lab) Open ended **3. Iodometry and Iodimetry** a. Estimation of Cu^{2+} /$CuSO_4$ $5H_2O$. b. Estimation of potassium dichromate. **4.Colorimetry** a. Verification of Beer-Lambert law for $KMnO_4$, b. Determination of the concentration of the given solution	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford niversity Press
2. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
3. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
4. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
5. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd

6. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
7. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.
8. Physical Chemistry: W.J. Moore, Orient Longmans.
9. Physical Chemistry: N. Kundu & S.K. Jain, S. Chand & Company.
10. Chemical Thermodynamics: J. Rajaram and J.C. Kuriakose, Pearson.
11. Physical Chemistry: A Molecular Approach by Donald A Mc Qurrie
12. Physical chemistry by G W Castellan.
13. Safarstein Criminalistics: An introduction to Forensic Science, Pearson, 12 thed, 2017
14. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*** Average mark of the best two written tests may be considered for internal mark**

KU2DSCCHE112: PRINCIPLES OF PHYSICAL CHEMISTRY AND ENVIRONMENTAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE112	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This discipline specific course offers an enriching exploration of fundamental physical chemistry and environmental and water chemistry concepts in the first four modules. Practical chemistry provides knowledge regarding the analytical tools like redox titration and colorimetry.

Course Prerequisite: Should be aware of characteristics of acids and bases, thermodynamic terms and concepts like energy and heat, reaction rate environmental aspects of chemistry and fundamentals of titration.

CO No.	Expected Outcome	Learning Domains
1	Understand thermodynamic principles and analyse the spontaneity of a particular reaction.	U
2	Classify the compounds based on their acidic and basic properties and calculate the pH of a solution	A
3	Understand the surface phenomenon and properties and applications of colloids.	U
4	Familiarize the principles of redox titration and investigate the principles of colorimetry	A
5	Describe the significance of Environmental Chemistry and recommend the importance of protection of environmental segments.	C
6	Employ the applications of redox titrations and chromatographic techniques in practice.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO1	3	0	0	0	0	0	0
CO2	0	3	0	0	0	0	1
CO3	0	0	3	0	0	0	0
CO4	0	1	0	3	0	0	1
CO5	0	0	0	0	3	1	0
CO6	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
	THERMODYNAMICS AND IONIC EQUILIBRIUM		**15**
1	1	**Thermodynamics -** Basic concepts– System – surroundings – open, closed and isolated systems -Process- Isothermal – isochoric and isobaric process	
	2	Work – heat – energy – internal energy- Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv	
	3	First law of thermodynamics – The second law of thermodynamics – Enthalpy-Entropy-and Free energy- Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes	
	4	**Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts	
	5	Ionization of weak electrolytes. pH and pOH values. Buffer solutions and calculations of their pH- Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant	
2	**ENVIRONMENTAL CHEMISTRY**		**10**

	1	Environmental segments: Lithosphere, Hydrosphere, Atmosphere and Biosphere- Hydrosphere- Chemical composition of water in water bodies –(Ground water, river water and lake water, sea water wetlands)- Hydrological cycle	
	2	Water pollution **-**Water resources, - water pollution – sources – Industrial effluents – agriculture discharge oilspills – heavy metals – pesticides – detergents	
	3	Eutrophication – biomagnifications and bioaccumulation – experimental determination of Dissolved oxygen, BOD and COD – Thermal Pollution – Control of water pollution –ISI/BSI standards of drinking water.	
	4	Hardness of water – causes and effects –methods of estimation – removal of hardness- Domestic water treatment – Sewage –Sewage analysis -Sewage treatment.	
3	**SURFACE CHEMISTRY AND COLLOIDS**		**10**
	1	Physical and chemical adsorption – Adsorption isotherms – use and limitations .B.E.T. equations (B.E.T. no derivation)	
	2	Freundlich adsorption isotherm –effect of temperature on adsorption. Langmuir adsorption isotherm -thermodynamic derivation	
	3	Gibbs adsorption equation (no derivation)-Surface films -Determination of surface area using Langmuir equations.	
	4	COLLOIDS-Classification – preparation – structure and stability – The electrical double layer – zeta potential–	
	5	Properties of Colloids – Tyndall effect – Brownian Movement-Coagulation of colloidal solution – Hardy-Schultz rule – Flocculation value.	
	6	Protective colloids – Gold number –Emulsions – oil in water and water in oil type emulsions – Emulsifying agents – Gels –imbibition – syneresis – applications of colloids in food, medicine and industry.	

4	**ANALYTICAL CHEMISTRY AND CHROMATOGRAPHY**		**10**
	1	**Redox titrations –** Permanganometry and Dichrometry- redox indicators. Iodometry and Iodimetry -Indicators – theory of adsorption indicators	
	2	Introduction - Adsorption and partition chromatography – Principle and applications of column, thin layer, paper, Liquid and gas chromatography	
	3	HPLC, Ion Exchange chromatography (IEC)	
	4	Rf value – Relative merits of different techniques	
5	**TEACHER SPECIFIC MODULE- PRACTICALS-QUANTITATIVE ANALYSIS -II***		**30**
	*A minimum of six experiments must be done. Two burette method (As per Green Chemistry Protocol) may be preferred for the titrations. Out of the six experiments one is open-ended and is subjected to teacher's choice.		
	Quantitative Analysis- Redox Titrations **1 Permanganometry** a. Estimation of oxalic acid. b. Estimation of Fe^{2+} c. Estimation of Nitrite **2. Dichrometry** a. Estimation of Fe^{2+} -using internal and external indicator b. Estimation of Fe^{3+} - reduction by $SnCl_2$ - internal indicator **Open ended** **3**. Iodometry and Iodimetry a. Estimation of Cu^{2+} /$CuSO_4$ $5H_2O$. b. Estimation of potassium dichromate		

	. **4. Colorimetry** a. Verification of Beer-Lambert law for $KMnO_4$, b. Determination of the concentration of the given solution.	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
3. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
4. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
5. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
6. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
7. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

KU2DSCCHE113: GENERAL CHEMISTRY-II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	**KU2DSCCHE113**	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on liquid state, solutions, Instrumental techniques in analytical chemistry, chemical equilibrium, corrosion, environmental chemistry and a module on practicals

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of the properties of liquid state and solutions	U
2	Understanding about the various instrumental techniques in analytical chemistry	U
3	A comprehensive understanding of the laws and theories of chemical equilibrium and corrosion and analyse them to apply in real life situations.	An
4	Analyse the environmental issues and develop habits to protect our environment.	An

5	Acquire proficiency in analytical chemistry techniques, chromatographic separation techniques, solvent extraction and in virtual lab titrations	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	2	0	1	2	2
CO 2	3	1	2	0	1	2	2
CO 3	3	0	2	0	1	2	2
CO 4	3	1	2	1	3	3	2
CO 5	3	1	2	1	2	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**LIQUID STATE &SOLUTIONS**		**13**
	1	Liquid State: Introduction - Vapour pressure – Raoult's law- ideal and non-ideal solutions-.	
	2	Surface tension and viscosity –Explanation of these properties based on intermolecular attraction.	
	3	Solutions: Kinds of solutions – Concentration of solutions-molarity, normality, mole fraction. percentage by mass-Solubility of gases in liquids – Henry's law and its applications	

	4	Colligative properties - Determination of molecular mass using colligative properties-Abnormal molecular mass	
2	**INSTRUMENTAL TECHNIQUES IN ANALYTICAL CHEMISTRY**		**10**
	1	Thermogravimetric analysis – introduction – instrumentation – factors affecting TGA –application of TGA.	
	2	Differential thermal analysis – introduction – instrumentation – principle of working – factors affecting DTA- application.	
	3	Thermometric titrations – a brief study- Spectrophotometry	
	4	Potentiometric Titration and their applications	
3	**CHEMICAL EQUILIBRIUM &CORROSION**		**12**
	1	Reversible reactions-Law of mass action-relationship between Kc, Kp and Kx- Thermodynamic derivation of chemical equilibrium	
	2	Le Chatelier's Principle-Effects of temperature, pressure and concentration	
	3	Corrosion Introduction. Causes of corrosion-types of corrosion	
	4	Theories of corrosion- (Direct chemical attack or drycorrosion. Electrochemical theory or wet corrosion- Factors influencing corrosion-nature of the metal- nature of the environment. Corrosion control	
4	**ENVIRONMENTAL CHEMISTRY**		**10**
	1	Introduction-environment and segments- Pollutants of water – sewage, industrial effluents, soap and detergents, pesticides, fertilizers, heavy metals, biological magnification and bioaccumulation, Toxic effect of pollutants	
	2	Water quality parameters – DO, BOD and COD, Water purification-sedimentation, coagulation, filtration, disinfection, ionexchange, desalination	

	3	Air pollution – major regions of atmosphere, pollution by oxides of N, S, C, hydrocarbons and other organic chemicals, automobile exhausts, their physiological effects on vegetation and living organisms, Ozone layer – importance – depletion of ozone –consequences,	
	4	Greenhouse effect – global warming – acid rain, Toxicity and environmental hazards of pesticides, Radiation pollution and noise pollution.	
5	**TEACHER SPECIFIC MODULE-PRACTICALS**		**30**
	Quantitative and Chromatographic Analysis Practicals Total **7** experiments must be done. Out of this 2 must be from permanganometry and 2 from dichrometry. Remaining 3 experiments can be from surface tension/Viscosity/chromatography.		
	1.**Permanganometry** a. Estimation of oxalic acid. b. Estimation of Fe^{2+} c. Estimation of Nitrite **2.Dichrometry** 1.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using internal indicator 2.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using external indicator		
	Teacher specific (suggestions) Surface tension-Measurement using Stalagnometer Viscosity-Using Ostwald viscometer		
	3.Chromatography Experiments. a) Setting up a thin layer plate, Iodine chamber for chromatographic separation b) Setting up paper (both horizontal and vertical) chromatography c) Column packing and elution in Column chromatography. d) Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques		

	e) Separation of plant pigments using TLC, Paper and Column Chromatography	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
4. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
5. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
6. Environmental Chemistry A.K.De
7. Pragathi's Instrumental Methods of Analysis: H.Kau
8. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
9. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.
10. Physical Chemistry: W.J. Moore, Orient Longmans.
11. Physical Chemistry: N. Kundu & S.K. Jain, S.Chand& Company.
12. Chemical Thermodynamics: J.Rajaram and J.C.kuriacose,Pearson.
13. Physical Chemistry: A Molecular Approach by Donald A Mc Qurrie
14. Physical chemistry by G W Castellan.
15. Environmental Chemistry, A.K.De.
16. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

KU2DSCCHE121: ESSENTIAL CONCEPTS IN CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
2	DSE	100	KU2DSECHE121	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: The course is intended to deliver the fundamental concepts in physical chemistry, that includes the solution state, thermodynamics and chemical equilibrium. Also, the course offers communication of various aspects of instrumentation techniques and environmental chemistry.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of the properties of liquid state and solutions	U
2	Understanding about the various instrumental techniques in analytical chemistry	U
3	A comprehensive understanding of the laws and theories of chemical equilibrium and corrosion and analyse them to apply in real life situations.	U
4	Understanding the concepts of thermodynamics in the context of chemical reactions	U
5	Analyse the environmental issues and develop habits to protect our environment.	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	1	0	0	0	0
CO 2	3	0	1	0	0	0	0
CO 3	3	0	1	0	0	0	0
CO 4	3	0	1	0	0	0	0
CO 5	3	0	1	0	0	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**LIQUID STATE &SOLUTIONS**		**13**
	1	Liquid State: Introduction - Vapour pressure – Raoult's law- ideal and non-ideal solutions.	
	2	Surface tension and viscosity –Explanation of these properties on the basis of intermolecular attraction.	
	3	Solutions: Kinds of solutions – Concentration of solutions-molarity, normality, mole fraction. Percentage by mass-Solubility of gases in liquids – Henry's law and its applications	
	4	Colligative properties - Determination of molecular mass using colligative properties-Abnormal molecular mass	

2	**INSTRUMENTAL TECHNIQUES IN ANALYTICAL CHEMISTRY**		**10**
	1	Thermogravimetric analysis – introduction – instrumentation – factors affecting TGA –application of TGA.	
	2	Differential thermal analysis – introduction – instrumentation – principle of working – factors affecting DTA- application.	
	3	Thermometric titrations – a brief study.	
	4	Spectrophotometry	
	5	Potentiometric Titration and their applications	
3	**CHEMICAL EQUILIBRIUM &CORROSION**		**12**
	1	Reversible reactions-Law of mass action-relationship between Kc, Kp and Kx	
	2	Thermodynamic derivation of chemical equilibrium-	
	3	Le-Chatliers Principle-Effects of temperature, pressure and concentration	
	4	Corrosion: Introduction. Causes of corrosion-types of corrosion	
	5	Theories of corrosion- (Direct chemical attack or dry corrosion. Electrochemical theory or wet corrosion	
	6	Factors influencing corrosion- nature of the metal- nature of the environment. Corrosion control	
4	**THERMODYNAMICS**		**10**
	1	**Thermodynamics -** Basic concepts– System – surroundings – open, closed and isolated systems – Isothermal – isochoric and isobaric process – work – heat – energy – internal energy – Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv	
	2	First law– The second law – Enthalpy-Entropy-and Free Energy-Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes.	
	3	**Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts, ionization of weak electrolytes. pH and pOH values. Buffer solutions and calculations of their pH.	

		Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant.	
5	**TEACHER SPECIFIC MODULE-ENVIRONMENTAL CHEMISTRY**		**12**
	Directions: Introduction-environment and segments- Pollutants of water – sewage, industrial effluents, soap and detergents, pesticides, fertilizers, heavy metals, biological magnification and bioaccumulation, Toxic effect of pollutants		
	Water quality parameters – DO, BOD and COD, Water purification-sedimentation, coagulation, filtration, disinfection, ion exchange, desalination,		
	Air pollution – major regions of atmosphere, pollution by oxides of N, S, Hydrocarbons and other organic chemicals, automobile exhausts, their physiological effects on vegetation and living organisms, Ozone layer – importance – depletion of ozone –consequences		

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
4. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
5. Environmental Chemistry A.K.De
6. Pragathi's Instrumental Methods of Analysis: H.Kau
7. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.
8. Chemical Thermodynamics: J.Rajaram and J.C.kuriacose, Pearson.
9. Physical Chemistry: A Molecular Approach by Donald A Mc Qurrie
10. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		100

KU2DSCCHE114: FOUNDATIONS IN PHYSICAL AND ORGANIC CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE114	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course offers an exploration of fundamental chemistry concepts. Students will delve into topics such as thermodynamics, organic chemistry, stereochemistry, ionic equilibrium and analytical techniques.

Course Prerequisite: system, surroundings, organic chemistry, molecular geometry, volumetry experiments.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of thermodynamic concepts the laws of thermodynamics.	U
2	Understand the fundamentals of organic chemistry and use Huckel's rule to analyze aromaticity in benzene.	U
3	Attain basic understanding of acid-base concepts. Apply Henderson's equation to solve numerical problems.	A
4	To get basic idea about chirality and stereo isomerism. Apply the knowledge in optically active carbon compounds.	A
5	Learners will acquire proficiency in analytical chemistry techniques. They will also gain hands-on experience in various chromatographic separation techniques.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	2	0	0	3	2
CO 2	3	1	2	0	0	3	2
CO 3	3	1	2	1	0	2	2
CO 4	3	1	2	1	0	2	2
CO 5	3	1	2	0	3	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**THERMODYNAMICS**	**10**
	1	**Thermodynamics -** Basic concepts– System – surroundings – open, closed and isolated systems – Isothermal – isochoric and isobaric process – work – heat – energy – internal energy – Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv	
	2	First law– The second law – Enthalpy-Entropy-and Free energy-Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes.	
	3	**Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts, ionization of weak electrolytes. pH and pOH values. Buffer solutions and calculations of their pH.	
	4	Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant.	
2		**BASICS OF ORGANIC CHEMISTRY AND AROMATICITY**	**10**
	1	Classification of organic compounds – functional groups, Homologous series –Nomenclature of organic compounds	
	2	IUPAC system of nomenclature of hydrocarbons (alkane, alkene and alkynes), halo compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid halides, anhydrides, esters, amides, amines, nitriles, nitro, cyclic, heterocyclic compounds and bicycloalkanes	
	3	Bond fission – homolysis and heterolysis – carbocation – carbanion – and free radicals	
	4	Aromaticity-Huckel's rule. Structure of benzene.	

3	**STEREOCHEMISTRY**		**10**
	1	Isomerism – general – stereoisomerism – optical isomerism – chirality – plane polarized light – specific rotation.	
	2	Enantiomers – racemization – diastereomers – optical activity of lactic acid and tartaric acid – meso tartaric acid – resolution.	
	3	Conformational isomerism – ethane, propane and cyclohexane – chair and boat forms- stability	
	4	Geometrical isomerism – causes – maleic acid and fumaric acid – 1-butene and 2-butene stability.	

4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**		**10**
	1	**Redox titration-** Permanganometry, Dichrometry, Cerimetry, Iodometry and Iodimetry	3
	2	**Solvent extraction:** Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation	2
	3	**Chromatographic Separation techniques** Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC	**5**
5	**TEACHER SPECIFIC MODULE-** **QUANTITATIVE AND CHROMATOGRAPHIC ANALYSIS PRACTICALS**		**30**
	Total 7 experiments may be done. Out of this 2 may be from permanganometry and 2 from dichrometry. Remaining 3 experiments can be		

	from solvent extraction, /chromatography sections according to teachers' choice.	
	1.**Permanganometry** a. Estimation of oxalic acid. b. Estimation of Fe^{2+} c. Estimation of Nitrite **Dichrometry** 1.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using internal indicator 2.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using external indicator	10
	Teacher Specific Module(suggestions) **2. Solvent Extraction** a. Sugar-Organic Acid Mixture. b. Separation of Polyphenols from Plant extracts c. Curcumin extraction from Turmeric d. Lignin extraction from Tree bark	10
	3.Chromatographic Experiments. 6.Setting up a thin layer plate, Iodine chamber for chromatographic separation 7.Setting up paper (both horizontal and vertical) chromatography 8.Column packing and elution in Column chromatography 9.Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques 10.Separation of plant pigments using TLC, Paper and Column Chromatography	10

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Jonathan Clayden, Nick Greeves, and Stuart Warren, "Organic Chemistry," Oxford University Press

3. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
4. Stanley E. Manahan, "Environmental Chemistry," CRC Press
5. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
6. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick Woodward, "Chemistry: The Central Science," Pearson
7. Morrison and Boyd, "Organic Chemistry," Prentice Hall
8. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: Graduates will be equipped for job markets in pharmaceuticals, analytical laboratories, research, and quality control, with strong foundations in in laboratory techniques and analytical methods.

KU2DSCCHE115: FOUNDATION IN PHYSICAL, ORGANIC & BIOINORGANIC CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE115	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course demonstrates basic principles of thermodynamic and ionic equilibrium applicable to Chemistry. Also demonstrates principles of organic chemistry and bioinorganic chemistry.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand basic concepts in organic chemistry including fundamentals, classifications, nomenclature, and structural features. They will understand bond fission processes and apply Huckel's rule to analyse aromaticity, particularly in benzene	U
2	Understand the basic concepts of thermodynamics and laws of thermodynamics.	U
3	Gain a comprehensive understanding of acid-base concepts and will analyse ionization of weak electrolytes, pH, pOH values, buffer	U

	solutions, and hydrolysis of salts, applying Henderson's equation to solve numerical problems	
4	Understand the chemistry behind various biological processes that include oxygen/CO2 transfer, photosynthesis and role of various metal ions in biological processes	A
5	Acquire proficiency in analytical chemistry techniques, including redox titration methods and chromatographic separation techniques	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	2
CO 2	2	1	0	0	0	0	2
CO 3	0	0	3	0	0	0	2
CO 4	0	0	2	0	0	0	2
CO 5	0	0	0	2	3	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**BASICS OF ORGANIC CHEMISTRY AND AROMATICITY**	**10**
	1	Classification of organic compounds – functional groups, Homologous series –Nomenclature of organic compounds	
	2	IUPAC system of nomenclature of hydrocarbons (alkane, alkene and alkynes), halo compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid halides, anhydrides, esters, amides, amines, nitriles, nitro, cyclic, heterocyclic compounds and bicycloalkanes	
	3	Bond fission – homolysis and heterolysis – carbocation – carbanion – and free radicals	
	4	Aromaticity-Huckel's rule. Structure of benzene.	
2		**THERMODYNAMICS AND IONIC EQUILIBRIUM**	**15**
	1	Thermodynamics**:** Basic concepts– System – surroundings – open, closed and isolated systems – Isothermal – isochoric and isobaric process – work – heat – energy – internal energy – Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv	
	2	First law– The second law – Enthalpy-Entropy-and Free Energy-Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes.	

	3	Ionic equilibrium: Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts, ionization of weak electrolytes. pH and pOH values. Buffer solutions and calculations of their pH.	
	4	Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant	
3	**BIOINORGANIC CHEMISTRY**		**10**
	1	Role of alkali and alkaline earth metal ions in biology; Na -K Pump, ionophores and crown ethers, porphyrins and calix arenes. Oxygen transport and storage:	
	2	Iron transport and storage: Ferritin, Transferrin, Siderophores and metallothionein. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins.	
	3	Haemoglobin, myoglobin, hemerythrin, hemocyanin Oxygen activation: vitamin B12 coenzyme, photosystem I and II, oxygen evolving centre	
4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES-2**		**10**
	1	**Redox titration-** Permanganometry, Dichrometry, Cerimetry, Iodometry and Iodimetry	
	2	**Solvent extraction:** Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation	
	3	**Chromatographic Separation techniques:** Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC	
5	**TEACHER SPECIFIC MODULE- QUANTITATIVE AND CHROMATOGRAPHIC ANALYSIS** *Directions: Total 7 experiments must be done. Out of this 2 must be from permanganometry and 2 from dichrometry. Remaining 3 experiments can be from solvent extraction,/chromatography sections according to teachers' choice.*		**30**

	1	**Permanganometry** a) Estimation of oxalic acid b) Estimation of Fe^{2+} c)Estimation of Nitrite	
	2	**Dichrometry** 1.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using internal indicator 2.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr's salt using external indicator	
	3	**Solvent Extraction** a) Sugar-Organic Acid Mixture, b) Separation of Polyphenols from Plant extracts, c) Curcumin extraction from Turmeric	
	4	**Chromatography experiments** Setting up a thin layer plate, Iodine chamber for chromatographic separation Separation of plant pigments using TLC, Paper and Column Chromatography Column packing and elution in Column chromatography Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Jonathan Clayden, Nick Greeves, and Stuart Warren, "Organic Chemistry," Oxford University Press
3. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
4. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry
5. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
6. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick Woodward, "Chemistry: The Central Science," Pearson
7. Morrison and Boyd, "Organic Chemistry," Prentice Hall
8. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU2DSCCHE116: PRINCIPLES OF BASIC CHEMISTRY -II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	KU2DSCCHE116	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This comprehensive course offers an enriching exploration of fundamental chemistry concepts. Students will delve into topics such as thermodynamics, organic chemistry, ionic equilibrium, environmental chemistry, and analytical techniques. By mastering theory and hands-on skills, students will be well-prepared for dynamic careers in chemistry and related fields.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the thermodynamic principles and correlate them with the natural processes.	U
2	Understand organic chemistry fundamentals, including classification, nomenclature, and structural features of various organic compounds.	U
3	A comprehensive understanding of ionic equilibria in solutions and solve numerical problems involving pH.	A

4	Develop awareness of environmental issues, and their control measures.	An
5	Acquire proficiency in analytical chemistry techniques, chromatographic separation techniques, solvent extraction and in virtual lab titrations	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**THERMODYNAMICS AND IONIC EQUILIBRIUM**	**15**
	1	**Thermodynamics -** Basic concepts– System – surroundings – open, closed and isolated systems – Isothermal – isochoric and isobaric process – work – heat – energy – internal energy – Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv	
	2	**Thermodynamics** - First law– The second law – Enthalpy-Entropy- and Free Energy-Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes.	
	3	**Ionic Equilibrium-** Concepts of Acids and Bases-Arrhenius, Lowry-Bronsted and Lewis concepts, ionization of weak electrolytes. pH and pOH values. Buffer solutions and calculations of their pH.	
	4	**Ionic Equilibrium-** Henderson equation (numerical problems expected). Hydrolysis of salt – degree of hydrolysis and hydrolytic constant	

2		**BASICS OF ORGANIC CHEMISTRY AND AROMATICITY**	**10**
	1	Classification of organic compounds – functional groups, Homologous series –Nomenclature of organic compounds	

	2	IUPAC system of nomenclature of hydrocarbons (alkane, alkene and alkynes), halo compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid halides, anhydrides, esters, amides, amines, nitriles, nitro, cyclic, heterocyclic compounds and bicycloalkanes	
	3	Bond fission – homolysis and heterolysis – carbocation – carbanion – and free radicals	
	4	Aromaticity-Huckel's rule. Structure of benzene.	
3	**ENVIRONMENTAL CHEMISTRY**		**10**
	1	Introduction-environment and segments- Pollutants of water – sewage, industrial effluents, soap and detergents, pesticides, fertilizers, heavy metals, biological magnification bioaccumulation	
	2	Toxic effect of pollutants, Water quality parameters – DO, BOD and COD, Water purification- sedimentation, coagulation, filtration, disinfection, ion exchange, desalination,	
	3	Air pollution – major regions of atmosphere, pollution by oxides of N, S, C, hydrocarbons and other organic chemicals, automobile exhausts, their physiological effects on vegetation and living organisms	
	4	Ozone layer – importance – depletion of ozone – consequences,	
	5	Greenhouse effect – global warming – acid rain, Toxicity and environmental hazards of pesticides, Radiation pollution and noise pollution	
4	**ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES**		**10**
	1	**Redox titration-** Permanganometry, Dichrometry, Cerimetry, Iodometry and Iodimetry	3
	2	**Solvent extraction:** Classification, principle, and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation	

<table>
<tr><td></td><td>3</td><td>Chromatographic Separation techniques

Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC</td><td></td></tr>
<tr><td rowspan="3">5</td><td colspan="2">Quantitative and Chromatographic Analysis Practicals

Total 7 experiments may be done. Out of this 2 may be from permanganometry and 2 from dichrometry. Remaining 3experiments can be 2 from solvent extraction/ chromatography according to teachers’ choice</td><td>30</td></tr>
<tr><td colspan="2">1 Permanganometry
a. Estimation of oxalic acid.
b. Estimation of Fe^{2+}
c. Estimation of Nitrite
Dichrometry
1.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr’s salt using internal indicator
2.Estimation of Fe^{2+}, $FeSO_4.7H_2O$/Mohr’s salt using external indicator</td><td>10</td></tr>
<tr><td colspan="2">Teacher Specific Module(suggestions)
2. Solvent Extraction
a. Sugar-Organic Acid Mixture.
b. Separation of Polyphenols from Plant extracts
c. Curcumin extraction from Turmeric
d. Lignin extraction from Tree bark</td><td>10</td></tr>
<tr><td></td><td colspan="2">3.Chromatography Experiments.

a) Setting up a thin layer plate, Iodine chamber for chromatographic separation
b) Setting up paper (both horizontal and vertical) chromatography
c)Column packing and elution in Column chromatography
d)Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques</td><td></td></tr>
</table>

	e) Separation of plant pigments using TLC, Paper and Column Chromatography.	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Jonathan Clayden, Nick Greeves, and Stuart Warren, "Organic Chemistry," Oxford University Press
3. Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press
4. Stanley E. Manahan, "Environmental Chemistry," CRC Press
5. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
6. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J.Murphy, and Patrick Woodward, "Chemistry: The Central Science," Pearson
7. Morrison and Boyd, "Organic Chemistry," Prentice Hall
8. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learnin

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

Employability for the Course: Graduates of this course are well-equipped for diverse careers in pharmaceuticals, environmental management, research, and quality control Opportunities abound in government agencies, research institutions, and private sectors, with potential for further academic pursuits.

KU2DSCCHE117: FOUNDATION COURSE IN CHEMISTRY-II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	DSC	100	**KU2DSCCHE117**	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course deals with the fundamental principles of thermodynamics, crystallography, nuclear chemistry, cement, glass, etc. To generate the practical skill and employability laboratory experience is also included.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will be able to define and explain fundamental concepts in thermodynamics, including system, surroundings, state functions, and thermodynamic processes.	U
2	Comprehensive understanding of both the theoretical aspects of crystallography and solid-state chemistry.	U
3	Students will be able to define and explain the fundamental concepts of nuclear chemistry, including nuclear structure, types of radiation, and nuclear reactions.	C
4	Students will acquire proficiency in classifying various glasses and cements.	E
5	Students will be able to synthesis Personal hygiene products	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create ©

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	0	0	3

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**THERMODYNAMICS**		**12**
	1	Basic concepts– System – surroundings – open, closed and isolated systems.	
	2	Isothermal – isochoric and isobaric process – work – heat – energy – internal energy.	
	3	Heat capacity at constant volume (Cv) and at constant pressure (Cp) – relation between Cp and Cv.	
	4	First law– The second law – Enthalpy-Entropy-and Free energy-Criteria for reversible and irreversible process- Gibbs –Helmholtz equation (no derivation) concepts of spontaneous and non-spontaneous processes.	
2	**CRYSTALLINE STATE**		**12**
	1	Solids – crystalline and amorphous solids – space lattice and unit cell- crystal planes- laws of crystallography	
	2	Weiss indices and Miller indices - Bravais lattice – Bravais lattices of cubic crystals	
	3	Characteristic planes in these lattices – interplanar distance ratio. X-ray analysis of crystals – Bragg's equation – problem – crystal structure of NaCl	
	4	Liquid crystals – types, properties and applications.	
3	**NUCLEAR CHEMISTRY**		**12**
	1	Concept of nuclides – representation of nuclides – isobars, isotopes and isotones with examples – Detection of isotopes using Aston's mass spectrograph – separation of isotopes by diffusion methods – stability of nucleus – n/p ratio.	

	2	Liquid drop model, Radioactivity – natural and artificial. Decay constant and half-life period-Radioactive series.	
	3	Group displacement law – radio isotopes and their applications in structural elucidation, in agriculture and in industry.	
	4	Radiocarbon dating – Nuclear fission and nuclear fusion. Problems associated in the nuclear waste disposal. Derivation of decay constant – Atom bomb and hydrogen bomb. Mass defect, nuclear binding energy.	
4	**CEMENT &GLASS**		**9**
	1	Cement- Classification – Portland cement – Raw materials – manufacture – setting and hardening.	
	2	Glass – Different types – manufacture – raw materials – manufacture of ordinary glass – annealing.	
5	**TEACHER SPECIFIC MODULE- PRACTICALS**		**30**
	Directions: Prepare any one personal hygiene product and one oral hygiene product each as per teacher's choice. a) Personal hygiene products synthesis: Antiperspirants and deodorants, composition, methods of preparation. b) Oral hygiene products, mouth wash, flavours and essential oils. Any other relevant topics.		

Essential Readings:

1.B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.

2. J D Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press New Delhi, 2008.

3. F A Cotton and Wilkinson, Advanced Inorganic Chemistry, Wiley India Pvt.Ltd., 2008.

4. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.

5.Vogel's Textbook of Quantitative Chemical Analysis

6.P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press

7.Brian P. Atkins and Julio de Paula, "Principles of Physical Chemistry," Oxford University Press.

8.Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
9.A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of the best two test papers

- **Employability for the Course:** The course enhances employability of the students by equipping them with essential knowledge and practical skills in chemistry.

KU2DSCCHE125: CONCEPTS IN COORDINATION AND ORGANIC CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	Minor	Foundation	KU2DSCCHE125	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: This course offers an exploration of fundamental chemistry concepts. Students will be introduced into topics such as coordination chemistry, organic chemistry, stereochemistry. Also, the course aim to transact the molecular level understanding of food components and some concepts in analytical chemistry.

Course Prerequisite: system, surroundings, organic chemistry, molecular geometry, volumetry experiments.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	The learner will get essential understanding in coordination chemistry.	U
2	Understand the fundamentals of organic chemistry. Apply Huckel's rule to analyze aromaticity in benzene.	U
3	To get basic idea about chirality and stereo isomerism. Apply the knowledge in optically active carbon compounds.	U
4	Gain an impression of molecules related to food and related products.	U
5	Understanding basic laboratory techniques	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	1	0	0	0	0
CO 2	3	0	1	0	0	0	0
CO 3	3	0	1	0	0	0	0
CO 4	2	0	1	0	0	0	0
CO 5	2	3	1	0	0	0	0

MODULE	UNIT	DESCRIPTION	HOURS
1		**BASICS OF COORDINATION CHEMISTRY**	**12**
	1	Introduction-Double salts and Coordination compounds	
	2	Werner's coordination theory- Classification of coordination compounds and various types of ligands	
	3	Nomenclature of coordination compounds- Application of coordination compounds in qualitative and quantitative analysis.	
	4	VBT- Square planar and octahedral complexes with examples	
2		**BASICS OF ORGANIC CHEMISTRY AND AROMATICITY**	**12**
	1	Classification of organic compounds – functional groups, Homologous series –Nomenclature of organic compounds	
	2	IUPAC system of nomenclature of hydrocarbons (alkane, alkene and alkynes), halo compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, acid halides, anhydrides, esters, amides, amines, nitriles, nitro, cyclic, heterocyclic compounds and bicycloalkanes	
	3	Bond fission – homolysis and heterolysis – carbocation – carbanion – and free radicals	
	4	Aromaticity-Huckel's rule. Structure of benzene.	
3		**STEREO CHEMISTRY**	**12**
	1	Isomerism – general – stereoisomerism – optical isomerism – chirality – plane polarized light – specific rotation.	

	2	Enantiomers – recemization – diastereo isomer – optical activity of lactic acid and tartaric acid – meso-tartaric acid – resolution.	
	3	Conformational isomerism – ethane, propane and cyclohexane – chair and boat forms- stability	
	4	Geometrical isomerism – causes – maleic acid and fumaric acid – 1-butene and 2-butene stability.	

4	**FOOD CHEMISTRY**		**12**
	1	Basic food molecules; The chemical components of food (carbohydrates, fats, proteins and water) Mineral functions, sources, Bioavailability, and deficiency of following minerals – calcium, Iron, Iodine, Fluorine, sodium, potassium.	
	2	Vitamins – Classification, units of measurement, sources, functions and deficiency diseases caused by following vitamins: a) Fats soluble vitamins – Vitamin A, D, E and K. b) Water soluble vitamins – Vitamin C and B-complex	
	3	Chemistry of colours. An overview of naturally occurring pigments in food. Artificial colours in processed food and health impacts. Food Adulteration -Definition, Classification, Different types of adulterants	
	4	Science behind food preservation, processing and packing to ensure food safety and waste management	
5	**TEACHER SPECIFIC MODULE-ANALYTICAL CHEMISTRY AND GOOD LABORATORY PRACTICES-2**		**12**
	1	**Directions:** **Redox titration-** Permanganometry, Dichrometry, Cerimetry, Iodometry and Iodimetry	
	2	**Solvent extraction:** Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation	

	3	**Chromatographic Separation techniques** Chromatography: Classification, principle and efficiency of the technique-Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC	

Essential Readings:

1. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.
2. J E Huheey, Inorganic Chemistry, Derling Kindersley (India) Pvt. Ltd., 2006.
3. Jose Miguel Aguilera; Edible Structures: The Basic Science of What We Eat
4. H.-D. Belitz, W. Grosch and P. Schieberle; Food Chemistry
5. Jonathan Clayden, Nick Greeves, and Stuart Warren, "Organic Chemistry," Oxford University Press
6. Daniel C. Harris, "Quantitative Chemical Analysis," W. H. Freeman
7. Theodore L. Brown, H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick Woodward, "Chemistry: The Central Science," Pearson
8. Morrison and Boyd, "Organic Chemistry," Prentice Hall
9. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, "Principles of Instrumental Analysis," Cengage Learning

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		100

SEMESTER III

KU3DSCCHE201: INORGANIC CHEMISTRY- I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE201	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises modules on nuclear chemistry, Theoretical basis of analysis, Bonding in coordination compounds, Representative elements and Noble gases. Practical session deals with the qualitative analysis of anions and preparation of inorganic complexes.

Course Prerequisite: Knowledge in first, second semester chemistry topics.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding about nuclear reactions to distinguish the constructive and destructive applications and use them wisely	A
2	Understand statistical treatment of analytical data and the principles underlying qualitative mixture analysis to apply them in practical scenario.	A

3	A comprehensive understanding of periodicity in properties of **s** and **p** block elements and their compounds.	U
4	Able to analyse the various theories of bonding in coordination compounds and predict the geometry and properties of complexes.	An
5	Acquire skill in identifying the anions in a salt mixture, understand the way to eliminate an interfering acid radical	A
6	Acquire skill in preparing alums and its application in water purification.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	1
CO 3	0	0	3	0	0	0	0
CO 4	0	1	0	3	0	0	1
CO 5	0	0	0	0	3	1	0
CO 6	0	0	0	0	1	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**NUCLEAR CHEMISTRY**		**10**
	1	Radioactivity - rate of radioactive disintegration – half life - Nature of radiation from radioactive elements. Artificial radio activity - Artificial transmutations of elements – cyclotrons	
	2	Stability of nucleus-binding energy-mass defect-packing fractions-n/p ratio- Detection and measurement of radioactivity - Radioactive tracers - Rock dating, Carbon dating	
	3	Induced radio activity - Q values of nuclear reactions - nuclear reactors nuclear fission and nuclear fusion	
	4	Classification of reactors - Breeder reactor - India's nuclear energy programme – BARC Nuclear energy programmes of India.	
2	**THEORETICAL BASIS OF ANALYSIS – II**		**6**
	1	Statistical treatment of analytical data-Average deviation from the mean - Standard Deviation – Relative standard deviation.	
	2	Reporting of analytical data- Statistical treatment of analytical data – Population and samples – Confidence limit- Test of significance – Student t-test, f-test, Q-test for rejecting data.	
	3	Applications of solubility product and common ion effect in the precipitation of cations – Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate).	

3		**CHEMISTRY OF REPRESENTATIVE ELEMENTS AND NOBLE GASES**	**19**
	1	Hydrogen: Isotopes (separation method not needed)-Ortho and para hydrogen-Hydrides and their classification.	
	2	Alkali and alkaline earth metals: Periodic properties of, oxides, halides, hydroxides and carbonates (preparation not needed)	
	3	p block elements: Comparative study based on electronic configuration - Periodic properties of oxides and oxoacids of Nitrogen, Phosphorus and Chlorine (preparation not needed)-Acid-base properties of oxides- Inert pair effect-Metallic and non-metallic character of p-block elements.	
	4	Noble gases: Discovery of noble gases. Electronic configuration and position in the periodic table. General physical properties, uses of noble gases. Compounds of noble gases– Clathrates, compounds of Xenon— XeF_2, XeF_4, XeF_6, XeO_2F_2, $XeOF_2$, $XeOF_4$ and XeO_3-Hybridization and geometry of these compounds	
4		**BONDING IN COORDINATION COMPOUNDS- I**	**10**
	1	Theories of bonding in transition metal complexes–Werner's theory-Valence bond theory-Application to some complexes-Hybridization in tetrahedral, square planar and octahedral complexes – explanation of magnetic properties based on VBT. Limitations of VBT.	
	2	Crystal field theory-Crystal field splitting in octahedral, tetrahedral and square planar geometries. Factors affecting the magnitude of crystal field splitting- Spectrochemical series - Crystal field stabilization energy (CFSE). Explanation of colour, spectral and magnetic properties.	

<table>
<tr><td rowspan="4">5</td><td colspan="2">TEACHER SPECIFIC MODULE- PRACTICAL

INORGANIC QUALITATIVE ANALYSIS- I AND PREPARATION OF INORGANIC COMPOUNDS</td><td>30</td></tr>
<tr><td colspan="2">Directions: Minimum 6 mixtures to be done. Familiarise virtual lab experiments related to the modules (minimum one). Any application like (b,c)those given in open ended section to be familiarised.</td><td></td></tr>
<tr><td>1.</td><td>Systematic analysis of anions by semimicro method. Study of the reactions of the following anions with a view to the identification, confirmation and procedure for elimination - carbonate, acetate, oxalate, fluoride, chloride, bromide, iodide, nitrate, sulphate, borate, phosphate, chromate, arsenate, arsenite. One of the anions should be eliminating radical.</td><td></td></tr>
<tr><td>2.</td><td>Open ended (suggestions)

a) Virtual lab for nuclear fission and fusion etc.
b) Preparation of alums (maximum two) and its application in water purification.
c)Use of bleaching powder in disinfecting water
d)Use of lime in adjusting pH of soil for agriculture</td><td></td></tr>
</table>

Essential Readings:

1. H J Arinikar, Essentials of Nuclear Chemistry, 4th edition, New Age International, New Delhi, 1995.
2. Puri, Sharma and Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008.
3. G D Christian, Analytical Chemistry, John Wiley and Sons
4. DA Skoog, DM West, Analytical Chemistry, An Introduction, 9th Edn., Mary Frinch.
5. J D Lee, Concise Inorganic Chemistry, 5th edition, Oxford University Press, New Delhi 2008.
6. Shriver and Atkins, Inorganic Chemistry, W. H Freeman and Company, 2006

7. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson.
8. Dr.Wahid.U. Malik, Dr. G.D. tuli, Dr. R.D. Madan, Selected Topics in Inorganic Chemistry, S. Chand Publications
9. G. Svehla and B SIvasankar, Vogel's Qualitative Analysis, 7th Edn., Pearson, 2012.

Suggested Readings:

1. P L Soni and Mohan Katyal, Textbook of inorganic Chemistry, S. Chand and Sons, 20th rev. edn.
2. J.B. Rajam Atomic Physics, S. Chand and Co. Pvt.Ltd, 1974.
3. P L Soni and Mohan Katyal, Textbook of inorganic Chemistry, S. Chand and Sons, 20th rev. edn.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in chemistry

KU3DSCCHE202: ORGANIC CHEMISTRY- I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE202	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	-	30	70	100	2

Course description: The course comprises of modules on hydrocarbons, hydroxy compounds and halogen compounds, stereochemistry, organic reaction mechanism and a teacher specific module

Course Prerequisite: Basic knowledge about reaction intermediates, electron displacement in molecules, types of reagents, electrophiles, nucleophiles and bond fission. Basic idea regarding the classification of organic compounds based on functional groups.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Examine the chemical properties of different classes of organic compounds.	U
2	Understand various named reactions and their applications in the synthesis of organic compounds.	U
3	Propose the stereochemistry of organic molecules and predict the stability of conformers.	A

4	Analyse different reaction mechanisms and suggest a mechanism for a particular reaction.	An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	1
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**HYDROCARBONS**	**12**
	1	Alkanes: Preparation by Reduction of alkyl halides and Wurtz reaction and Kolbe's electrolytic method-Alkenes: Preparation by dehydration of alcohols, de-hydrohalogenation of alkyl halides, dehalogenation of vic-dihalides and by Kolbe's electrolytic method	
	2	Reactions of alkenes- Hydrogenation, addition of water-Oxidation with $KMnO_4$, $K_2Cr_2O_7$ and Osmium Tetroxide-Ozonolysis and polymerization	

	3	Alkynes: Preparation by de-hydrohalogenation of vic-dihalides and gem dihalides-Kolbe's electrolytic method-Reactions of alkynes- Addition of Hydrogen, Halogen, Halogen acid and water-Oxidation using alkaline $KMnO_4$, Acidic $K_2Cr_2O_7$ and Selenium dioxide- Ozonolysis, hydroboration- oxidation and polymerization reactions specific to alkynes.	
	4	Dienes: Conjugated, cumulated and isolated dienes with examples- preparation of 1, 3 butadiene by dehydration of diols- Reactions of 1, 3 butadiene: 1,2 and 1,4 additions, polymerization- Polynuclear Hydrocarbons- Haworth Synthesis of naphthalene-synthesis of Anthracene from benzyl chloride	
	5	Cycloalkane –Methods of formation-chemical reactions- Baeyer's strain theory and its limitations- Ring strain in small rings (cyclopropane and cyclobutane)	

2		**HYDROXY COMPOUNDS AND HALOGEN COMPOUNDS**	**10**
	1	Alcohols – Preparation of monohydric alcohols from carbonyl compounds using Grignard reagents - Preparation with hydro-boration reaction-Ascent and Descent in alcohol series- Methods to distinguish 1^o, 2^o and 3^o alcohols: Lucas method, Victor Meyer's method and oxidation method.	
	2	Glycerol- Isolation from fats and oils- Preparation from Propene- Reactions: Oxidation, Reduction with HI, Dehydration, Nitration, Acetylation	
	3	Phenols - Acidic character of phenol - Preparation of phenol from diazonium salt, aryl sulphonates, cumene-Important reactions of Phenol: Bromination, Kolbe-Schmidt reaction, Riemer-Tiemann reaction, Hauben-Hoesch reaction, Gattermann-Koch reaction, $FeCl_3$ reaction, azo coupling-Naphthols- Preparation of Alpha and Beta Naphthol-	

	4	Halogen compounds**:** Nomenclature of Alkyl and Aryl Halides- Classes of alkyl halides- Methods of formation and chemical reactions of Geminal and Vicinal dihalides- Polyhalogen compounds-Methods of formation of Carbon tetrachloride and Chloroform	
	5	Aryl Halides-Preparation of Chloro, bromo and iodo-benzene from phenol- Sandmeyer & Gattermann reactions- Relative reactivity of alkyl, allyl /benzyl, vinyl and aryl halides towards nucleophilic substitution reactions-Nucleophilic aromatic substitution-SNAr and Benzyne mechanism.	
3	**STEREOCHEMISTRY**		**14**
	1	Isomerism: Geometrical isomerism: cis-trans and, syn-anti isomerism. Optical Isomerism-Optical Activity-Definition-wave nature of light-plane polarised light-optical rotation and specific rotation-chiral centres. Chiral molecules: definition and criteria - absence of plane, centre and Sn axis of symmetry – asymmetric and dissymmetric molecules.	
	2	Fischer Projection, Newman and Sawhorse Projection formulae and their inter-conversions - Examples of asymmetric molecules (Glyceraldehyde, Lactic acid, Alanine) and dissymmetric molecules (trans-1,2-dichlorocyclopropane). optical isomerism in compounds without any stereo centres (allenes, biphenyls)	
	3	Molecules with constitutionally symmetrical chiral carbons (Tartaric acid) Molecules with constitutionally unsymmetrical chiral carbons (2,3-dibromopentane)-D, L &, R, S configuration, Cahn-Ingold-Prelog rules. Racemic mixture, Racemisation and Resolution techniques. Geometrical isomerism with reference to alkenes and cyclo alkanes– cis, trans and E, Z configuration	
	4	Conformational analysis: Definition and examples of conformational and configurational isomers. Difference between configuration and	

		conformation- Types of cycloalkanes and their relative stability, Baeyer strain theory. Conformation analysis of alkanes- Conformational analysis of ethane, n-butane, 1,2-dichloroethane,2-chloroethanol	
	5	Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams., Inter-conversion of axial and equatorial bonds in chair conformation of cyclohexane, conformation of mono and di-substituted cyclohexane derivatives.	
4	**ORGANIC REACTION MECHANISM**		**12**
	1	Aliphatic nucleophilic substitutions: Mechanism of S_N1 and S_N2. Stereo Chemistry of S_N1 and S_N2 reaction- Walden Inversion- Effect of nucleophile, leaving group, and solvent on the relative rates of S_N1 versus S_N2 reactions.	
	2	Aromatic Electrophilic Substitution: Mechanism of halogenation, nitration and sulphonation – Friedel-crafts alkylation and acylation- Orientation and reactivity in mono-substituted benzene rings – ortho/para ratio- Aromatic Nucleophilic Substitution: SNAr and Benzyne mechanisms- Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions	
	3	Elimination: E1 and E2 mechanism - mechanism of dehydrohalogenation of alkyl halides - Saytzeff rule and Hofmann's rule- Effect of nucleophile, leaving group, and solvent on the relative rates of and E1 versus E2 reactions-E1CB mechanism- Thermal elimination reactions- Chaugaev and Cope elimination	
	4	Addition reactions: Mechanism of Electrophilic addition of Hydrogen halides to Carbon- Carbon double bond-Markownikoff's rule - Kharasch effect (Free radical addition of HBr on unsymmetrical double bond)- Method for determination of reaction mechanism: product analysis, intermediates, isotope effect, kinetic and stereochemical studies	

5	**TEACHER SPECIFIC MODULE**	**12**
	Directions: A module on polymers or any other topic relevant to the course according to the teacher can be proposed.	
	Polymers: Introduction and classification of polymers; Number average molecular weight, Weight average molecular weight, Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics - thermosetting (phenol-formaldehyde, Polyurethanes) and thermo softening (PVC, polythene –LDPE and HDPE) – polyamides, Polycarbonates, and silicone polymers. Rubbers - natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.	12

Essential Readings:

1. M. K. Jain and S. C. Sharma ‘Modern Organic Chemistry’ 3rd Edition, Visal PublishingCompany Co.
2. K. S. Tewari and N. K. Vishnoi ‘Organic Chemistry’, 3rd Edition, Vikas Publishing House
3. B. S. Bahl ‘Advanced organic Chemistry’, S. Chand.
4. R. T. Morrison and R. N. Boyd, ‘Organic Chemistry’, 6th Edition - Prentice Hall of India.
5. I. L. Finar ‘Organic Chemistry’, Vol.- 1, Pearson Education
6. P. S. Kalsi’ ‘Organic Reactions and their Mechanisms’’ New Age International Publishers
7. Peter Sykes, ‘A Guidebook to Mechanism in Organic Chemistry’, Pearson Education
8. V.R. Gowariker, N.V Viswanathan and Jayader Sreedhar,’ Polymer Science’, Wiley Eastern Ltd., New Delhi.
9. F. W. Billmeyer, Textbook of Polymer Science, John Wiley &Sons.

Suggested Readings:

1. P. Y. Bruice, ‘Organic Chemistry’, Pearson Education.
2. J. March, ‘Advanced Organic Chemistry’, 4 thEdn., John Wiley & Sons, NY
3. S. H. Pine ‘Organic Chemistry’, McGraw Hill

4. J. Clayden, N. Greeves, S. Warren and P. Wothers, ‘Organic Chemistry’, Oxford University Press

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper *	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		**100**

* Average mark of the best two written tests may be considered for internal mark.

KU3DSCCHE211: PROPERTIES OF MATTER AND ELECTROCHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE211	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This discipline specific course comprises of five modules out of which the first four modules describe the solid state and gaseous state properties of matter and electro chemistry concepts, and the fifth one provides knowledge regarding the methods of qualitative analysis.

Course Prerequisite: Should be aware of characteristic properties of matter and the basics of interaction of matter with light. Should have basic idea regarding - current, resistance and potential and reactions of various cations**.**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of properties of matter in the gaseous state and crystalline state	U
2	Understand the principles of spectroscopic analysis.	U
3	Apply the theoretical concepts in applications related to electrochemistry and electromotive force.	A
4	Understand the significance of nanomaterials.	U
5	Acquire skills in conducting qualitative analysis of cation mixtures.	An
6	Employ the techniques of nano material synthesis in practice.	An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	1
CO 5	0	0	0	0	3	1	0
CO 6	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**GASEOUS STATE**		**9**
	1	Gaseous State: Introduction - Kinetic molecular model of gases	
	2	Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required)	
	3	Collision number and collision frequency, mean free path	
	4	Boyle's law – Charles's law – Ideal gas equation	
	5	Behaviour of real gases –Deviation from ideal behaviour - Van der Waals equation (derivation not required).	
	6	Joule-Thomson effect and Liquefaction of gases.	
2	**CRYSTALLINE STATE AND SPECTROSCOPY**		**18**
	1	Solids – crystalline and amorphous solids – space lattice and unit cell	
	2	Crystal planes-laws of crystallography – Weiss indices and Miller indices. Bravais lattice – Bravais lattices of cubic crystals – characteristic planes in these lattices - interplanar distance ratio	
	3	X-ray analysis of crystals – Bragg's equation – problems-Crystal structure of NaCl	
	4	Liquid crystals – types, properties and application	
	5	Spectroscopy**:** Electromagnetic spectrum- Ranges of different radiation-general features of spectroscopy.	
	6	Types of spectra – Rotational, vibrational and electronic spectra	

	7	Rotational spectra - Moment of inertia, rotational constant and bond length	
	8	Vibrational spectra – stretching and bending modes-Force Constant-Zero-point energy	
	9	Raman spectra – Stokes and Anti Stokes Lines	
	10	NMR spectra-chemical shift and spin-spin splitting	
3	**ELECTROCHEMISTRY AND ELECTROMOTIVE FORCE**		**12**
	1	Specific conductance – molar conductance and equivalent conductance – variation with dilution. - Ohm's law - Conductors - metallic and ionic conductors	
	2	Electrolysis – laws of electrolysis	
	3	Electrolytic conduction - Migration of ions – relative speed of ions – Transport number	
	4	Kohlrausch's law and applications. Conductometric titrations – advantages	
	5	Electro chemical cell – Daniel cell – Cell reaction – Single electrode potential – statement –explanation of Nernst equation	
	6	Standard hydrogen electrode – Calomel electrode –measurement of EMF-determination of pH using Hydrogen electrode	
	7	Potentiometric titration– concentration cells.	
4	**NANO CHEMISTRY**		**6**
	1	Evolution of Nano science – Historical aspects – preparations containing nano gold in traditional medicine, Lycurgus cup – Faraday's divided metal etc. Nano systems in nature.	
	2	Preparation of Nano particles – Top – down approach and bottom – up approach, sol – gel synthesis, colloidal precipitations, Co-precipitation, combustion technique.	

	3	Properties of nano particles: optical, magnetic and mechanical properties.	

	TEACHER SPECIFIC MODULE- PRACTICALS QUALITATIVE INORGANIC MIXTURE ANALYSIS	**30**
	Total 7 experiments to be done. A minimum of six cation mixtures are to be analysed and recorded. One experiment on nano synthesis is open-ended and is subjected to teacher's choice.	
5	**a. Reactions of cations**: Study of the reactions of the following cations with a view of their identification and confirmation. Lead, Copper, Iron, Aluminium, Zinc, Manganese, Cobalt, Nickel, Barium, Calcium, Magnesium and Ammonium.	
	b.Cation analysis: Systematic qualitative analysis of a solution containing any two of the cations given in by semi micro methods.	
	Open ended Synthesis of Nanomaterials (suggestion) Synthesis of metal or metal oxide nano particles by sol gel method or some other method of teacher's choice may be carried out.	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
4. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
5. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
6. D A Skoog, D M West and S R Crouch, *Fundamentals of Analytical Chemistry,* 8th Edition, Brooks/Cole Nelson (Chapter 12-17).

7. Vogel's *Textbook of Qualitative Analysis*
8. G D Christian, *Analytical Chemistry,* John Wiley and Sons.
9. Solid state chemistry and its applications-Antony. R. West
10. Solid state chemistry by Lesley E. Smart and Elaine A. Morre
11. Introduction to solids Leonid V Azaroff
12. T. Pradeep, Nano: The Essentials, Mc Graw Hill Publishing Company, New Delhi (2007).
13. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005).
14. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in chemistr

KU3DSCCHE212: PHYSICAL CHEMISTRY AND METALLURGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE212	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This discipline specific course comprises of five modules out of which the first four modules describe metallurgy, corrosion, crystalline state, electrochemistry, electromotive force, spectroscopy and the fifth one provides knowledge regarding the methods of qualitative analysis and chromatography.

Course Prerequisite: Should be aware of characteristic properties of matter and the basics of interaction of matter with light. Should have basic idea regarding - current, resistance and potential and reactions of various cations**.**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of properties of matter in the gaseous state and crystalline state	U
2	Understand the principles of spectroscopic analysis.	A
3	Apply the theoretical concepts in applications related to electrochemistry and electromotive force.	A
4	Understand the significance of nanomaterials	U
5	Acquire skills in conducting cation mixture analysis.	A
6	Employ the applications chromatographic techniques in practice.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	1	0
CO 6	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**METALLURGY AND CORROSION**	**14**
	1	Occurrence of metals. Various steps involved in metallurgical Processes- Electrometallurgy-Hydrometallurgy-Coinage Metals- Occurrence and extraction of copper, silver and gold- Powder metallurgy (brief discussion)	
	2	Alloy steels- composition of alloy steels-application of alloy steels- Heat treatment of steel- Nonferrous alloys and their uses	
	3	Corrosion-Introduction-Causes of corrosion-types and Theories of corrosion-Direct chemical attack or dry corrosion-Electrochemical theory of wet corrosion-Peroxide theory, acid theory and oxide theory- Differential Aeration or concentration cell corrosion.	
	4	Factors influencing corrosion- nature of the metal- nature of the environment-Corrosion control	
2		**CRYSTALLINE STATE**	**9**
	1	Solids – crystalline and amorphous solids – space lattice and unit cell- Crystal planes-laws of crystallography – Weiss indices and Miller indices- Bravais lattice – Bravais lattices of cubic crystals – characteristic planes in these lattices - interplanar distance ratio	
	2	X-ray analysis of crystals – Bragg's equation – problems-Crystal structure of NaCl-Liquid crystals – types-properties and application	
3		**ELECTROCHEMISTRY AND ELECTROMOTIVE FORCE**	**9**

	1	Specific conductance – molar conductance and equivalent conductance – variation with dilution- Ohm's law - Conductors - metallic and ionic conductors	
	2	Electrolysis – laws of electrolysis- Electrolytic conduction - Migration of ions – relative speed of ions – Transport number- Kohlrausch's law and applications. Conductometric titrations – advantages	
	3	Electro chemical cell – Daniel cell – Cell reaction - Single electrode potential – statement –explanation of Nernst equation	
	4	Standard hydrogen electrode – Calomel electrode- measurement of EMF-determination of pH using Hydrogen electrode- Potentiometric titration– concentration cells.	
4	**SPECTROSCOPY**		**9**
	1	Electromagnetic spectrum- Ranges of different radiation- general features of spectroscopy- Types of spectra – Rotational, vibrational and electronic spectra.	
	2	Rotational spectra - Moment of inertia, rotational constant and bond length	
	3	Vibrational spectra – stretching and bending modes-Force Constant-Zero-point energy	
	4	Raman spectra – Stokes and Anti Stokes Lines- NMR spectra-chemical shift and spin-spin splitting	
5	**TEACHER SPECIFIC MODULE- PRACTICALS**		**30**
	QUALITATIVE INORGANIC MIXTURE ANALYSIS		
	Total 7 experiments to be conducted. Minimum of six cation mixtures are to be analysed and recorded. Out of the 8 experiments one is open-ended and are subjected to teacher's choice.		

	a. Reactions of cations: Study of the reactions of the following cations with a view of their identification and confirmation. Lead, Copper, Iron, Aluminium, Zinc, Manganese, Cobalt, Nickel, Barium, Calcium, Magnesium and Ammonium.	
	b. **Cation analysis:** Systematic qualitative analysis of a solution containing any two of the cations given in by semimicro methods.	
	Open ended **2. Chromatographic Analysis** Suggested Experiments.1. Setting up a thin layer plate, Iodine chamber for chromatographic separation 2.Setting up paper (both horizontal and vertical) chromatography 3.Column packing and elution in Column chromatography 4.Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques 5.Separation of plant pigments using TLC, Paper and Column Chromatography	
	Open ended **3.Water analysis (**Suggested Experiments) 1.Determination of pH 2.Determination of Dissolved Oxygen 3.Determination of Biological oxygen demand	

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
4. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
5. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press

6. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.
7. Physical Chemistry: W.J. Moore, Orient Longmans.
8. Physical Chemistry: N. Kundu & S.K. Jain, S.Chand& Company.
9. D A Skoog, D M West and S R Crouch, Fundamentals of Analytical Chemistry,8th Edition, Brooks/Cole Nelson (Chapter 12-17).
10. Vogel's Textbook of Qualitative Analysis
11. G D Christian, Analytical Chemistry, John Wiley and Sons.
12. Solid state chemistry and its applications-Antony. R .West
13. Solid state chemistry by Lesley E. Smart and Elaine A. Morre
14. Introduction to solids Leonid V Azaroff
15. Jain & Jain, Engineering Chemistry, Dhanpat Rai Publishing Company.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*** Average mark of the best two written tests may be considered for internal mark.**

KU3DSCCHE213: GENERAL CHEMISTRY-III

Semester	Course yType	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE213	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on carbohydrates, bioorganic chemistry, stereochemistry, nucleic acids, proteins, enzymes and a module on qualitative and quantitative analysis.

Course Prerequisite: Elementary idea on simple biological molecules

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding of carbohydrates and their properties	U
2	Understand the chemistry behind various biological processes that include oxygen/CO2 transfer, photosynthesis and role of various metal ions in biological processes	U
3	Understand concept of isomerism and analyze stereochemical properties of organic compounds.	An
4	Comprehend Nucleic Acids and Proteins: Learn DNA/RNA structures, protein synthesis, and properties of amino acids	U

5	Acquire proficiency in analytical chemistry techniques, including qualitative and quantitative analysis	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	0	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**CARBOHYDRATES**		**10**
	1	Introduction – Definition and classification- Preparation and properties of Glucose and Fructose-Fischer projection and Haworth structure of glucose and fructose	
	2	Mutarotation – Epimers and Anomers. D and L configuration	
	3	Cane sugar – Structure and important properties	
	4	Polysaccharides. Starch, Cellulose and Chitin – structure, properties and tests.	

2	**BIOINORGANIC CHEMISTRY**		**10**
	1	Role of alkali and alkaline earth metal ions in biology; Na-K Pump, ionophores and crown ethers, porphyrins and calixarenes.	
	2	Iron transport and storage: Ferritin, Transferrin, Siderophores and metallothionein. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins.	
	3	Oxygen transport by heme proteins-haemoglobin and myoglobin-structure of the oxygen binding site-nature of heme-dioxygen binding-cooperativity	
	4	Hemerythrin and hemocyanin-Vitamin B12 and coenzyme, photosystem I and II.	
3	**STEREOCHEMISTRY**		**10**
	1	Isomerism – general – stereoisomerism – optical isomerism – chirality – plane polarized light – specific rotation	
	2	Enantiomers – racemization – diastereoisomer – optical activity of lactic acid and tartaric acid – mesotartaric acid – resolution.	
	3	Conformational isomerism – ethane, propane and cyclohexane – chair and boat forms- stability	
	4	Geometrical isomerism – causes – maleic acid and fumaric acid – 1-butene and 2-butene stability	
4	**NUCLEIC ACID, PROTEINS AND ENZYMES**		**15**
	1	Classification – Purine and pyrimidine bases - structure of DNA and RNA	
	2	Functions of Nucleic Acids – DNA replication Bio synthesis of Proteins – Test for DNA and RNA. Effect of hydrogen bonding in biological systems	
	3	Classification of Amino acids – Physical and Chemical Properties – Zwitter ions – Iso-electric point – Sorensen formal titration – chromatographic separation of amino acids	
	4	Peptides – Proteins classification: Primary, Secondary and Tertiary level structures of proteins – Tests for Proteins-Enzymes-classifications-Mechanism of catalytic activity- Enzyme inhibition, reversible and irreversible	

5	**TEACHER SPECIFIC MODULE-PRACTICALS**	**30**
	Directions: Total 6 experiments to be done. Minimum 4 salt analysis and any other two experiments of teacher's choice.	
	1.Qualitative analysis-Salt analysis (NH_4^+, Al^{3+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+}) **Open ended** (Suggestions) **2.Colorimetry** Verification of Beer-Lambert law for KMnO4, determination of the concentration of the given solution. **3.Surface Tension**-Measurement using Stalagnometer **4.Viscosity**-Using Ostwald viscometer	5

Essential Readings:

1. Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th edn., Wiley.
2. Ernest L. Eliel, Stereochemistry of Organic Compounds, Wiley-Interscience
3. Albert L. Lehninger, David L. Nelson, and Michael M. Cox, Lehninger Principles of Biochemistry, 7th edn., W.H. Freeman.
4. Lubert Stryer, Biochemistry, 8th edn., W.H. Freeman.
5. Robert J. Ouellette and J. David Rawn, Organic Chemistry: Structure, Mechanism, and Synthesis, Elsevier.
6. Jonathan Clayden, Nick Greeves, and Stuart Warren, Organic Chemistry, 2nd edn., Oxford University Press.

Web References:

1. Royal Society of Chemistry, Learn Chemistry, www.rsc.org/learn-chemistry
2. Khan Academy, Chemistry, www.khanacademy.org/science/chemistry

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU3DSCCHE214: REACTION KINETICS AND BIOMOLECULAR CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE214	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course consists of modules on chemical kinetics, nucleic acids, proteins, enzymes, spectroscopy, bio-inorganic chemistry, and qualitative chemical analysis.

Course Prerequisite: Basic concepts of chemical reactions, electromagnetic spectrum, amino acids, cations.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding on the rate of chemical reaction and the factors affecting it.	U
2	Get insight about the basics of biologically important molecules. They will classify the various amino acids based on their properties.	U
3	Apply the principles of spectroscopy in structural identification of the molecules.	A
4	Students will understand the biological importance of metals.	U
5	Apply the knowledge for the Qualitative analysis of various cations.	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**CHEMICAL KINETICS & QUALITATIVE ANALYSIS**	**15**
	1	Definition – reaction rate – factors affecting the rate of a chemical reaction – units.	
	2	Zero order reactions – Order versus molecularity. Pseudo order reactions.	
	3	Integrated rate equation for first order reaction – half life – Ester hydrolysis – equation.	
	4	Collision theory (qualitative) Effect of temperature on reaction rate.	
	5	Inorganic Qualitative analysis - Solubility product – ionic product – common ion effect- principle of separation of cations in various groups	
2		**NUCLEIC ACID, PROTEINS AND ENZYMES**	**10**
	1	Classification – Purine and pyrimidine bases - structure of DNA and RNA- Functions of Nucleic Acids – DNA replication	
	2	Biosynthesis of Proteins – Test for DNA and RNA. Effect of hydrogen bonding in biological systems.	
	3	Classification of Amino acids – Physical and Chemical Properties – Zwitter ions – Iso Electric point – Sorensen formol titration – chromatographic separation of amino acids-Peptides – Proteins classification, Primary, Secondary and Tertiary level structures of proteins – Tests for Proteins.	
	4	Enzymes-classifications-Mechanism of catalytic activity- Enzyme inhibition, reversible and irreversible	
3		**SPECTROSCOPY**	**10**
	1	Electromagnetic radiation, spectrum- Interaction with matter- Factors affecting shape and intensity of a spectral line	

	2	Absorption spectroscopy- Basic principle and application- Beer-Lamberts law- Bathochromic, hypsochromic, hyperchromic and hypochromic shifts	
	3	Fluorescence and phosphorescence- IR spectroscopy- Principle and application- Mass spectroscopy principle and application.	
4	**BIO INORGANIC CHEMISTRY**		**10**
	1	Myoglobin and Haemoglobin - Structure and functions of haemoglobin and myoglobin-Cooperativity effect- Bohr effect.	
	2	Metallo enzymes of iron and zinc (structural details not needed).	
	3	Metal ion transport across cell membrane sodium/potassium pump	
	4	Biological functions of Co, Mn, Zn, Mg and Ca and toxicity of As, Cd, Pb, Hg.	
5	**TEACHER SPECIFIC MODULE-PRACTICALS**		**30**
	Directions: Total 7 experiments to be done. Analysis of a minimum of 6 cation mixtures to be recorded. In addition to this any one experiment related to the theory topics according to teachers' choice must also be done.		
	1.Inorganic qualitative analysis of cation mixtures (NH_4^+, Al^{3+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+})		
	Open ended (Teacher's choice) suggestion 1.Detection of sugar and amino acids 2.Estimation of proteins by biuret method 3.Estimation of reducing sugar by DNS (3,5-dinitrosalicylic acid) method		

Essential Readings:

1. P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press
2. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.

3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O K Medhi, Inorganic Chemistry, Pearson.

4. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi.

5. I. L. Finar, 'Organic Chemistry', Vol.- I, Pearson Education

6. W Kemp, Organic spectroscopy, Palgrave

7. Donald L Pavia, Gary M Lampman, George S Kriz and James R Vyvyan, Spectroscopy, Cengage Learning

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: Graduates will be equipped for job markets in the area of pharmaceuticals, analytical laboratories, research, and quality control, with strong foundations in in laboratory techniques and analytical methods.

KU3DSCCHE215: CHEMISTRY OF BIOMOLECULES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE215	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course demonstrates the structure of various biomolecules and the importance of stereochemistry on these structures. Also introduces various analytical techniques including spectroscopy.

Course Prerequisite: Basic idea in organic and biochemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the importance of stereochemistry of compounds in determining their properties.	U
2	Comprehensive understanding on the structure and properties of carbohydrates	U
3	Understand the structural properties of proteins, nucleic acids and enzymes	U
4	Understand the basic principles of spectroscopy and will be able to analyse the structure of various molecules using suitable spectroscopic technique.	An
5	Able to analyse inorganic and organic samples qualitatively	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**STEREOCHEMISTRY**		**10**
	1	Isomerism – general – stereoisomerism – optical isomerism – chirality – plane polarized light – specific rotation – enantiomers – racemization – diastereomers – optical activity of lactic acid and tartaric acid – meso tartaric acid – resolution	
	2	Conformational isomerism – ethane, propane and cyclohexane – chair and boat forms- stability – geometrical isomerism – causes – maleic acid and fumaric acid – 1-butene and 2-butene stability	
2	**CARBOHYDRATES**		**10**

	1	Introduction – Definition and classification. Preparation and properties of Glucose, and Fructose (Fischer projection and Haworth structure of glucose and fructose)	
	2	Mutarotation – Epimers and Anomers- D and L configuration	
	3	Cane sugar – Structure and important properties	
	4	Polysaccharides: Starch, Cellulose and Chitin – structure, properties and tests	
3	**NUCLEIC ACID, PROTEINS AND ENZYMES**		**15**
	1	Classification – Purine and pyrimidine bases - structure of DNA and RNA	
	2	Functions of Nucleic Acids – DNA replication	
	3	Bio synthesis of Proteins – Test for DNA and RNA. Effect of hydrogen bonding in biological systems.	
	4	Classification of Amino acids – Physical and Chemical Properties – Zwitter ions – Iso Electric point – Sorensen formol titration – Chromatographic separation of amino acids	
	5	Peptides – Proteins classification, Primary, Secondary and Tertiary level structures of proteins – Tests for Proteins.	
	6	Enzymes-classifications-Mechanism of catalytic activity- Enzyme inhibition.	
4	**BASIC SPECTROSCOPY**		**10**
	1	Electromagnetic radiation, spectrum. Interaction with matter. Factors affecting shape and intensity of a spectral line	
	2	Absorption spectroscopy. Basic principle and application. Beer-Lamberts law. Bathochromic, hypochromic and hyperchromic shifts.	
	3	Fluorescence and phosphorescence. IR spectroscopy. Principle and application. Mass spectroscopy principle and application	

	TEACHER SPECIFIC MODULE -QUALITATIVE ANALYSIS *Directions: Total 7 experiments to be done. Analysis of a minimum of 6 cation mixtures to be recorded. In addition to this any one experiment related to the theory topics according to teachers' choice must also be done.*		**30**
	1	Inorganic qualitative analysis of cations (NH_4^+, Al^{3+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+})	
	2	**Open ended experiments**(suggestions)	
		1.Detection of sugar and amino acids	
		2.Estimation of proteins by biuret method	
		3.Estimation of reducing sugar by DNS (3,5-dinitrosalicylic acid) method	

Essential Readings:

1. David L. Nelson and Michael M. Cox; Lehninger Principles of Biochemistry
2. M. K. Jain and S. C. Sharma; Modern Organic Chemistry, Visal Publishing Company Co.
3. B. S. Bahl; Advanced organic Chemistry, S. Chand.
4. J. Clayden, N. Greeves, S. Warren and P. Wothers; Organic Chemistry, Oxford University Press
5. C. N. Banwell and E M Mc Cash; Tata Mc GrawHill, Fundamentals of molecular spectroscopy
6. D. L. Pavia, G. M. Lampman and G. S. Kriz; Introduction to spectroscopy
7. A. I. Vogel; A Textbook of Quantitative Inorganic Analysis.
8. V.V. Ramanujan; Semi-micro qualitative analysis.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in chemistry

KU3DSCCHE216: BIOORGANIC CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE216	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course explores stereochemistry, wood chemistry, nucleic acids, proteins, enzymes, carbohydrates, and qualitative analysis. Topics include isomerism, wood cell wall components, DNA/RNA structures, amino acids, protein structures, and carbohydrate properties. Practical skills in qualitative analysis of cations, sugars, proteins, and reducing sugars are emphasized.

Course Prerequisite: Basic concepts of stereochemistry, wood chemistry and biological molecules

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the importance of stereochemistry of compounds in determining their properties	U

2	Analyze Wood Chemistry to identify wood cell wall components and understand chemical treatments and extractives' effects.	An
3	Comprehend Nucleic Acids and Proteins: Learn DNA/RNA structures, protein synthesis, and properties of amino acids.	U
4	Comprehensive understanding on the structure and properties of carbohydrates	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**STEREOCHEMISTRY**		**10**
	1	Isomerism – general – stereoisomerism – optical isomerism – chirality – plane polarized light – specific rotation – enantiomers – racemization – diastereomers– optical activity of lactic acid and tartaric acid – meso tartaric acid – resolution	

	2	Conformational isomerism – ethane, propane and cyclohexane – chair and boat forms- stability – geometrical isomerism – causes – maleic acid and fumaric acid – 1-butene and 2-butene stability.	

2	**CHEMISTRY OF WOOD**		**10**
	1	Structure of softwoods, hardwoods, and non-woods; Pulpwood species; Ultrastructure of cell wall, cell wall components - cellulose, hemi cellulose, lignin, extractives and inorganic components. Difference in cell wall composition of softwood and hard wood	
	2	Wood extractives - Essential oils, Tannins, flavonoids and dyestuff, properties and uses. Effect of extractives on durability of wood, gluing characteristics, surface coating. Pectin – uses	
	3	Chemical Treatment of wood - chemical resistance of softwood and hardwood. Effect of chemicals on wood - aqueous solutions of inorganic salts, alkaline degradation of wood, Oxidation and bleaching of wood	
	4	Wood Analysis. - Preparation of sample - Moisture content-oven dry method and dean and stark Ash content, Cellulose - cross &bevan, alpha, beta, gamma, holocellulose Lignin, Extractives - steam distillation and solvent extraction (Soxhlet extraction)	
3	**NUCLEIC ACID, PROTEINS AND ENZYMES**		**15**
	1	Classification – Purine and pyrimidine bases - structure of DNA and RNA- Functions of Nucleic Acids – DNA replication- Bio synthesis of Proteins – Test for DNA and RNA. Effect of hydrogen bonding in biological systems.	
	2	Classification of Amino acids – Physical and Chemical Properties – Zwitter ions – Iso Electric point – Sorensen formol titration – chromatographic separation of amino acids	
	3	Peptides – Proteins classification, Primary, Secondary and Tertiary level structures of proteins – Tests for Proteins.	

	4	Enzymes-classifications-Mechanism of catalytic activity- Enzyme inhibition, reversible and irreversible	
4	**CARBOHYDRATES**		**10**
	1	Introduction – Definition and classification. Preparation and properties of Glucose and Fructose (Fischer projection and Haworth structure of glucose and fructose)	
	2	Mutarotation – Epimers and Anomers. D and L configuration	
	3	Cane sugar – Structure and important properties	
	4	Polysaccharides. Starch, Cellulose and Chitin – structure, properties and tests	
5	**INORGANIC QUALITATIVE ANALYSIS** Directions: Total 8 experiments to be done. Analysis of a minimum of 6 cation mixtures must be recorded. In addition to these any two experiments related to the theory topics according to teachers' choice must also be done		**30**
	1	Inorganic qualitative analysis of cation mixtures (NH_4^+, Al^{3+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+})	
	2	**Open ended experiments** (Teacher's choice) -suggestions Qualitative analysis of sugars (Monosaccharides, Disaccharides and Polysaccharides) by using specific organic reagents 1.Estimation of proteins by biuret method 2.Estimation of reducing sugar by DNS (3,5-dinitrosalicylic acid) method	

Essential Readings:

1. Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th edn., Wiley.
2. Ernest L. Eliel, Stereochemistry of Organic Compounds, Wiley-Interscience.
3. Rowell, Roger M., Handbook of Wood Chemistry and Wood Composites, CRC Press.

4. David N.-S. Hon and Nobuo Shiraishi, Wood and Cellulosic Chemistry, 2nd edn., CRC Press.
5. Albert L. Lehninger, David L. Nelson, and Michael M. Cox, Lehninger Principles of Biochemistry, 7th edn., W.H. Freeman.
6. Lubert Stryer, Biochemistry, 8th edn., W.H. Freeman.
7. Robert J. Ouellette and J. David Rawn, Organic Chemistry: Structure, Mechanism, and Synthesis, Elsevier.
8. Jonathan Clayden, Nick Greeves, and Stuart Warren, Organic Chemistry, 2nd edn., Oxford University Press.

Web References:

1. Royal Society of Chemistry, Learn Chemistry, www.rsc.org/learn-chemistry
2. Khan Academy, Chemistry, www.khanacademy.org/science/chemistry

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: This course prepares graduates for careers in pharmaceuticals, environmental science, and chemical industries by providing in-depth knowledge and practical skills in stereochemistry, wood chemistry, Equips Graduates for roles in research, quality control, and chemical analysis in various sectors

KU3DSCCHE217: PHYSICAL AND MEDICINAL CHEMISTRY-III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	Foundation	KU3DSCCHE217	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This course deals with the fundamental principles of Medicinal chemistry, electrochemistry, fuels, batteries nanoscience and nanotechnology, etc. To generate the practical skill and employability laboratory experience is also included.

Course Prerequisite: Basic knowledge in organic and inorganic chemistry.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students will be able to understand the chemistry of drugs, their classification, use and abuse.	U
2	Students will understand the basics of electrochemical reactions. They will formulate mechanism to assemble cells	C
3	To perform a range of activities related to Nanoscience and Nanotechnology.	C
4	To get comprehensive idea about various types of fuels and their caloric value.	An
5	To perform a range of activities related to Nanoscience and Nanotechnology.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0
CO 3	0	0	3	0	0	0	0
CO 4	0	0	0	3	0	0	0
CO 5	0	0	0	0	3	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**MEDICINAL CHEMISTRY**	**10**
	1	Drugs- classification- Sulpha drugs - mode of actions, examples and uses.	
	2	Antibiotics Discovery, examples and importance. Misuse of antibiotics.	
	3	Antipyretics, Analgesics and Anti-inflammatory agents, Narcotic analgesics, Anaesthetic, Antiseptic, Anti histamines and Tranquillizers, - examples and abuse.	
	4	Disinfectant & germicides examples, importance and uses.	
2		**ELECTROCHEMISTRY**	**15**
	1	Specific conductance – molar conductance and equivalent conductance – variation with dilution. Ohm's law - Conductors - metallic and ionic conductors	
	2	Electrolysis – laws of electrolysis –Electrolytic conduction - Migration of ions – relative speed of ions – Transport number. Kohlrausch's law and applications. Conductometric titrations – advantages	
	3	Electro chemical cell – Daniel cell – Cell reaction – Single electrode potential – statement – explanation of Nernst equation – Standard hydrogen electrode – Calomel electrode	
	4	Measurement of EMF – determination of pH using Hydrogen electrode – Potentiometric titration – concentration cells	
3		**NANO SCIENCE AND NANOTECHNOLOGY**	**10**
	1	Evolution of Nano science – Historical aspects – preparations containing nano gold in traditional medicine	
	2	Lycurgus cup – Faraday's divided metal etc. -Nano systems in nature	

	3	Preparation of Nano particles – Top – down approach and bottom – up approach- Sol – gel synthesis, colloidal precipitations, Coprecipitation, combustion technique	
	4	Properties of nano particles: optical, magnetic and mechanical properties	
4	**FUELS, CELLS & BATTERIES**		**10**
	1	Definition and classification of fuels – Characteristics of good fuel – Combustion - Calorific value – wood- coal – origin of coal- - petroleum-origin –fractional distillation –different fractions, their composition & uses	
	2	Natural gas, Biogas & LPG – their composition and uses. Pollution due to burning of fossil fuel. Batteries and fuel cells – Different types – Applications in modern life	
5	**TEACHER SPECIFIC MODULE- PRACTICALS**		**30**
	Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microwave synthesis. Any other relevant synthetic routes		

Essential Readings:

1.B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.

2.M.M. Chakrabarthy: Chemistry and Technology of oils and fats

3. Howard L White: Introduction to Industrial Chemistry

4.M.S. Yadav: Synthetic drugs

5.A. Nabok, Organic and Inorganic Nanostructures, Artech House 2005.

6.C. Dupas, P.Houdy, M.Lahmani, Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg 2007

7.Nanotechnology- Richard Brooker, EARL Boyson- Wiley Dream Tech India

8.P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press

9.Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.

10.A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.

11.Vogel's Textbook of Quantitative Chemical Analysis

12.P. W. Atkins and Julio de Paula, "Physical Chemistry," Oxford University Press

.

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in chemistry

KU3DSCCHE218: CHEMISTRY OF BIOORGANIC MOLECULES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	DSC	200	KU3DSCCHE218	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	2	0	30	70	100	2

Course Description: This course explores stereochemistry, nucleic acids, proteins, enzymes, carbohydrates, and qualitative analysis. Topics include isomerism, DNA/RNA structures, amino acids, protein structures, and carbohydrate properties. Practical skills in qualitative analysis of cations, sugars, proteins, and reducing sugars are also emphasized.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the importance of stereochemistry of compounds in determining their properties	U
2	Understand the chemistry of heterocycles	U
3	Comprehend Nucleic Acids and Proteins: Learn DNA/RNA structures, protein synthesis, and properties of amino acids.	U

4	Comprehensive understanding on the structure and properties of carbohydrates	U
5	Apply the knowledge for the Qualitative analysis of various cations	An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	1	0	0	0	0
CO 2	2	0	0	2	0	0	0
CO 3	3	0	1	2	0	0	0
CO 4	3	0	1	2	0	0	0
CO 5	2	3	0	2	0	0	0

Level 0- No Correlation, Level 1- low Correlation, Level 2- Medium Correlation

Level 3- High Correlation

Course Description: This paper describes the concepts of metals in biological systems, transition elements, inner transition elements, industrially important compounds, metallurgy and organometallic compounds. Practical session deals with the qualitative analysis of cations and preparation of inorganic complexes.

Course Prerequisite: Basic knowledge in transition metals and industrially relevant molecules.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding about transition and inner transition elements	U
2	Able to explain the industrial importance of certain inorganic compounds and metallurgical process for extracting metals form ores.	U
3	Differentiate the role of different metals in various biological processes	An
4	Comprehensive understanding about organometallic compounds, their structure and applications	U
5	Acquire skill in the qualitative analysis of salt mixtures	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	2	0	0	0	0
CO 2	3	0	0	0	0	2	0
CO 3	3	0	2	0	0	0	0
CO 4	3	0	2	0	0	0	0
CO 5	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**TRANSITION AND INNER TRANSITION ELEMENTS**		**10**
	1.	General properties of transition elements – Electronic configurations, Oxidation states, colour, magnetic properties, tendency to form complexes and catalytic properties. Comparison of first transition series with second and third series.	
	2.	Lanthanides – Occurrence, separation by ion-exchange chromatography. Electronic configurations, oxidation states, magnetic properties and spectra of lanthanides. Lanthanide Contraction—causes and consequences.	
	3.	Actinides: Electronic configurations, oxidation states, spectra and magnetic properties. Trans actinide elements – Preparation, IUPAC nomenclature. Comparison of transition and inner transition elements	
2.	**INDUSTRIALLY IMPORTANT INORGANIC COMPOUNDSAND METALLURGY**		**12**
	1.	Structure, properties and uses of: Hydrides of boron – B_2H_6 and B_4H_{10} (preparation also). Borazine, Boric acid, Inter halogen compounds, Pseudo halogens, Fluorocarbons. Inorganic polymers- Phosphorous based, sulphur based, and silicon based - silicones and silicates - polymers.	
	2.		

		Occurrence of metals. Various steps involved in metallurgical processes. Electrometallurgy, Hydrometallurgy. Coinage metals - Occurrence and extraction of copper, silver and gold. Powder metallurgy (brief discussion). Alloy steels- composition of alloy steels - application of alloy steels. Heat treatment of steel. Nonferrous alloys and their uses – Refractories – definition, classification and uses.	

3.	**METALS IN BIOLOGICAL SYSTEMS**		**8**
	1.	Myoglobin and Haemoglobin - Structure and functions of haemoglobin and myoglobin. Cooperativity effect. Bohr effect.	
	2.	Metallo enzymes of iron and zinc (structural details not needed).	
	3.	Metal ion transport across cell membrane – sodium/potassium pump.	
	4.	Biological functions of Co, Mn, Zn, Mg and Ca and toxicity of - As, Cd, Pb, Hg.	
	5.	Biological fixation of nitrogen.	
4.	**ORGANOMETALLIC COMPOUNDS**		15
	1.	Introduction - Classification based on the nature of metal-carbon bond. Preparation, structure - valence bond theory - of mononuclear (Ni, Fe), binuclear (Fe, Mn, Co) and trinuclear (Fe) metal carbonyls - Application of 18 electron rule to predict M-M bond.	
	2.	Preparation, properties, structure and bonding of Ferrocene- carbonyl hydrides and carbonylate anions and cations –carbonyl halides – phosphene and phosphorous trihalides complexes. Dinitrogen complexes – nitric oxide complexes.	
	TEACHER SPECIFIC MODULE-PRACTICALS *Minimum 6 mixtures to be analysed and recorded. One more experiment other than mixture analysis to be carried out and recorded as per teacher's choice.* INORGANIC QUALITATIVEANALYSIS-II		**30**

5	1.	Systematic qualitative analysis of mixture two anions and cations by semi micro method. The cation mixtures may be given as solution. Cations in same group can be avoided. Cations given for analysis may include NH_4^+, Al^{3+}, Co^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+} etc.	
	2	Open ended (Suggestions) a) Bordeaux mixture preparation, application and warnings b) Virtual laboratory- Forensic toxicology- Heavy metal ions	

Essential Readings:

1. J E Huheey, E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, Pearson.
2. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi.
3. F A Cotton and G Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York.
4. R C Mehrothra and A Singh, Organometallic chemistry, New age publishers.
5. D F Shriver and P W Atkins, Inorganic Chemistry 3rd edn., Oxford University Press.
6. J D Lee, Concise Inorganic Chemistry 5th edn., Blackwell Science, London.
7. R A Mackay, W Henderson, Introduction to Modern Inorganic Chemistry, 6th edition Nelson Thornes Ltd.
8. Emelus and Anderson, Principles of Inorganic Chemistry.
9. Vogel's Textbook of Qualitative Analysis

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

SEMESTER IV

KU4DSCCHE201: INORGANIC CHEMISTRY II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCHE201	4	75

Learning Approach (Hours/Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This paper describes the concepts of metals in biological systems, transition elements, inner transition elements, industrially important compounds, metallurgy and organometallic compounds. Practical session deals with the qualitative analysis of cations and preparation of inorganic complexes.

Course Prerequisite: Basic knowledge in transition metals and industrially relevant molecules.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding about transition and inner transition elements	U

2	Able to explain the industrial importance of certain inorganic compounds and metallurgical process for extracting metals form ores.	U
3	Differentiate the role of different metals in various biological processes	An
4	Comprehensive understanding about organometalliccompounds, their structure and applications	U
5	Acquire skill in the qualitative analysis of salt mixtures	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	2	0	0	0	0
CO 2	3	0	0	0	0	2	0
CO 3	3	0	2	0	0	0	0
CO 4	3	0	2	0	0	0	0
CO 5	0	0	0	0	0	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**TRANSITION AND INNER TRANSITION ELEMENTS**		**10**
	1.	General properties of transition elements – Electronic configurations, Oxidation states, colour, magnetic properties, tendency to form complexes and catalytic properties. Comparison of first transition series with second and third series.	
	2.	Lanthanides – Occurrence, separation by ion-exchangechromatography. Electronic configurations, oxidation states, magnetic properties and spectra of lanthanides. Lanthanide Contraction—causes and consequences.	
	3.	Actinides: Electronic configurations, oxidation states, spectra and magnetic properties. Trans actinide elements – Preparation, IUPAC nomenclature. Comparison of transition and inner transition elements	

2.	**INDUSTRIALLY IMPORTANT INORGANIC COMPOUNDSAND METALLURGY**		**12**
	1.	Structure, properties and uses of: Hydrides of boron – B_2H_6 and B_4H_{10} (preparation also). Borazine, Boric acid, Inter halogen compounds, Pseudo halogens, Fluorocarbons. Inorganic polymers- Phosphorous based, sulphur based, and silicon based - silicones and silicates - polymers.	
	2.		

		Occurrence of metals. Various steps involved in metallurgical processes. Electrometallurgy, Hydrometallurgy. Coinage metals - Occurrence and extraction of copper, silver and gold. Powder metallurgy (brief discussion). Alloy steels- composition of alloy steels - application of alloy steels. Heat treatment of steel. Nonferrous alloys and their uses – Refractories – definition, classification and uses.	

3.	**METALS IN BIOLOGICAL SYSTEMS**		**8**
	1.	Myoglobin and Haemoglobin - Structure and functions of haemoglobin and myoglobin. Cooperativity effect. Bohr effect.	
	2.	Metallo enzymes of iron and zinc (structural details not needed).	
	3.	Metal ion transport across cell membrane – sodium/potassium pump.	
	4.	Biological functions of Co, Mn, Zn, Mg and Ca and toxicity of - As, Cd, Pb, Hg.	
	5.	Biological fixation of nitrogen.	

4.	**ORGANOMETALLIC COMPOUNDS**		15
	1.	Introduction - Classification based on the nature of metal-carbon bond. Preparation, structure - valence bond theory - of mononuclear (Ni, Fe), binuclear (Fe, Mn, Co) and trinuclear (Fe) metal carbonyls - Application of 18 electron rule to predict M-M bond.	
	2.	Preparation, properties, structure and bonding of Ferrocene- carbonyl hydrides and carbonylate anions and cations –carbonyl halides – phosphene and phosphorous trihalides complexes. Dinitrogen complexes – nitric oxide complexes.	

5	**TEACHER SPECIFIC MODULE-PRACTICALS** *Minimum 6 mixtures to be analysed and recorded. One more experiment other than mixture analysis to be carried out and recorded as per teacher's choice.* INORGANIC QUALITATIVEANALYSIS-II		**30**
	1.	Systematic qualitative analysis of mixture two anions and cations by semi micro method. The cation mixtures may be given as solution. Cations in same group can be avoided. Cations given for analysis may include NH_4^+, Al^{3+}, Co^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Mg^{2+} etc.	
	2	Open ended (Suggestions) a) Bordeaux mixture preparation, application and warnings	
		b) Virtual laboratory- Forensic toxicology- Heavy metal ions	

Essential Readings:

1. J E Huheey, E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, Pearson.

2. B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi.

3. F A Cotton and G Wilkinson, Advanced Inorganic Chemistry 5th edn., John Wiley, New York.

4. R C Mehrothra and A Singh, Organometallic chemistry, New age publishers.

5. D F Shriver and P W Atkins, Inorganic Chemistry 3rd edn., Oxford University Press.

6. J D Lee, Concise Inorganic Chemistry 5th edn., Blackwell Science, London.

7. R A Mackay, W Henderson, Introduction to Modern Inorganic Chemistry, 6th edition Nelson Thornes Ltd.

8. Emelus and Anderson, Principles of Inorganic Chemistry.

9. Vogel's Textbook of Qualitative Analysis

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test paper

SEMESTER IV
KU4DSCCHE202: ORGANIC CHEMISTRY II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCHE202	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on carbonyl compounds, carbohydrates, carboxylic acids, their derivatives, nitrogen compounds, dyes and a module on organic chemistry practicals.

Course Prerequisite: Basic knowledge about functional groups and homologous series. Awareness of IUPAC and common names of first five members of different classess of compounds such as carbonyl compounds, carbohydrates, carboxylic acids and nitrogen containing compounds.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the preparative methods and properties of carboxylic acids, carbonyl compounds and nitrogen containing compounds.	U
2	Describe the classification, structure and properties of carbohydrates.	U

3	Explain the configuration of glucose and fructose	U
4	Examine the carbohydrate content of biological samples	An
5	Analyse the characteristics of different functional groups	An
6	Classify different dyeing agents	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	3	0	2	0	0	0	0
CO 3	3	0	0	0	0	0	0
CO 4	3	0	0	0	0	0	0
CO 5	3	0	2	0	0	0	0
CO 6	3	0	0	0	0	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**CARBONYL COMPOUNDS**	**15**
	1	Aldehydes and ketones: Preparation of aldehydes and ketones: Rosenmund's reduction, Stephen's reduction, Etard's reaction, Oppenauer oxidation, Houben-Hoesch synthesis.	
	2	Reactions of aldehydes and ketones: Meerwein-Ponndorf-Verley reduction, Clemmensen reduction, Wolff-Kishner reduction, Reduction using $LiA1H_4$ and $NaBH_4$ and reduction to pinacols.	
	3	Oxidation using mild and strong oxidizing agents- SeO_2 oxidation. Reaction with alcohols, KCN, sodium bisulphite and derivatives of ammonia. Distinction between acetaldehyde and benzaldehyde and acetaldehyde and acetone.	
	4	Mechanisms of Aldol and Benzoin condensation reactions, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reactions, Beckmann and Benzil-Benzilic acid rearrangements- Addition reactions of unsaturated carbonyl compounds: Michael addition	
2		**CARBOHYDRATES**	**9**
	1	Occurrence, classification and functions of carbohydrates- Monosaccharide: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation	

	2	Determination of ring size of glucose and fructose, Haworth projections and conformational structures- Interconversion of Monosaccharides: Aldopentose to Aldohexose (Arabinose to D-Glucose, D Mannose) (Kiliani - Fischer method)	
	3	Epimers, Epimerization – Aldohexose to Aldopentose (D glucose to D- Arabinose) by Ruff degradation.	
	4	Aldohexose to Ketohexose [Glucose to Fructose] and Ketohexose to Aldohexose (Fructose to Glucose)- Structure of disaccharides-sucrose, maltose and lactose. Structure of polysaccharides - starch and cellulose (excluding structure elucidation). Colour tests for carbohydrates	
3	**CARBOXYLIC ACIDS & DERIVATIVES**		**7**
	1	Carboxylic acids - Preparation and reactions of acrylic and crotonic acids. Preparation and reactions of Hydroxy acids - lactic acid, tartaric acid and citric acid	
	2	Dicarboxylic acids - Preparation and reactions of malonic, succinic, maleic and fumaric acids - Blanc's rule	
	3	Preparation and reactions Aromatic acids - Benzoic acid, Phthalic acids, anthranilic acid, salicylic acid and cinnamic acid.	
	4	Acid derivatives – Acyl chlorides, anhydrides, esters and amides	
4	**NITROGEN CONTAINING COMPOUNDS AND DYES**		**13**
	1	Nitro compounds –General methods of preparation- (From alkanes, alkyl halides and halogeno carboxylic acids).	
	2	Nitro benzene: Preparation and reactions - Reduction, Electrophilic substitution and Nucleophilic substitution Cyanides and isocyanides: - General methods of preparation	
	3	Amines: Preparation – From Alkyl halide, Nitro Compounds, Nitriles, Hoffman Bromamide reaction, Curtius reaction, Schmidth reaction, reduction of Alkyl isocyanide, Preparation of tertiary amine	

	4	Amines: Chemical reactions- Acylation, Benzoylation, Diazotisation, Reactions of diazonium salt, Carbylamine reaction, Hofmann's exhaustive methylation, Hofmann's elimination, Mannich reaction, Ring substitution, Separation of mixture by Hinsberg method, Hoffman's tests for amine.	

5	**TEACHER SPECIFIC MODULE**		
	PRACTICALS		
	ORGANIC QUALITATIVE ANALYSIS*		30
	A minimum of ten compounds should be analysed and recorded. Microscale analytical technique is preferred for carrying out the reactions. Out of the ten experiments one is to be open-ended and is subjected to teacher's choice.		
	1	Reactions of Organic Compounds- Detection of elements- Preparation of derivatives of organic compounds containing single functional group only.	
	2	Identification and confirmation of functional groups (single functional group only) in the given organic compound	
	3	Suggestion and Preparation of derivative of the given organic compound	
	5	**ORGANIC COMPOUNDS FOR ANALYSIS** Analyse the following organic compounds with a view to characterize functional group/groups in them.	
		Carbohydrates (glucose, sucrose)	
		Aliphatic saturated amide (Urea)	
		Carboxylic acid (benzoic acid, cinnamic acid, succinic acid, salicylic acid and phthalic acid)	
	9	Carbonyl compounds (benzaldehyde, acetophenone and benzophenone)	

	10	Phenols (phenol, cresol, naphthols and resorcinol)	
	11	Aromatic hydrocarbons (naphthalene and anthracene)	
	12	Halocompound (chlorobenzene, bromobenzene and benzyl chloride)	
	13	Ester (ethyl benzoate and methyl salicylate)	
	14	Aromatic compounds containing nitrogen (nitrobenzene, aniline, p-toluidine, N, N-dimethyl aniline, benzamide and o-nitrotoluene)	
	15	Suggestions for open- ended experiments. a) Determination of melting point of an organic compound. b) Determination of boiling point of an organic compound	

Essential Readings:

1.M. K. Jain and S. C. Sharma *'Modern Organic Chemistry'* 3rd Edition, Visal PublishingCompany Co.

2.K. S. Tewari and N. K. Vishnoi*'Organic Chemistry'*, 3rd Edition, Vikas Publishing House

3.B. S. Bahl '*Advanced organic Chemistry'*, S. Chand.

4. R. T. Morrison and R. N. Boyd, *'Organic Chemistry',* 6th Edition - Prentice Hall of India.

5.I. L. Finar *'Organic Chemistry',* Vol.- 1, Pearson Education

6.P. S. Kalsi' *'Organic Reactions and their Mechanisms"* New Age International Publishers.

7.Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry,* JohnWiley& Sons (2014).

8.McMurry, J.E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning IndiaEdition, 2013

9.B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5thEdn., Pearson Education, Noida, 2014.

10.F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4thEdn., Pearson Education, Noida, 2011.

11.Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2ndEdn., Pearson Education, Noida, 2013

Suggested Readings:

1.P. Y. Bruise, '*Organic Chemistry',* Pearson Education.

2.J. March, '*Advanced Organic Chemistry'*, John Wiley & Sons, NY

3.S. H. Pine '*Organic Chemistry'*, McGraw Hill

4.J. Clayden, N. Greeves, S. Warren and P. Wothers, *'Organic Chemistry'*, Oxford University

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

KU4DSCCHE203: PHYSICAL CHEMISTRY –I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	DSC	200	KU4DSCCHE203	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on solutions, gaseous state, liquid state, ionic equilibrium and Physical Chemistry practical-I. The course will develop a good understanding about the topics covered in the different modules and quantitative analysis skills essential for a career in chemistry and related fields.

Course prerequisite: Basic knowledge on solutions and colligative properties

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Identify and distinguish the types of solutions	U
2	Explain colligative properties of dilute solution and determine the molecular weight of a solute	A
3	Recognize and relate the properties of ideal and real gases	A
4	Describe the properties of liquids.	U
5	Understand the basic principle of ionic equilibrium and its application in laboratories	U
6	Acquire practical skill in physical chemistry experiments such as Cryoscopy, Transition temperature, Viscosity, CST, etc.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	0	0	0	0
CO 2	3	0	0	0	0	0	0
CO 3	3	0	0	0	0	0	0
CO 4	3	0	0	0	0	0	0
CO 5	3	0	0	0	0	0	0
CO 6	3	0	0	0	0	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**SOLUTIONS**		**15**
	1	Types of solutions and methods for expressing concentration – Liquid systems — Completely miscible- Ideal and non- ideal solutions – Raoult's Law – Vapour pressure – composition diagrams-Azeotropic mixtures– Temperature – composition curves – Partially miscible liquids – Upper and Lower Critical solution temperature –Immiscible liquids – Steam distillation – Molar mass from steam distillation – Dilute Solutions	
	2	Lowering of vapour pressure and Raoult's law – Calculation of molar mass. Elevation of boiling point – relation to lowering of vapour pressure – Thermodynamic derivation – Calculation of molar mass – Depression of freezing point – Thermodynamic derivation – Calculation of molar mass – Measurement by Beckmann's method	

	3	Osmotic pressure – Measurement by Berkely and Hartley's method – Laws of Osmotic pressure – Van't Hoff equation – Calculation of molar mass – Abnormal molar mass – Van't Hoff factor – Degree of dissociation and association and their calculation from colligative properties. Gas Liquid system — Henry's Law	
2	**GASEOUS STATE**		**15**
	1	Gas laws – The general gas equation– The Kinetic model of gases – gas laws from the kinetic theory of gases-Molecular Speeds – Maxwell's distribution of molecular speeds – Most probable velocity, average velocity and root mean square velocity — Collision diameter – Mean free path, The compressibility factor – virial equation of state –Collision number and collision frequency	
	2	Degrees of freedom of a gaseous molecule – Principle of equipartition of energy and contribution towards heat capacity of an ideal gas. Real gases – Molecular attractions	
	3	Van der waals equation expressed in virial form – calculation of Boyle's temperature – Isotherm of real gases and their comparison with Van der waals isotherms – continuity of states	
	4	Critical phenomenon – critical constants of a gas and its determination, derivation of relationship with van der waal constants	
	5	Determination of molecular mass by limiting density method – Principle of corresponding states – Liquefaction of gases by Joule Thomson effect	
3	**LIQUID STATE**		**7**
	1	Theories of Liquids state, Vacancy Theory and Free volume theory.	
	2	Properties of liquids– vapour pressure- Heat of vaporisation- Trouton's Rule, Surface tension and its determination by capillary rise method and by using stalagmometer	
	3	Interfacial tension – surface active agents –effect of temperature on surface tension	

	4	Parachor and its applications – Viscosity - determination of coefficient of viscosity and its variation with temperature	
	5	Refractive index– specific and molar refraction– Measurement of refractive index– Abbe's refractometer optical activity and its measurement using Polarimeter	
4	**IONIC EQUILIBRIUM**		**8**
	1	Ionic product of water – Dissociation constants of acids and bases – pH and its determination – Heat of neutralization	
	2	Incomplete neutralization – Hydrolysis of different types of salts – Degree of hydrolysis and hydrolytic constant – and its relationship with pH and pOH	
	3	Buffer solution – pH of Buffer solution – Henderson's equation – Buffer capacity – Application of buffer – Preparation of a buffer (one example)	
	4	Acid – base indicators –Theory of acid – base indicators	
5	**TEACHER SPECIFIC MODULE-PHYSICAL CHEMISTRY PRACTICALS-I** *Directions: A minimum of 6 experiments (2 from CST,2 from cryoscopy) must be done. Out of the seven experiments 2 are open ended and can be selected by the teacher.*		**30**
	1.CST a) Critical solution temperature of phenol - water system b) Concentration (% composition) of NaCl/KCl by C.S.T Measurements **2.Cryoscopy** Cryoscopy Using Solid Solvent a) Cryoscopic constant of solid solvent using a solute of known molar mass (cooling curve method) Solid solvents/solutes given: Naphthalene, Biphenyl, diphenyl amine. b) Molar mass of the given solute, using solvent of known K_f. Solid solvents/solutes given: Naphthalene, Biphenyl, diphenyl amine.		30

	Teacher specific /open ended experiments (suggestions) **3.Transition temperature**. Transition Experiments (cooling curve method) a) Transition point, depression constant (KT) of the given Salt hydrate, using solute of known molar mass. salt hydrates: $Na_2S_2O_3$. $5H_2O$. / $CH_3COONa.3H_2O$. Solutes: Urea, Glucose, b) Molar mass determination of given solute using salt hydrates of known (KT) Salt hydrates and solutes as a **4.Viscosity, Surface Tension determination** Viscosity-Ostwald viscometer Surface tension –Measurement using Stalagmometer to fill the selected arvity	

Essential Readings:

1. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
2. Physical Chemistry: P.W. Atkins, Oxford University Press
3. Physical Chemistry: W.J. Moore, Orient Longmans.
4. Physical Chemistry: N. Kundu & S.K. Jain, S.Chand& Company
5. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press Ltd.
6. Advanced Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut.
7. Physical Chemistry: W.J. Moore, Orient Longmans

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

KU5DSCCHE301: PHYSICAL CHEMISTRY-II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCHE301	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on Chemical equilibrium, Colloids, Surface chemistry, Chemical Kinetics, catalysis, Phase rule and Physical Chemistry Practicals. Learning the course will develop a deep understanding of the above said topics and good practical skills**.**

Course Prerequisite:

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the basic principles of chemical equilibrium, Le-Chatlier principle and its application in industries.	U
2	Understand basic principles of surface chemistry and its application in various fields.	U
3	Correlate the types of colloids with their properties and to explore the applications in day today life.	A
4	Apply scientific principles of kinetics to simple, complex, enzymatic, and surface reactions	U

5	Construct phase diagrams and study the equilibrium that exists between various states of matter. And apply principles of phase diagram to separation processes and for property modification of different types of system in laboratory experiments.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	2	2	1	1	0
CO 2	3	3	2	2	1	1	1
CO 3	3	3	2	2	1	1	0
CO 4	3	3	2	2	1	1	1
CO 5	3	3	2	2	1	1	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**CHEMICAL EQUILIBRIUM**		**8**
	1	Law of mass action-Equilibrium constant – Relation between Kp, Kc and Kx-3Thermodynamic treatment of the law of mass action	

	2	Vant Hoff reaction isotherm-Temperature dependence of the equilibrium constant-The Van't Hoffs isochore– Pressure dependence of the equilibrium constant Kp	
	3	Study of heterogeneous equilibria -Heterogeneous equilibria – Dissociation of solid calcium carbonate and decomposition of solid NH_4HS	
	4	Factors that change the state of equilibrium- Le –Chatelier's principle and its application to chemical and physical equilibria-Mention homogeneous gaseous equilibria having zero, positive and negative values of Δn-Calculation of degree of dissociation and Kp	
2	**COLLOIDS AND SURFACE CHEMISTRY**		**13**
	1	Colloids, Classification – preparation-structure and stability – The electrical double layer –Zeta potential (no derivation)	
	2	Properties of Colloids – Tyndall effect – Brownian movement– Coagulation of colloidal solution – Hardy – Schulze rule – Flocculation Value Electro kinetic properties – Electrophoresis – Electro-osmosis – Protective colloids – Gold number	
	3	Emulsion – Oil in water emulsion and water in oil emulsion – Emulsifying agents – Gels –Micelles-CMC Donnon membrane equilibrium (basic idea only)	
	4	Physical and chemical adsorption – Adsorption isotherms – Freundlich adsorption isotherm – effect of temperature on adsorption – Langmuir adsorption isotherm -thermodynamic derivation – use and limitation.	
	5	B.E.T. equations (B.E.T. no derivation) – Gibbs adsorption equation (no derivation)-Surface films - Determination of surface area using Langmuir equations.	
3	**CHEMICAL KINETICS AND CATALYSIS**		**12**
	1	The rates of chemical reactions – Experimental techniques – rate laws and rate constant – Order and molecularity of reactions – Methods of determining the order of reaction	
	2	Integrated rate laws of zero order, first order and second order reactions — General integrated rate equation for nth order reaction- Zero and	

		fractional order reactions - Half life- Types of complex reactions consecutive parallel and opposing reactions-their derivation (first order only)- Temperature dependence of reaction rates – Arrhenius equation – Interpretation of parameters	
	3	Steady state approximation – Kinetics of unimolecular reactions – Lindemann's Theory-Theories of reaction rates — Collision theory – Derivation of rate equation for second order reaction from collision theory- Thermodynamic approach of transition state theory – Entropy activation	
	4	Catalysis – Homogeneous and Heterogeneous catalysis – examples – Features of homogeneous catalysis — Langmuir isotherm- Enzymes – Michalis – Menten mechanism. Heterogenous catalysis – Kinetics of unimolecular surface reactions-2nd order surface reactions-Hinshelwood mechanism	
	PHASE RULE		**12**
	1	Statement of phase rule and explanation of terms (component, degree of freedom, phase)- thermodynamic derivation	
		One component system – water system and sulphur system (including meta stable equilibrium	
	2	Two component systems – reduced phase rule --- simple eutectic systems—lead-silver system --- desilverisation of lead--- KI –water system --- freezing mixtures	
	3	Systems involving the formation of compounds with congruent and incongruent melting points—ferric chloride water system and Na_2SO_4 water system- Solid-gas equilibria - decomposition of $CuSO_4.5H_2O$ — deliquescence and efflorescence	
	4	Nernst distribution law-Thermodynamic derivation and derivation from phase rule. Limitations- modifications under special conditions- Applications of distribution law to study association and dissociation of salts, solvent extraction, hydrolysis of salts and equilibrium constant of the reaction $KI + I_2 \rightleftharpoons KI_3$	

<table>
<tr><td rowspan="4">5</td><td colspan="2">TEACHER SPECIFIC MODULE
PHYSICAL CHEMISTRY PRACTICALS -II
Minimum 4 experiments to be done and recorded</td><td>30</td></tr>
<tr><td>1</td><td>Chemical Kinetics - Hydrolysis of methyl acetate using HCl acid</td><td></td></tr>
<tr><td>2</td><td>Phase diagram
Critical Solution Temperature (C.S.T)
a) Critical solution temperature of phenol - water system
b) Concentration (% composition) of NaCl/ KCl by C.S.T Measurements</td><td></td></tr>
<tr><td>3</td><td>Adsorption experiments- (open ended)
Suggestions
a) Verification of Freundlich and Langmuir adsorption isotherms- charcoal—acetic acid system
b) Determination of concentration of given acetic acid solution using the isotherms
c) Verification of Freundlich and Langmuir adsorption isotherms- charcoal—acetic acid system
d) Determination of concentration of given acetic acid solution using the isotherms</td><td></td></tr>
</table>

Essential Readings:

1. Physical Chemistry: P.W. Atkins, Oxford University
2. Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.
3. A Textbook of Physical Chemistry: A S Negi and S C Anand, New Age International Publishers.
4. A Textbook of Physical chemistry: K. L. Kapoor, Volumes 2 &3, Macmillan India Ltd
5. Textbook of Physical Chemistry: Samuel Glasstone, McMillan Press
6. Physical Chemistry: Gurdeep Raj, Goel Publishing House, Meerut
7. Physical Chemistry: W.J. Moore, Orient Longmans
8. Physical Chemistry: K. J. Laidler, John H.Meiser
9. Physical Chemistry: N. Kundu & S.K. Jain, S. Chand& Company
10. Chemical Kinetics: K.J. Laidler, Pearson Education.
11. Chemical Thermodynamics: J. Rajaram and J. C. Kuriakose, Pearson

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

SEMESTER V

KU5DSCCHE302: INORGANIC CHEMISTRY- III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCHE302	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: This major paper describes the concepts of gravimetric analysis, separation-chemistry, instrumental techniques in analytical chemistry and chromatography, acids, bases, non-aqueous solvents, introduction to gravimetric techniques and corrosion. Practical session deals with introduction to gravimetric techniques.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the qualitative and quantitative aspects of analysis and separation techniques and get practical knowledge in laboratory	U /A
2	Explain instrumentation and working principle of different analytical techniques –TGA, DTA and radio chemical method of analysis	R
3	To understand scientific principles of corrosion, theories of corrosion and factors affecting Corrosion	U

4	Understanding the properties, behaviour and applications of acids, bases and non-aqueous solvents	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	3	2	3	1	0
CO 2	3	2	3	2	2	1	1
CO 3	3	3	3	2	2	1	0
CO 4	3	3	3	2	2	1	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**PRINCIPLES OF GRAVIMETRIC ANALYSIS AND SEPARATION-CHEMISTRY**	**15**
	1	Gravimetric analysis – unit operations in gravimetric analysis. Precipitation: Conditions of precipitation – co precipitation and post precipitation	
	2	Principle of gravimetric estimation of iron and nickel - Precipitation phenomena – precipitation trans homogenous solution	
	3	Organic precipitants in inorganic analysis (a detailed study) – extraction of metal ions – nature of extractants – distribution law – partition coefficients – types of extraction and applications	

	4	Chelometric titrations (a detailed study) – titration curves with EDTA – feasibility of EDTA titration – indicators for EDTA titration and its theory (a detailed study) – selective masking and demasking techniques – industrial application of masking	
2	**INSTRUMENTAL TECHNIQUES IN ANALYTICAL CHEMISTRY AND CHROMATOGRAPHY**		**14**
	1	Thermo-gravimetric analysis – introduction – instrumentation – factors affecting TGA – application of TGA- Differential thermal analysis – introduction – instrumentation – principle of working – factors affecting DTA – application- Differential thermal analysis – introduction – instrumentation – principle of working – factors affecting DTA – application	
	2	Radio chemical methods of analysis – introduction – activation analysis – a brief study- Neutron diffraction – theoretical aspects – thermal neutron – instrumentation – application	
	3	Basic principle, Column chromatography – Adsorption column chromatography and Partition column chromatography- Ion exchange chromatography - Ion exchange resins	
	4	Thin layer chromatography - preparation of chromatoplate - running a thin layer chromatogram - location of spots- Brief introduction on Gel chromatography and paper chromatography –HPLC	
3	**CORROSION AND CORROSION CONTROL**		**6**
	1	Introduction - Causes of corrosion, types and Theories of corrosion- (Direct chemical attack or dry corrosion- Electrochemical theory or wet corrosion-Peroxide theory, acid theory, oxide theory)	
	2	Differential aeration or concentration cell corrosion- Factors influencing corrosion- nature of the metal- nature of the environment. Corrosion control	

4.	**ACIDS, BASES AND NON-AQUEOUS SOLVENTS**		**10**
	1	A generalized acid base concept-Measure of acid base strengths – gas phase basicities – proton affinities – gas phase acidities – proton loss gas phase acidities	
	2	Electron affinities – systematic of Lewis acid-base interaction – bond energies – steric effect – proton sponges-Solvation effects and acid base anomalies	
	3	Hard and soft acids and bases – classification – strength and hardness and softness – symbiosis – theoretical basis of hardness and softness – electron negativity and hardness and softness	
	4	Classification of solvents – properties of non-aqueous solvents like NH_3 and H_2SO_4 – chemistry of molten salts as non-aqueous solvent systems – solvent properties – room temperature molten salts –unreactivity molten salts	
5	**TEACHER SPECIFIC MODULE -** INTRODUCTION TO GRAVIMETRIC TECHNIQUES AND ITS HIGHLIGHTS – PRACTICAL Minimum 6 experiments to be done.		**30**
	1.	Determination of water of hydration in crystalline barium Chloride.	
	2.	Determination of barium as barium sulphate.	
	3.	Determination of sulphate as barium sulphate.	
	4.	Determination of iron as ferric oxide.	
		Open endedExperiments (Suggestions)	
	5.	Determination of calcium as calcium carbonate.	
	6.	Estimation of nickel as nickel dimethylglyoxime.	
	7.	Determination of copper as cuprous thiocyanate.	
	8.	Determination of magnesium as magnesium oxinate.	

Essential Readings:

1.B R Puri, L R Sharma, K C Kalia, Principles of Inorganic Chemistry, Milestone publishers, New Delhi.

2. D A Skoog, D M West and S R Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Brooks/Cole Nelson (Chapter 12-17).

3. Vogel's Textbook of Quantitative Chemical Analysis
4. G D Christian, Analytical Chemistry, John Wiley and Sons.
5. J.D Lee, Concise inorganic chemistry, Blackwell Science, London
6. Jain & Jain, Engineering Chemistry, Dhanpat Rai Publishing Company.
7. Chatwal and Anand, Instrumental methods of chemical analysis.
8. A K Srivastava, P C Jain, Instrumental approach to chemical analysis. S Chand.
9. H Kaur, Instrumental methods of chemical analysis, PragatiPrakashan, Meer
10. Emelus and Anderson, Principles of Inorganic Chemistry.
11. R P Budhiraja, Separation Chemistry, Second edition, New age international publishers
12. Dr.S.K.Agarwala and Dr.Keemtilal, Advanced Inorganic Chemistry.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*Average of best two test papers

KU5DSCCHE303: THEORETICAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU5DSCCHE303	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description*:* This course discovers the basic concepts of quantum mechanics and group theory. You can learn the history of groundbreaking experiments that led to the development of quantum mechanics. Understand why classical wave equations limitations have to capture the science of microscopic particles and how the Schrödinger equation brings a new perspective. Connect classical and quantum ideas and get comfortable with required mathematical tools for better insight into the concepts of quantum mechanics. Explore the rules governing quantum systems and see how symmetry matters in molecules using point group concepts.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To identify the fundamental experiments and theories that led to the development of quantum mechanics, also the limitations of classical models.	U
2	To understand and explain the core postulates of quantum mechanics, including the state function, operator, eigenvalue, and	An

	expectation value postulates, and describe their significance and application in solving quantum mechanical problems.	
3	To apply the Schrödinger equations to various potential problems, such as the particle in a box, and compute quantized energy levels and corresponding wavefunctions	A
4	To combine knowledge of symmetry elements and operations to systematically identify and classify symmetry point groups of simple molecules, and predict the effects of symmetry on physical properties like dipole moments and optical activity	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	2	2	1	0
CO 2	3	3	3	2	2	1	1
CO 3	3	3	3	2	2	1	0
CO 4	3	3	3	3	2	1	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**FUNDAMENTAL CONCEPTS IN QUANTUM MECHANICS**		**12**
		Limitations of Bohr atom model –Development of quantum mechanics – Blackbody Radiation and Planck's Formula	
		Einstein's Photoelectric effect – Compton effect – de-Broglie hypothesis – Electron diffraction – Davison and Germer Experiment – Young's double slit experiment – Stern- Gerlach Experiment – Heisenberg's uncertainty Principle	

2	**POSTULATES OF QUANTUM MECHANICS**		**12**
	1	Postulate 1:(State function postulate): – Statement – Physical significance of wave function: Born interpretation of wave function – Ortho-normality of wave function – Well behaved functions – Conditions of well-behaved functions	
	2	Postulate 2 :(Operator postulate): – Statement – Observables and Operators – Examples of different operators: momentum operators, kinetic energy operators, potential energy operators, Hamiltonian operators, Hermitian operators	
	3	Postulate 3: (Eigen value postulate) Statement – Eigen values and eigen functions- Postulate 4 (Expectation value postulate):– Statement – Definition of expectation value – Physical interpretation – Application to operators – Schrödinger's cat paradox	

	4	Postulate 5: (Time-dependent Schrödinger): The classical wave equation –Time-independent Schrödinger wave equation – Deduction of Schrödinger equation from classical wave equation. Stationary waves and steady-state equation	

3	**QUANTUM TRANSLATIONAL MOTION**		**8**
	1	Particle in a one-dimensional box with infinite potential walls – Boundary conditions – Normalized wave functions – Quantization of energies – Plotting energy levels, wave functions and probability densities	
	2	Application of particle in a box to simple conjugated aliphatic hydrocarbons (Free electron model)-Particle in a three-dimensional box – Boundary conditions, wave functions and energies – degeneracy and its connection with symmetry of the box	

4	**MOLECULAR SYMMETRY**		**16**
	1	Historical Sketch – Symmetry in everyday life - Symmetry elements and symmetry operations with examples: Identity operation, Symmetry planes and reflections, Proper axes and proper rotations, Improper axes and Improper rotations – Product of symmetry operations – General relation between symmetry operations	
	2	Complete set of symmetry operations of a molecule – Symmetry point groups – Schoenflies notation –GMT of some simple molecules (H_2O_2, H_2O, NH_3)-Classes of symmetry operations – Systematic identification of point groups (C_n, C_i,C_s,C_{nv}, C_{nh}, D_{nh} only) -Point groups of simple molecules – H_2O_2, H_2O, NH_3, N_2O_4, N_2F_2, BF_3	
5	**TEACHER SPECIFIC MODULE** ***Directions:*** *Mathematical tools for quantum chemistry& group theory or any other topic relevant to the course*		**12**

	1	Complex Numbers – Complex functions – Odd and even functions	
	2	Coordinate system: Cartesian and spherical polar coordinates and their relationships. – Basics of differentiation and integration – Solution of a second order ODE – Power series solution of differential equation	
	3	Probability: average, variance and standard deviation– Elements of operator algebra: definition – Linear and non-linear operators – Commutator of two operators - Commuting and non-commuting operators – Vector operators – Laplacian operators and their expressions in cartesian and spherical polar coordinates	
	4	Matrices and determinants: matrix algebra – character of a square matrix – diagonal matrix, orthogonal and unitary matrices – direct product and direct sum of square matrices – block factored matrices	

Essential Readings:

1. D. A. McQuarrie, "Quantum Chemistry", University Science Books,1983 (Viva books, 2003).
2. A.K. Chandra, "Introduction to Quantum Chemistry", 4th Edition, Tata McGraw-Hill, 1994.
3. I.N. Levine, Quantum Chemistry, 6th Edition, Pearson Education Inc., 2009
4. F.A. Cotton, "Chemical applications of Group Theory", 3rd Edition, John Wiley &SonsInc., 2003
5. Arthur M Lesk, "Introduction to Symmetry & Group theory for Chemists", Kluwer Academic Publishers,2004
6. Robert L. Carter, 'Molecular Symmetry and Group Theory", Wiley India Edition, 2005

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-voce	6
Total		**100**

*Average of best two test papers

DISCIPLINE SPECIFIC ELECTIVE COURSES

KU5DSECHE301: -INDUSTRIAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	**KU5DSECHE301**	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: The course covers topics such as the necessity and demands of industrialization, as well as the design of its machinery and pilot plants. Four primary and significant domains of industrialization are covered, along with its chemistry. These include fertilizers, pharmaceuticals, batteries, and the industries of polymers. The production of representative goods like urea, paracetamol, and so on is covered in detail.

The economic and environmental aspects are also aimed.

Course Prerequisite: Basic knowledge in chemistry and instrumentation

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop knowledge of the numerous industrial processes, such as distillation, extraction, and others, as well as the necessity of industrialization and the chemical industry.	U

2	To learn about the scientific principles of drug metabolism and activity.	U
3	To study about various glasses andlearn the manufacturing process of various polymers.	A
4	Analyze the detrimental impacts of industries, their administration, and the mitigation of pollution.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	2	2	2	0
CO 2	3	3	3	2	2	1	1
CO 3	3	3	3	2	2	2	0
CO 4	3	3	3	3	2	3	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
	UNIT OPERATIONS AND UTILITIES IN CHEMICAL INDUSTRIES		**18**
	1	Distillation- introduction- batch and continuous distillation- separation of azeotropes- plate columns and packed columns-Absorption: introduction-equipment-packed columns-spray columns- bubble columns- mechanically agitated contractors-Evaporation: introduction-	

1		equipments- short tube evaporator- forced circulation evaporator- wiped film evaporators	
	2	Filtration: introduction-equipment's-plate and frame filter press-Nutsche filter- rotary drum filter-sparkler filter-candle filter-bag filter Drying: introduction- free moisture- bound moisture- drying curve-equipment: tray dryer, fluid bed dryer, drum dryer, spray dryer	
	3	Crystallisation: introduction- solubility nucleation and supersaturation-fractional crystallisation- Equipments: tank crystalliser, evaporator crystallisation- Extraction – introduction- selection of solvents-equipment: spray, column, packed column, Soxhlet extractor	
	4	Fuels: types of fuels- advantages & disadvantages. Boilers- types of boilers and their functioning- Water specification for industrial use-various water treatments. Air- specifications for industrial use, processing of air. Quality control and quality assurance	

2	**PHARMACEUTICAL AND FERTILIZER INDUSTRIES**		**15**
		Drug metabolism principles- Drug action-Pharmacokinetics and Biopharmaceutics- Theories of drug dissolution.	
	2	The pharmaceutical industry: Manufacture of ibuprofen- Material procurement- flow-chart- manufacturing process- Chemistry of synthesis of ibuprofen	
	3	Manufacture of Paracetamol- Action of the drug- chemical reactions involved- raw materials- flow-chart- Quality Control: Sampling plan, In-process quality control tests, Pharmaceutical Analysis	
	4	Manufacture of Urea, Ammonium Sulphate and Ammonium Phosphate. Raw materials, process, chemical reaction and flow chart	

3	**POLYMER INDUSTRY**		**8**
	1	Introduction of polymer industries- manufacture of polyvinyl chloride-Bakelite- Nylon and polyethylene-Raw Materials used.	
	2	Types of moulding techniques: Pipe extrusion, Blow Moulding injection moulding- process development-Applications	

4	**GLASS &CEMENT INDUSTRIES**		
	1	Glass: Composition- raw materials- verities of glass: borosilicates, optical and safety glass-composition and uses- glass manufacturing methods- heat treatments.	
	2	Cement: Raw materials- setting of cement.	

5	**TEACHER SPECIFIC MODULE-INDUSTRIAL MANAGEMENT**	**12**
	Directions: A module on industrial management or any other topic relevant to the course according to the teacher can be proposed.	
	Air and sound pollutants- Source- prevention and analysis of water pollution.	
	Industrial safety parameters- industrial safety and environmental laws-environmental protection act- Chemical Process.	
	Economics and Entrepreneurship- Quality considerations during packaging operation- Main industries in India.	

Essential Readings:

1. Vogel's Textbook of Practical Organic Chemistry, by Furniss, Hannaford, Smith and Tatchell, ELBS Longmann
2. Introduction to Chromatography- Theory and Practice-V.K. Srivastava and K.K. Srivastava, S. Chand Company Ltd., IV ed., 1991

3. Air pollution control and design handbook P.N. Cheremisioff and R AYound: Vol-I & II Dekker
4. Drug Metabolism Chemical andEnzymatic Aspects, Uetrecht, Informa Healthcare publishers
5. Rang and Dale's Pharmacology, Rang H. P., Dale M. M., Ritter J. M., Flower R.J., Churchil Livingstone Elsevier
6. Active Pharmaceutical Ingredients: Development, Manufacturing, andRegulation (Drugs and the Pharmaceutical Sciences), NUSIM S.H. Taylor &Francis
7. Fertilizers Manufacturing Handbook: DAP, Urea - Ammonium Nitrate, NeemCoated Urea, N.P.K. Complex Fertilizers, SSP, Triple Superphosphate, ZincSulfate Monohydrate, Magnesium Sulfate with Manufacturing Process, Machinery Equipment Details & Factory Layout), P. K. Chattopadhyay, NirProject Consultancy Services
8. Introduction of polymer industries, manufacture of polyvinyl chloride, Bakelite, Nylon and polyethylene. Raw Materials used.
9. Types of moulding techniques, Pipe extrusion, Blow Moulding injectionmoulding, process development, Applications
10. A Textbook on Environmental Pollution and Control, H S Bhatia, GalgotiaPublications.
11. Environmental Pollution and Management, Avnish Chauh, Wiley India
12. Industrial Reliability and Safety Engineering, Panchal, Dilbagh, CRC Press
13. Industrial Safety and Environment, Anupama Prashar, S.K. Kataria &Sonpublishers
14. Basic and clinical pharmacology, Katzung B. G., Masters S. B., Trevor A. J., Tata Mc Graw-Hill
15. Modern Pharmaceutics, Banker, G.S., Rhodes, C.T. 1989. II Edition. Marcel Dekker.l
16. Fundamentals of Medicinal Chemistry, Gareth Thomas, Wiley
17. Industrial Chemistry, Clerk Ranken, Maxwell Press
18. Indian Industry, Siddhartha&MukherjeeDr. Qamar Ahsan, Kitab Mahal publishers
19. Shaping the Industrial Century: The Remarkable Story of the Evolution of the Modern Chemical and Pharmaceutical Industries. Chandler, Alfred D. (2005). Harvard University Press
20. A Short History of Technology: From the Earliest Times to A.D. 1900. Derry, Thomas
21. Kingston; Williams, Trevor I, Dove, New York:

Suggested Readings:

1. The Theory and Practice of Industrial Pharmacy, Lachman, L., Herbert A., 1991 3rd edition, Verghese publishing house.
2. . The Fertilizer Industry, Murray-Park, , Google books 2001
3. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
4. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L. Bottenbruch, Hanser Publishers, 1996
5. Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc,2000
6. PVC Technology, A. S. Athalye and Prakash Trivedi, Multi-Tech Publishing Co, 1994.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar,Viva-Voce	12
Total		100

.KU5DSECHE302: GREEN & SUSTAINABLE CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECHE302	4	60

Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	-	30	70	100	2

Course Description: Green chemistry is the utilization of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products. This course will focus on the development of green chemistry, definitions and metrics, prevention of pollution at source through new/sustainable synthetic methods. The course will also focus on few examples of commercial applications of green chemistry.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply the principles of green chemistry to chemical-related problems and waste reduction.	A
2	Acquire knowledge on applications of non-conventional energy sources for green synthesis	U
3	Acquire scientific knowledge on environmentally benign solvents and sustainable raw materials used in green chemistry	U

4	Rationalize the existing chemical processes to able to apply their sustainability and propose more sustainable amendments or commercially viable alternatives	E

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	3	2	1
CO 2	3	3	3	3	3	2	0
CO 3	3	3	3	3	3	2	0
CO 4	3	3	3	3	3	2	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE		DESCRIPTION	HOURS
1		**INTRODUCTION TO GREEN CHEMISTRY**	10
	1	Introduction- principle and concepts of green chemistry	
	2	Need for green chemistry- inception and evolution of green chemistry	
	3	Twelve principles of green chemistry with their explanations and examples- Designing a green synthesis using these principles.	
	4	Green chemistry in day-to-day life	

2	**DIFFERENT APPROACHES TO GREEN SYNTHESIS**		15
	1	Uses of green reagents in organic synthesis - Dimethyl carbonate- polymer supported reagents peracids and chromic acid.	
	2	Green catalysts- role of catalysis in sustainable development- homogeneous and heterogeneous catalysts.	
	3	Introduction- advantages and applications of nano-catalysts and phase transfer catalysts.	
	4	Biocatalysts- advantages and applications of organo-catalysts in organic synthesis.	

3	**APPLICATIONS OF NON- CONVENTIONAL ENERGY SOURCES**		**15**
	1	Introduction of microwave induced synthesis: Microwave activation, equipment, time and energy benefits, limitations.	
	2	Organic transformations under microwaves: Fries rearrangement, Diels-Alder reaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds	
	3	Introduction of ultrasound assisted green synthesis: Instrumentation- physical aspects- applications in organic transformations	
	4	Electrochemical synthesis: Introduction- synthesis of sebacic acid and adiponitrile	
4	**PHOTOCHEMICAL DEGRADATION**		**8**
	1	Photochemical Principles- Heterogeneous Photocatalysis- Homogeneous Photodegradation- photo oxidation- Direct Photo-degradation.	

	2	Gas phase Detoxification- application of photo degradation in wastewater treatment.	

5	**TEACHER SPECIFIC: GREEN SOLVENTS AND RENEWABLE RESOURCES**		12
	Directions: A module on green solvents and Renewable Resources or any other topic relevant to the course as per teacher's choice can be proposed		
	1	Ionic liquids as green solvents- Introduction- properties and types of ionic liquids- carbon Aqueous phase reactions- Enhancement of selectivity, efficiency.	
	2	Role of supercritical dioxide in green chemistry- Fluorous solvents in green chemistry- Scope, definition and their synthetic applicability.	
	3	Green chemistry in material science- synthesis of porous polymers- green nanotechnology.	
	4	Biomass as a renewable resource of energy- Chemicals and polymers from renewable feedstock.	

Essential Readings:

1. Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005
2. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker, 2001
3. V Kumar, An Introduction to Green Chemistry,
4. Lancaster, Mike, Green Chemistry an Introductory Text 2 nd Ed., RSC Publishing. ISBN: 978- 1-84755-873-2
5. Mukesh Doble, Anil Kumar Kruthiventi, in Green Chemistry and Engineering, 2007
6. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

7. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, 1998.

Suggested Readings:

1. M.C. Cann& M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of best two test papers

KU5DSECHE303: ENVIRONMENTAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECHE303	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: This course in Environmental Chemistry provides a comprehensive understanding of the chemical principles and processes affecting the environment. It covers atmospheric structure and composition, water and soil chemistry, and pollution sources and control measures. Topics include toxicology, air and water pollution, soil contamination, and noise and radiation hazards. Students will explore environmental segments, chemical toxicology, greenhouse effects, eutrophication, and bioremediation, emphasizing pollution control and environmental management techniques. This knowledge prepares students for careers in environmental science, research, and policy-making

Course Prerequisite: Basic idea about environmental pollutants

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand Environmental Segments: Describe lithosphere, hydrosphere, atmosphere, and biosphere, and their chemical compositions.	U

2	Analyze Air Pollution: Identify air pollutants, their effects, and scientific control methods including devices and regulations.	An
3	Assess Water Pollution: Evaluate sources, impacts, and control methods of water pollution, including sewage treatment and water standards.	An
4	Examine Soil Pollution: Investigate soil pollution causes, effects on plants, and scientific bioremediation techniques for soil management.	E
5	Understand Noise and Radiation Pollution: Explain sources, effects, and control measures of noise and radiation pollution, including case studies in scientific manner.	E

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	3	3	0
CO 2	3	3	3	3	3	3	1
CO 3	3	3	3	3	3	3	0
CO 4	3	3	3	3	3	3	1
CO 5	3	3	3	3	3	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ENVIRONMENTAL SEGMENTS AND AIR POLLUTION**		**9**
	1	Environmental segments: Lithosphere, Hydrosphere, Atmosphere and Biosphere- Atmospheric structure and composition - chemical composition of water in water bodies – (Ground water, river water and lake water, sea water wetlands)	
	2	Hydrological cycle- Chemical Toxicology–Toxic chemicals in environment –Sources, effects and treatment of heavy metal poisoning – Pb, As, Cd, Hg, Cr, Cu & Co- Mina Mata and Itai-Itai diseases.	

2	**WATER POLLUTION**		**12**
	1	Water resources- water pollution – sources – Industrial effluents – agriculture discharge oil spills – heavy metals – pesticides – detergents. Eutrophication – bio magnification and bioaccumulation – Experimental determination of Dissolved oxygen, BOD and COD	
	2	Thermal Pollution – Control of water pollution –ISI/BSI standards of drinking water- Hardness of water – causes and effects – methods of estimation – removal of hardness.	
	3	Domestic water treatment – Sewage – Sewage analysis -Sewage treatment	

3	**SOIL POLLUTION**		**12**
	1	Lithosphere – soil formation-Different types of weathering – components of soils – Acid Base and ion exchange reactions in soil	
	2	Soil pollution – soil acidification – effects on plants – liming of soil – Industrial and urban wastes – plastics, pesticides and heavy metals in soil – garbage –biomedical waste – E waste –Municipal Solid waste management. Bioremediation	

4	**NOISE AND RADIATION POLLUTION**		**12**
	1	Noise pollution and Radioactive Pollution: Human acoustics - Noise – general features - types of Noise – Measurement of noise – sound pressure and power levels – sources and effects of noise pollution – prevention of hearing loss in industry – control of noise pollution	
	2	Radiation chemistry – Manmade and natural radiations – biological effects of radiation - radiation hazards from reactors –Fukushima nuclear disaster- radioactive waste management	
5	**TEACHER SPECIFIC MODULE -AIR POLLUTION**		**15**
	Directions: A module on Air Pollution or any other relevant topic to the course as per teacher's choice can be proposed		
	1	Air pollutants –CO, NOx, SO_2, H_2S, Hydrocarbons, particulate matter. Acid rain and its effects- Greenhouse effect and global warming	
	2	Climate change – ozone chemistry and ozone hole- chlorofluorocarbons, dioxins.	
	3	Photochemical smog (reactions), Bhopal gas tragedy.	
	4	Control of air pollution – control by devices – Stacks, filters, electrostatic precipitators, cyclone separators, scrubbers and catalytic converters.	

Essential Readings:

1. Baird, Colin, and Michael Cann, Environmental Chemistry, 5th edn., W.H. Freeman.
2. Manahan, Stanley E., Environmental Chemistry, 10th edn., CRC Press.
3. De, Anil Kumar, Environmental Chemistry, 8th edn., New Age International Publishers.
4. Sawyer, Clair N., Perry L. McCarty, and Gene F. Parkin, Chemistry for Environmental Engineering and Science, 5th edn., McGraw-Hill.
5. Masters, Gilbert M., Introduction to Environmental Engineering and Science, 3rd edn., Prentice Hall.
6. VanLoon, Gary W., and Stephen J. Duffy, Environmental Chemistry: A Global Perspective, 3rd edn., Oxford University Press.
7. Connell, Des W., Basic Concepts of Environmental Chemistry, 2nd edn., CRC Press.
8. Harrison, Roy M., Pollution: Causes, Effects and Control, 5th edn., Royal Society of Chemistry.

Web References:

1. Royal Society of Chemistry, Environmental Chemistry, www.rsc.org/learn-chemistry
2. Khan Academy, Chemistry of Life, www.khanacademy.org/science/chemistry
3. Environmental Protection Agency (EPA), Air Quality, www.epa.gov/air-quality
4. National Oceanic and Atmospheric Administration (NOAA), Water Pollution, www.noaa.gov/education/resource-collections/water-cycle/water-pollution

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of best two test papers

Employability for the Course: This course prepares students for careers in environmental science, research, and policy. Graduates can work in environmental monitoring, pollution control, waste management, and regulatory agencies. They will have the skills to address environmental challenges, conduct analyses, and develop sustainable solutions for various environmental issues.

KU5DSECHE304: BIOMATERIALS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSE	300	KU5DSECHE304	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: The course comprises of modules on chemistry of biomolecules, biocatalysis, bioactive polymers, ceramics, applications of biomaterials and a teacher specific module. **Course Prerequisite:** Basic understandings on biological molecules, polymer and material science.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Attain information of chemistry of biomolecules	U
2	Understand the scientific importance of enzymes as biocatalysts in various cellular processes	U
3	Get insight about biomaterials that includes polymers and ceramics.	U
4	To understand the importance of compatibility and immunological responses of biomaterials	U
5	Analyse the properties of biomaterials and predict various applications	An

6	Rationalise the host-reactions with biomaterials in scientific approach.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	3	3	3	1
CO 2	3	3	3	3	3	3	0
CO 3	3	3	3	3	3	3	1
CO 4	3	3	3	3	3	3	0
CO 5	3	3	3	3	3	3	1
CO6	3	3	3	3	3	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**CHEMISTRY OF BIOMOLECULES**		**10**
	1	Cell structure- Chemistry of biomolecules- basic aspects of structure and classification of carbohydrates	
	2	Lipids-Amino acids- Proteins and Nucleic acids	

	3	Supramolecular assemblies- Bio membranes	
	4	Lipo and Glycoproteins	

2	**BIOCATALYSIS**		**10**
	1	Biocatalysis- concept of enzyme catalysis- role of vitamins and metals as cofactors- enzyme kinetics- Michaelis-Menten equation	
	2	Inhibition of enzyme action- regulatory aspects- Metabolism: Overview and important relationships between-glycolysis	
	3	TCA cycle- HMP shunt-oxidation of fatty acids-amino acids and urea cycle	
	4	Flow of genetic information- nature of genetic code- replication of DNA- transcription and translation- regulation of gene expression.	

3	**BIOACTIVE POLYMERS AND CERAMICS**		**12**
	1	Bioactive and biodegradable polymers- bioactive ceramics- Biocompatibility- toxicity- cytotoxicity- hypersensitivity	
	2	Protein interaction with synthetic materials- Immunological responses to biomaterials	
	3	Blood compatibility- platelet adhesion and aggregation- coagulation	
	4	Assessment of blood- compatibility- sterility and infection.	

4	**APPLICATIONS OF BIOMATERIALS**		**16**
	1	Interactions of bacteria with biomaterials- methods for sterilization-assessment of sterility	
	2	Cardiovascular applications: grafts, catheters, stents, valves, embolic agents	
	3	Orthopaedic applications-joint prostheses, fracture fixation devices	
	4	Ophthalmologic applications, contact lenses, corneal implants, Dental materials and implants	

5	**TEACHER SPECIFIC MODULE- HOST REACTIONS TO BIOMATERIALS**		**12**
	Directions: A module on Host reactions to biomaterialsor any other topic relevant to the course as per teacher's choice can be proposed.		
	1	Inflammation, Wound healing and the foreign body response	
	2	Systemic toxicity and Hypersensitivity	
	3	Blood coagulation and Blood-materials Interactions, Tumorigenesis	
	4	Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.	

Essential Readings:

1. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E. (2004). Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science.
2. Hench, L. L., Ethridge, E. C. (1982). Biomaterials: an interfacial approach. United Kingdom: Academic Press.
3. Bronzino, J. D. (2000). The Biomedical Engineering Handbook. Germany: CRC Press.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of best two test papers

KU5DSEPCH305: POLYMER CHEMISTRY -I

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	DSC	300	**KU5DSEPCH305**	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
4	0		30	70	100	2

Course Description: The course comprises modules on chemistry and characterisation of polymers, kinetics of polymerisation and a teacher's specific module

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Summarize the techniques available for testing and characterization of polymers	U
2	Comprehensive understanding of the chemistry of polymerization	U
3	Able to explain the kinetics of polymerization	U
4	Able to suggest methods for degradation of different types of polymers	A
5	Analyse different methods of degrading polymers to suggest methods to minimise pollution	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**CHARACTERIZATION OF POLYMERS I**	**12**
	1	Importance of molecular weight – Average molecular weight - Number average, weight average.	
	2	Sedimentation and Viscosity average molecular weights - molecular weight and degree of polymerization	
	3	Polydispersity and PDI -osmometry - membrane osmometry - vapor-pressure osmometry-	
	4	Molecular weight determination-Methods based on colligative property measurements- cryoscopy- ebullioscopy -	

2	**CHARACTERIZATION OF POLYMERS II**	**12**

	1	Molecular weight determination -Methods based on viscosity measurements -viscometry -Light scattering method- ultracentrifuge techniques –	
	2	Sedimentation velocity method – Sedimentation equilibrium method - End group analysis - GPC method.	
	3	Thermal methods of analysis in polymers TGA, DTA, DSC	
	4	Applications of IR, UV, NMR, Raman and Mass spectroscopy in polymers (Basic concepts only) – Applications oy optical microscope, SEM, TEM, XRD in polymers (basic concepts only)	

3	**CHEMISTRY OF POLYMERIZATION**		**12**
	1	Addition polymerization -Free radical polymerization -Initiation, Propagation and termination - inhibitors and retarders-	
	2	Ionic polymerization -cationic and anionic –Living Polymers – Co-ordination polymerization - Zeigler -Natta catalyst.	
	3	Condensation polymerization – Extent of reaction and DP - Carother's equation and its significance.	
	4	Three-dimensional polymerization -cross linking -gel point -Ring scission polymerization.	
4	**KINETICS OF POLYMERIZATION**		**1 2**
	1	Kinetics of free-radical polymerization	
	2	Kinetic chain length and DP - Derivation for rate expression and expression for kinetic chain length and hence degree of polymerization	
	3	Ceiling temperature- Kinetics of cationic and anionic polymerizations –	
	4	Kinetics of polycondensation – non-catalyzed polycondensation and Acid catalyzed polycondensation - Simple kinetic expression.	

5	**TEACHER SPECIFIC MODULE - POLYMER DEGRADATION** Or any topic relevant to the course as per teacher's choice can be included	
	Polymer degradation - Type of degradation - Thermal degradation - factors affecting thermal stability – Polymer degradation involving substituent groups-mechanical degradation– Degradation by ultrasonic waves - Photodegradation – Photo stabilizer - Degradation by high energy radiation - Oxidative degradation – Oxidative degradation of saturated polymers – antioxidants – Hydrolytic degradation	**12**

References

1.Textbook of polymer science - P.L Nayak and S. Lenka

2.Physical Chemistry of polymers - A Tager

3.A textbook of Polymer Science - F. W. Billmeyer.

4.Polymer Science - V.R. Gowariker, N.V. Viswanathan, J. Sreedhar

5.Principles of Polymers Chemistry - P.J. Flory

6.Polymer Chemistry - M.G Arora & M. Singh

7. Principles of polymerization, P. Bahadhur, N.V. Sastry, Narosa Publishing House, New Delhi – 2002

Assessment rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

SEMESTER VI

KU6DSCCHE301: ORGANIC CHEMISTRY III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCCHE301	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules onamino acids, proteins, nucleic acids, natural products, photochemistry, pericyclic reactions, heterocyclic compounds, pharmaceutical compounds and a teacher specific module

Course Prerequisite: Basic knowledge about- functional groups and homologous series. Awareness on IUPAC names and common names of first five members of different class of compounds such as amino compounds and carboxylic acids. Basic idea regarding vitamins

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Analyse the structure of amino acids and proteins	An
2	Understand the properties of different heterocyclic compounds	U
3	Recognize different types of pericyclic reactions	U
4	Examine the photochemistry of chemical reactions	U

5	Estimate the amount of amines and phenols in samples in laboratory	An
6	Develop the skill to synthesize simple organic compounds.	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	0	3	3	3	0
CO 2	3	3	0	3	3	3	1
CO 3	3	3	1	3	3	3	0
CO 4	3	3	0	3	3	3	1
CO 5	3	3	1	3	3	3	1
CO 6	3	3	0	3	3	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**AMINO ACIDS, PROTEINS AND NUCLEIC ACIDS**	**12**
	1	Classification of amino acids. α-Amino Acids: Synthesis – Gabriel's phthalimide synthesis, Strecker's synthesis and Erlenmeyer azlactone synthesis.	

	2	Properties of aminoacids: Zwitterions, pKa values, isoelectric point and electrophoresis-Reactions of aminoacids. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation - Edman degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme)	
	3	Synthesis of simple peptides (upto dipeptides) by N-protection [(t-butyloxycarbonyl (t-boc) and Fluorenylmethyloxy carbonyl (Fmoc)& C-activating groups and Merrifield solid-phase peptide synthesis. Denaturation of proteins.	
	4	Components of nucleic acids: nucleosides and nucleotides. Structure of: Adenine, Guanine, Cytosine, Uracil and Thymine- Synthesis of Adenine and Thymine. Structure of DNA (Watson-Crick model) and RNA (types of RNA)- Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation. Polymerase chain reaction (PCR).	
2	**INTRODUCTION TO NATURAL PRODUCTS& GREEN CHEMISTRY**		**14**
	1	Alkaloids- Introduction- Properties and structure of Coniine, Nicotine and Quinine- Medicinal importance of Nicotine, Quinine, Morphine, Cocaine and Reserpine - Steroids: General characteristics and structure of cholesterol, Testosterone and Oestrone	
	2	Vitamins: Water soluble and fat-soluble vitamins. Synthesis of Vitamin C- Terpenes: Definition- Isoprene rule. -Classification of terpenes with examples. Occurrence and isolation of citral. Natural rubber	
	3	Lipids: Introduction to oils and fats -Common fatty acids present in oils and fats - Hydrogenation of fats and oils-Saponification value-acid value-iodine number	
	4	Synthetic reagents: Active methylene group- Preparation and synthetic application of Ethyl acetoacetate- Preparation and synthetic application	

		of Aluminium isopropoxide, N-Bromo Succinamide, Diazo methane and Wittig reagent-Reformatsky reaction and its application- Green chemistry:Need for Green chemistry - Goals of green chemistry – Limitations- Twelve principles of green chemistry with their explanations and examples	
	5	Designing a green synthesis - Prevention of waste / byproducts - Atom economy (maximum incorporation of materials used in the process) - Minimization of hazardous / toxic products	
	6	. Green synthesis - Microwave assisted reactions in water - Hoffmann Elimination - Microwave assisted reaction in organic solvent - Diels Alder reaction, Ultrasound assisted reaction -Esterification, SaponificationGreen chemistry in day to day life.	

3	**PHOTOCHEMISTRY AND PERICYCLIC REACTIONS**		**9**
	1	Introduction to photochemistry- Photochemical reactions of carbonyl compounds - Norrish type I and II cleavages (Acyclic only)-Photo reduction of ketone Concerted reactions.	
	2	LCAO-MO theory of ethene, 1,3-butadiene and cyclic polyenes-Symmetry properties of MOs, HOMO, LUMO, Thermal and photochemical pericyclic reactions	
	3	Types of pericyclic reactions – electrocyclic, cycloaddition, sigmatropic, chelotropic, and group transfer reactions – one example each. Explanation of these reactions by FMO theory.	
	4	Mechanism and stereo course of electrocyclic, cyclo addition, and sigmatropic reactions	

4		**HETEROCYCLIC COMPOUNDSAND PHARMACEUTICALCOMPOUNDS**	**10**
	1	Classification and nomenclature- Structure and aromaticity in 5-membered and 6-membered rings containing one heteroatom - Peparation, properties and structure of the following compounds: Pyrrole, Pyridine, Indole, Quinoline, Isoquinoline	
	2	Relative basic character of pyrrole, pyridine and piperidine. Hofmann's exhaustive methylation of piperidine-Classification of drugs - Antibiotics- Discovery and importance, mode of action and examples- Misuse of antibiotics	
	3	Antibacterial and antifungal agents- Sulpha drugs-mode of action-Importance- Examples and uses- Antipyretic, Analgesic and Anti-inflammatory agents - Mode of action	
	4	Narcotic and non-narcotic analgesic, examples and uses. Synthesis of Paracetamol and Aspirin -Anti histamine-example-CNS Drugs – Synthesis of Phenobarbital, Psychoactive drugs – Hallucinogens, tranquillizers, Examples.	

5	**TEACHER SPECIFIC MODULE- PRACTICALS**	
	ORGANIC QUALITATIVE ANALYSIS*	30
	Total 8 experiments must be done- A minimum of 6 compounds must be synthesized and recorded. Out of the six experiments two are open-ended and is subjected to teacher's choice.	
	1. Synthesis of Organic Compounds.	
	a. Aromatic electrophilic substitution Nitration - Preparation of dinitrobenzene from nitrobenzene, preparation of p-nitroacetanilide Halogenation -Preparation of *p*-bromoacetanilide, preparation of 2, 4, 6 -tribromophenol.	

	b. Diazotization and coupling Preparation of phenyl azo -naphthol. Preparation of methyl orange.	
	c.Oxidation Preparation of benzoic acid from benzyl chloride or benzaldehyde	
	d.Esterification Benzoylation of phenol/aniline to phenyl benzoate.	
	e. Hydrolysis Benzamide or ethylbenzoate to benzoic acid.	
	Quantitative analysis (Open ended)	
	Estimate, any one organic compound(suggestions)	
	a) Phenol (Using bromated-bromide mixture)	
	b) Aniline (Using bromated-bromide mixture)	
	Estimate any one biomolecule(suggestions)	
	a) Reducing sugars (Using Fehling's solution)	
	b) Saponification value of vegetable oil	
	c) Estimation of ascorbic acid (Colorimetric method)	

Essential Readings:

1. M. K. Jain and S. C. Sharma 'Modern Organic Chemistry' 3rd Edition, Visal PublishingCompany Co.
2. K. S. Tewari and N. K. Vishnoi 'Organic Chemistry', 3rd Edition, Vikas Publishing House
3. B. S. Bahl 'Advanced organic Chemistry', S. Chand.
4. R. T. Morrison and R. N. Boyd, 'Organic Chemistry', 6th Edition - Prentice Hall of India.
5. I. L. Finar 'Organic Chemistry', Vol.- 1, Pearson Education
6. P. S. Kalsi' 'Organic Reactions and their Mechanisms'' New Age International Publishers.
7. Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry,* JohnWiley& Sons (2014).
8. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning IndiaEdition, 2013

9. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5thEdn., Pearson Education, Noida, 2014.
10. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry*, 4thEdn., Pearson Education, Noida, 2011.
11. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2ndEdn., Pearson Education, Noida, 2013

Suggested Readings:

1. P. Y. Bruice, 'Organic Chemistry', Pearson Education.
2. J. March, 'Advanced Organic Chemistry', John Wiley & Sons, NY
3. S. H. Pine 'Organic Chemistry', McGraw Hill
4. J. Clayden, N. Greeves, S. Warren and P. Wothers, 'Organic Chemistry', Oxford University

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

* Average mark of the best two written tests may be considered for internal mark.

KU6DSCCHE302: PHYSICAL CHEMISTRY- III

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSC	300	KU6DSCCHE302	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	-	30	70	100	2

Course description: The course comprises of modules on thermodynamics and spectroscopy. The course will help students to develop good understanding on thermodynamics and spectroscopy**.**

Course Prerequisite: Basic idea about thermodynamics

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding about the various laws of thermodynamics	U
2	Able to explain the energy changes associated with various process around and predict the feasibility of a process or reaction in scientific way	A
3	Understand the concept of entropy	U

4	Comprehensive understanding of various spectroscopic techniques and able to apply in interpreting the spectra of compounds	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	0	3	3	0
CO 2	3	3	3	0	3	3	1
CO 3	3	3	3	1	3	3	0
CO 4	3	3	3	0	3	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**THERMODYNAMICS -I+**		**13**
	1	Basic concepts -- study of terms -- system and surroundings -- open, closed and isolated systems, isothermal, Isochoric – adiabatic systems- state and state variables -- macroscopic properties – intensive and extensive properties	
	2	Isothermal, adiabatic, isochoric and isobaric processes -- reversible and irreversible processes – work, heat and energy – state functions and path functions – exact and inexact differentials with notations	

	3	First law of thermodynamics- Internal energy and enthalpy —-- zeroth law of thermodynamics –concept of temperature. statement of first law of thermodynamics – conservation of energy – expansion work – general expression for work – work done during free expansion, expansion against constant pressure and isothermal reversible expansion.	
	4	Heat capacity of gases at constant volume Cv and constant pressure Cp – relation between Cp and Cv and its derivation – P, V, T relations during adiabatic process -- work done during reversible adiabatic expansion-comparison for isothermal and adiabatic process -- Change in enthalpy at constant pressure -- Joule Thomson effect -- internal pressure -- inversion temperature	
	3	Thermochemistry- Thermochemistry – standard enthalpy changes for physical and chemical changes –enthalpy of neutralization, transition, formation, phase changes, combustion and solution- heats of reaction at constant volume q_v and constant pressure q_p – relation between q_p and q_v	
	4	Hess's law and its applications –bond energy calculations-variation of enthalpy change of a reaction with temperature – Kirchoff equation.	

2		**THERMODYNAMICS II**	**12**
	1	Second law of thermodynamics -Limitations of first law – cyclic process – Carnot cycle – efficiency of heat engine – statement of second law of thermodynamics in terms of work and heat- Clausius, Kelvin Planck statement concept of entropy -- physical significance of entropy (microscopic)– variation of entropy of ideal gases with pressure and temperature	3
	2	Second law in terms of entropy – entropy change for phase transitions – criteria for spontaneous changes-for isolated system at constant (T&V), (T&P), (S&V), (S&P)– Gibbs and Helmholtz free energies – condition of spontaneity in terms of free energy – comparison of entropy and free energy – Gibbs- Helmholtz equation – Maxwell relations	

	3	Partial molar properties – concept of free energy – Gibbs Duhem equation – variation of chemical potential with temperature and pressure. Chemical potential of a component in a mixture of ideal gases.	
	4	Clapeyron equation- Clausius- Clapeyron equation for all phase equilibria- concept of fugacity.	
	5	Third law of thermodynamics—Nernst heat theorem – absolute entropy – calculation of absolute entropies.	
3	**SPECTROSCPY-I**		**13**
	1	Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with molecules, Born-Oppenheimer approximation.	
	2	Microwave Spectroscopy – Rotation spectra-Instrumentation- Moment of inertia, Rotational -Quantum numbers, Rotational Constant, Intensities of rotational spectral lines, Rotational –Vibrational Spectrum of diatomic molecules – Selection rules for rotational spectra.	
	3	Infrared Spectroscopy –Theory of infrared spectra-Degree of freedom in poly atomic molecules, Selection rule, Molecular vibration – Stretching and Bending modes, Calculation of stretching-frequencies – fundamental Bands and Overtones, hot bands and Fermi resonance. Factors influencing vibrational frequency – Electronic effects, hydrogen bonding, solvent effect. Applications of IR Spectroscopy.	

4	**SPECTROSCOPY-II**		**10**
		Raman Spectroscopy –block diagram, quantum theory of Raman scattering- Stokes and antistokes lines-selection rule, rule of mutual exclusion	
	2	NMR Spectroscopy –- Introduction, Theory of NMR, Phenomena of resonance, Modes of nuclear spin-Relaxation Process, Chemical Shift – Internal standard, δ and τ scale, Shielding Effects, Factors affecting	

		Chemical Shift, Spin-Spin interaction, Interpretations of spectra of ethyl bromide, ethanol, acetaldehyde, acetone, toluene and acetophenone.	
	3	Mass Spectrometry – Basic principles, Fragmentation pathway, Molecular ion peak, base peak, Meta stable ion, General rules for predicting the prominent peaks, Mc Lafferty Rearrangement, mass spectra of simple alkanes, cycloalkanes, saturated alcohols and aliphatic ketones	

5	**TEACHER SPECIFIC MODULE**	**12**
	Directions: A module on UV spectroscopy or any other relevant topic as per teacher's choice may be taught	
	UV Spectroscopy – Franck Condon principle-intensity of spectral lines - Absorption laws, Selection Rules – Types, Electronic transitions – Position and Intensity of absorption, Molar extinction coefficient, Chromophore – Auxochrome Concept, Absorption and Intensity Shifts, Types of Absorption Bands, Interpretations of spectra of simple conjugated dienes and enones, Woodward-Fieser Rule, Application to dienes and enones.	

Essential Readings:

1. Elements of Physical chemistry: Puri, Sharma and Pathania, Vishal Publishing Co
2. Physical Chemistry: W.J. Moore, Orient Longmans.
3. Physical Chemistry: N. Kundu & S.K. Jain, S. Chand & Company
4. Physical Chemistry: N. Kundu & S.K. Jain, S. & Company
5. Physical Chemistry: P.W. Atkins, Oxford University Press
6. Electronic absorption spectroscopy and related techniques: D. N. Satyanarayana, Universities
7. Symmetry and spectroscopy of molecules: K. Veera Reddy, New Age. International(P) Ltd
8. Fundamentals of molecular spectroscopy: C. N. Baanwell and E M Mc Cash, Tata McGraw Hill
9. Physical Chemistry – A molecular Approach: Mc Quarrie, J. D. Simon, Viva Books Pvt Ltd.
10. A Textbook of Physical chemistry: K. L. Kapoor, Volume 4, Macmillan India Ltd.
11. Physical Chemistry, I. N. Levine, Tata Mc Graw Hill.
12. Physical Chemistry, K. J. Laidler, John H. Meiser.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

KU6DSCCHE303: PHYSICAL CHEMISTRY IV

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	KU6DSCCHE303	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on electrical conductance, electromotive force, solid state, crystallography and a teacher specific module onn physical chemistry practicals

Course Prerequisite: Basic idea about electrochemistry and solid-state chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the mechanism of electrical conductance, theories of electrical conductance, and conductometric titration.	U
2	Design different types of electro chemical cell and able to calculate its potential.	A
3	Use scientifically different types of electrodes for pH measurement.	A
4	Comprehensive understanding about the laws of crystallography	U
5	Develop skill in practical chemistry from laboartory	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	3	3	0	0	3	0
CO 2	3	3	3	0	3	3	1
CO 3	3	3	3	0	3	3	0
CO 4	0	0	0	3	0	3	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ELECTRICAL CONDUCTANCE**		**16**
	1	Introduction -Mechanism of electrical conduction – Arrhenius theory – The laws of electrolysis – Faraday's law and its significance	
	2	Transference Number – True and apparent transport numbers Determination by Hittorf's method and moving boundary method	
	3	Equivalent conductance and Molar conductance -Effect of Dilution on conductance – Effect of dielectric constants of solvents	
	4	Ionic mobilities – Kohlrausch's Law – applications – Mobilities of Hydrogen and Hydroxyl ions – Diffusion and ionic mobility- Activity and activity coefficient – standard state ionic activities and activity coefficient – ionic strength	

	5	Debye – Huckel Theory – Ionic atmosphere – Debye – Huckel limiting law – Temperature dependence of ionic conductance-Debye Falkenhagen effect-Wein effect (definition only)	
	6	Determination of solubilities by conductance measurements – conductometric titrations – conductance in non-aqueous solvents.	

2	**ELECTROMOTIVE FORCE-I**		**8**
	1	Electrochemical cell-Daniell cell – Reversible and Irreversible cell – Single electrode potential – EMF of cells – Standard potential and standard emf – Standard Hydrogen electrode and calomel electrode – Types of electrodes	
	2	Electrode reaction – cell reaction -Nernst equation for electrode potential and emf of the cell – Electrochemical series – IUPAC sign convention	
	3	Application of Gibb's Helmholtz equation to galvanic cells – Calculation of ΔG, ΔH, ΔS and equilibrium constant from emf data – The standard cells – Weston Cadmium cell and its emf-Fuel cells. (Hydrogen-oxygen, hydrocarbon-oxygen)	

3	**ELECTROMOTIVE FORCE-II**		**12**
	1	Concentration cells – Electrode and electrolytic concentration cells with and without transference and their emfs	
	2	Liquid junction potential – Elimination of liquid junction potential – salt bridge	
	3	Application of potential measurements – Determination of solubility product, ionic product of water, transport number.	
	4	pH determination – Hydrogen, Quinhydrone electrode and glass electrode –advantages and disadvantages. Potentiometric titration – redox indicators	

4	**SOLID STATE &CRYSTALLOGRAPHY**		**9**
	1	Laws of crystallography – Law of constancy of interfacial angles – Law of constancy of symmetry – Law of rationality of indices	
	2	Isomorphism and polymorphism- Miller indices- diffraction of X-rays-Laue equation- Bragg's Law Determination of internal structure of crystals by X-ray diffraction methods – derivation of Bragg's equation	
	3	Bragg's rotating crystal method and De bye Scherrer Powder diffraction method, indexing of reflections	
	4	Crystal structure of NaCl – anomalous nature of diffraction pattern of KCl. Co-ordination Number – Efficiency of packing – Cubic and Hexagonal packing – Radius ratio rule – Tetrahedral and Octahedral voids.	

5	**TEACHER SPECIFIC MODULE**	
	PRACTICALS	**30**
	Directions: Minimum 4 experiments must be done.	
	1.POTENTIOMETRIC TITRATIONS a) Acid base titration (Strong acid Vs strong base)	
	2.COLORIMETRY Verification of Beer-Lambert law for KMnO4, determination of the concentration of the given solution	
	3.CONDUCTOMETRY **(Open ended)**	
	a) Conductometric titrations of strong acid vs strong base b) strong acid Vs weak base c) weak acid Vs strong base	

Essential Readings:

1) Physical Chemistry: Puri, Sharma and Pathania, Vishal Publishing Co
2) An introduction to Electrochemistry: Samuel Glasstone
3) Physical Chemistry: N. Kundu & S.K. Jain, S. Chand & Company

1) Advanced electrochemistry: Giridhar Sharma
2) Physical Chemistry: W.J. Moore, Orient Longmans.
3) Physical Chemistry: K. J. Laidler, John H.Meiser
7) Modern electrochemistry: John O M Pockris and Amulya KN Reddy Volume I
8) Solid State Chemistry: L E Smart, E A Moore, CRC press
9)A textbook of Physical chemistry: A S Negi, S C Anand, New age international publications
10)Physical Chemistry: G W Castellan, Narosa publications
11)Physical Chemistry: G K Vemulapalli, PHI publications

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

DISCIPLINE SPECIFIC ELECTIVE COURSES

KU6DSECHE301: APPLIED CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	**KU6DSECHE301**	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: Fuel and Food Chemistry explores the fundamental principles and chemical processes involved in the production, transformation, and utilization of fuels and foods. This interdisciplinary course bridges the gap between chemistry, energy, and nutrition, highlighting the chemical similarities and differences between fuels and foods, their roles in society, and their environmental and health impacts.

Course Prerequisite: Elementary idea on various sources of fuels; pesticides and fertilizers

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Explain the origin of coal, coal products, petroleum products and their applications	U
2	Explain the manufacture of fertilizers, pesticides, and their applications	U
3	Understand the manufacture of glasses, cement, ceramics and the formulations of paints and varnishes	U
4	Apply the chemistry of fats and oils and explain the production of soaps and detergents.	A
5	Analyse the chemistry of food additives and explain the manufacture and refining of pulp.	An

6	Understand importance of industrial safety and industrial pollution control to apply in real world scenario.	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	3	0	1	3
CO 2	0	3	0	1	3	0	3
CO 3	3	0	0	0	3	1	3
CO 4	0	1	0	3	0	0	3
CO 5	0	0	0	0	3	0	3
CO 6	0	1	0	1	0	1	3

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**FUEL CHEMISTRY**		**12**
	1	Coal- Origin of coal-carbonization of coal- coal gas- producer gas- water gas- coal based chemicals	
		Petroleum and Petrochemical Industry-Composition of crude petroleum-Refining and different types of petroleum products and their applications	
		Fractional Distillation-Principle and process-Cracking-Thermal and catalytic cracking.	

	2	Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG) biogas, fuels derived from biomass, Fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.	

2	**FOOD & AGROCHEMISTRY**		**15**
	1	Food additives- Food flavour-food colour-food preservatives- artificial sweeteners- edible emulsifiers and edible foaming agents- uses and abuses of these substances in food and beverages	
	2	Fermentation Chemicals: Production, and purification of ethyl alcohol, citric acid, lactic acid, Vitamin B12, Penicillin	
	3	Fertilizers: Classification of fertilizers- Manufacture of ammonium salts like ammonium nitrate, ammonium sulphate and urea- Action of Ammonium sulphate and urea as fertilizers. N.P.K. Fertilizers and Natural organic fertilizers.	
	4	Pesticides: Production and applications and residual toxicity of organo-chlorine pesticides (DDT, Aldrin), organophosphates (parathion, malathion), Carbamate (carbofuran). Bio-pesticides	

3	**SILICATE INDUSTRY**		**9**
	1	Glasses: Classification and manufacture of glasses- Annealing of glass- Fiber glass, coloured glass, and optical glass	
	2	Cement: Portland cement - types, manufacture, composition and setting of cement- White cement and waterproof cement	
	3	Ceramic: Subdivisions- raw materials - manufacturing-applications	

4	**PAINTS, LUBRICANTS, ADHESIVES AND PIGMENTS**	**12**

	1	Paints: Classification, primary constituents and manufacturing of paint. Emulsion paint - constituents and advantages- Latex paints and fire-retardant paints- Solvents and thinners	
	2	Lubricants: Properties and classification- additives for lubricating oil- lubricants of mineral origin- lubricating grease and solid lubricants	
	3	Adhesives: The Process of bonding- Classification and preparation of adhesives- synthetic resin adhesives, and rubber-based adhesives, uses of adhesives	

5	**TEACHER SPECIFIC MODULE: CHEMICAL EXPLOSIVES. INDUSTRIAL SAFETY AND POLLUTION PREVENTION**	**12**
	Directions: Explosive properties of any 3 explosives, important OSHA standards regarding industrial safety, Industrial pollution prevention methods based on any industry of your area can be introduced or any other topic relevant to the course as per teachers' choice	
	Chemical explosives: Characteristic of explosives- preparation and explosive properties of Trinitro toluene- Lead azide- Nitro-glycerine- RDX. Industrial safety: OSHA-Hazard analysis and risk assessment-types of hazards in industries -risk management plan. Industrial pollution prevention: Definition of industrial waste-types of industrial waste- Industrial pollution prevention -recycling -waste treatment.	

Essential Readings:

1. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

2. Industrial chemistry by B.K Sharma.

3. Industrial chemistry B.N Chakrabarthy

4. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK

5. W. D. Kingery, H. K. Bowen, D. R. Uhlmann: Introduction to Ceramics, Wiley Publishers, New Delhi

6. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

7. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.

8. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi

9. Carey, D.E. Casida Industrial Microbiology.

10. Mechanism and theory in food chemistry, Dominic W.S.Wong

11. Food Science, R. Sreelakshmi

12. Mohammad Farhat Ali, Bassam M. El Ali, James G Speight, Handbook of Industrial chemistry: Organic Chemicals, Publisher: Mc-graw Hill Education

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

KU6DSECHE302: PHARMACUETICAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	**KU6DSECHE302**	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: *The Pharmaceutical chemistry course explores the intricate relationships between molecular structures, biochemical processes, and drug actions, emphasizing the roles of proteins and DNA in drug efficacy and design. The course covers enzyme kinetics, the regulation of enzymatic activity, and the therapeutic applications of enzymes, along with the biochemical mechanisms of various pharmacodynamic agents. Additionally, students will study the biochemistry of gastrointestinal agents, antimicrobials, and radiopharmaceuticals. The course also integrates physical chemistry principles essential to pharmaceutical sciences, such as buffer systems, solubility, and diffusion, preparing students for advanced study and research in pharmaceutical biochemistry***.**

Course Prerequisite: Basic understanding on chemical kinetic, biomolecules and organic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To identify and recall the fundamental biochemical structures, such as proteins and DNA, and their relevance to drug action and design.	A

2	To describe the mechanisms of action for various pharmacodynamic agents	U
3	To apply principles of enzyme kinetics and regulation to understand enzyme inhibition and therapeutic uses, and utilize this knowledge in the context of drug interactions	A
4	To analyze the complex biochemical mechanisms and classification of antimicrobials, gastrointestinal agents, and radiopharmaceuticals, and compare their therapeutic and diagnostic applications	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	3	0	0	3
CO 2	0	3	0	0	3	1	3
CO 3	3	1	3	3	0	0	3
CO 4	0	0	0	3	0	0	3

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**PHARMACUETICAL BIOCHEMISTRY**		**10**
		Protein structure and its relevance to drug action-DNA structure and its importance to drug action- Drug absorption, distribution, metabolism	

	1	and excretion. Structure, activity and drug design- Drugs affecting the adrenergic system- Drugs exerting non-adrenergic effects on cardiac output and vascular tone.	
	2	Enzyme kinetics - Enzyme inhibitors with examples- Regulation of enzymes- enzyme induction and repression-Therapeutic and diagnostic applications of enzymes and isoenzymes Coenzymes- Structure and biochemical functions- Drugs interacting with mammalian enzymes.	

2	**PHRAMOCODYNAMIC AGENTS**		**10**
	1	Drug acting on CVS-Antihypertensive, anti-arrhythmic, anti-anginal, anti-lipidemic agents and diuretics-Analgesics, narcotics and Nonnarcotic antipyretics, anti-inflammatory, anti-gout drugs.	
	2	Drugs acting on CNS-Hypnotics; sedatives, general anesthetics, anti-epileptics. Psychotropic agents, anti-depressants, anti-parkinsonian agents, hypo glycaemic drugs, anti-thyroid drugs. Anti-histamins H1, and H2 antagonists, anti- serotonins. Carbohydrate based drugs, oligonucleotides.	
	3	Anticancer drugs, antimicrobial chemotherapy, Antiviral drugs, Antifungal chemotherapy.	

3	**INORGANIC CHEMISTRY IN PHARMACUETICS**		**18**
	1	Gastrointestinal agents Acidifiers: Antacids- Ideal properties of antacids -combinations of antacids- Sodium 40 Bicarbonate- Aluminum hydroxide gel- Magnesium hydroxide	
	2	Antimicrobials: Mechanism- classification- Potassium permanganate- Boric acid- Hydrogen peroxide- Iodine- Antidote: Sodium thiosulphate-	

		Activated charcoal- Sodium nitrite333 Astringents: Zinc Sulphate-Potash Alum	
	3	Electrolytes: Sodium chloride- Potassium chloride- Calcium gluconate and Oral Rehydration Salt (ORS)- Radiopharmaceuticals: Radio isotopes and study of radio isotopes - Sodium iodide I131- Storage conditions- precautions & application of radioactive substances as pharmaceutics	
	4	Impurities in pharmaceutical substances: Detection of impurities like Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals in pharmaceutical substances- Miscellaneous compounds: Expectorants- Potassium iodide- Ammonium chloride- Emetics: Copper sulphate, Sodium potassium tartrate	

4	**PHYSICAL PHARMACEUTICS**		**10**
		Buffer and pH in pharmaceutics: Buffer equations- buffers in pharmaceutical systems- preparation- stability- buffered isotonic solutions-Sorensen's pH scale- pH determination (electrometric and calorimetric), Solubility of drugs: Solubility expressions- solute solvent interaction mechanism- ideal solubility parameters- solvation & association- factors influencing solubility of drugs- diffusion principles in biological systems.	
5	**TEACHER SPECIFIC MODULE** **Directions: Topics such as** Pharmacology, Pharmacopoeia or any other topic relevant to the course can be included		**12**
	1	Introduction to pharmacology- sources of drugs- dosage forms and routes of administration- Pharmacodynamics: General principles of drug action- Molecular basis of drug targets	

	2	Pharmacokinetics: Absorption, distribution, metabolism and excretion of drugs. Principles of pharmacokinetics- bioavailability and bioequivalence- pharmacogenetics- drug interactions- bioassays & preclinical studies- Clinical trials	
	3	History of pharmacopoeia- Indian, British USP and Extra Pharmacopoeia.	

Essential Readings:

1. Textbook of Biochemistry by Rama Rao.
2. A.I. Vogel, Textbook of Quantitative Inorganic analysis
3. P. Gundu Rao, Inorganic Pharmaceutical Chemistry, 3 rd Edition
4. M.L Schroff, Inorganic Pharmaceutical Chemistry
5. Bentley and Driver's Textbook of Pharmaceutical Chemistry
6. Anand & Chatwal, Inorganic Pharmaceutical Chemistry
7. Principles of Biochemistry by Lehninger.
8. Harper’s Biochemistry by Robert K. Murry, Daryl K. Granner and Victor W. Rodwell.
9. Biochemistry by Stryer.
10. Physical Pharmaceutics by Ramasamy C and ManavalanR
11. Physical Pharmaceutics by C.V.S. Subramanyam
12. Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Rang and Dale’s Pharmacology, Churchill Livingstone Elsevier

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

KU6DSECHE303: NANO CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECHE303	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: This Nanochemistry course covers the fundamentals, synthesis, characterization, and applications of nanomaterials. Topics include nanotechnology history, quantum confinement, nanosynthesis methods, and nanomaterial characterization techniques. Applications span environmental remediation, solar energy, drug delivery, and electronics. Students gain comprehensive knowledge of nanomaterials' properties and practical uses.

Course Prerequisite: Preliminary idea on organic and inorganic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the Fundamentals of nanomaterials	U
2	Demonstrate proficiency in various Nano synthesis methods	A
3	Comprehensive and scientific understanding about the various characterisation techniques of Nanomaterials	U
4	Analyse and apply nanomaterials in environmental remediation, energy conversion and storage, biological imaging, drug delivery, and other complex electronic devices.	An

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	0	1	0	1	0
CO 2	0	3	2	0	1	0	1
CO 3	0	0	3	0	0	1	0
CO 4	3	3	0	3	0	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION TO NANOMATERIALS**		**16**
	1	Nanotechnology- Definition, Historical milestone-Faynmans hypothesis- Surface area to volume ratio- Quantum confinement- Classification of Nanomaterials based on dimensions (0D, 1D, 2D, 3D).	
	2	Different types of nano systems (synthesis and properties)- Carbon nano systems- fullerenes, graphenes, carbon nanotubes- Inorganic nano particles-TiO2, ZnO- Organic nano systems- dendrimers, Metal nano particles-quantum dots.	

2	**SYNTHESIS OF NANOMATERIALS-I**		**8**
	1	Various methods for the synthesis of nanoparticles: Top-down and Bottom-up approaches.	
	2	Physical methods-Ball Milling, Melt mixing techniques, Physical vapour deposition, Chemical vapour deposition (CVD).	
3	**SYNTHESIS OF NANOMATERIALS-II**		**8**
	1	Chemical methods-Chemical precipitation, Sol gel Method, Hydrothermal and Solvothermal synthesis, Microemulsion or Reverse micelle synthesis.	
	2	Microwave synthesis-Electrochemical method- Biological synthesis using plant extract and microorganism- Molecular self-assembly.	

4	**CHARACTERISATION OF NANOMATERIALS**		**16**
	1	Important methods for the characterization of nanomaterials–Principles and Applications of Scanning electron microscopy (SEM)- Transmission electron microscopy (TEM), Cryo-TEM.	
	2	Scanning tunnelling electron microscopy (STEM)- Scanning probe microscopies (SPM)-Scanning tunnelling microscopy (STM)- Atomic force microscopy (AFM).	
	3	Photoelectron spectroscopy (UPES and XPES)- Dynamic Light Scattering (DLS) for size measurements- X-ray diffractometer (XRD)- UV-visible and Raman Spectroscopy.	

5	**TEACHER SPECIFIC MODULE - APPLICATION OF NANOMATERIALS**	**12**
	Directions: Applications of nanomaterials or any other topic relevant to the course of teacher’s choice can be proposed	

	1	Nanomaterials for environmental Remediation- Photocatalysis-Water purification using nanomaterials- desalination of water- Heavy metal and oil spill removal	
	2	Solar energy conversion: (Dye sensitized solar cells) and storage (Supercapacitors)- Nanocatalyst- Biological applications Imaging-labelling- targeted drug delivery- Nanomaterials in electronics and spintronics	
	3	Nanosensors- Applications in Self-cleaning surfaces- sports equipment-cosmetics.	

References:

1. Poole, Charles P., and Frank J. Owens, Introduction to Nanotechnology, Wiley.
2. Rao, C. N. R., A. Muller, and A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Wiley-VCH.
3. Ratner, Mark, and Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall.
4. Cao, Guozhong, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Imperial College Press.
5. Kulkarni, Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company.
6. Murty, B. S., P. Shankar, Baldev Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, University Press.
7. Hornyak, Gabor L., H.F. Tibbals, Joydeep Dutta, and John J. Moore, Introduction to Nanoscience, CRC Press.
8. Shukla, Anubhuti, and Amit Srivastava, Essentials in Nanoscience and Nanotechnology, Jenny Stanford Publishing.

Web References:

1. Royal Society of Chemistry, Nanochemistry, www.rsc.org/nanochemistry
2. Khan Academy, Nanotechnology, www.khanacademy.org/science/nanotechnology
3. Environmental Protection Agency (EPA), Nanotechnology Research, www.epa.gov/nanotechnology-research

4. National Nanotechnology Initiative (NNI), www.nano.gov

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of best two test papers

Employability for the Course: Graduates of the Nanochemistry course are well-prepared for careers in cutting-edge industries such as electronics, pharmaceuticals, and materials science. They can pursue roles in research and development, quality control, and production. Expertise in nanomaterials also opens opportunities in environmental remediation, energy storage, and medical diagnostics, making them valuable assets in both industrial and academic settings.

KU6DSECHE304: MEDICINAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	DSE	300	KU6DSECHE304	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: Medicinal Chemistry is an interdisciplinary course that explores the design, development, and chemical properties of pharmaceutical agents. The course focuses on the relationship between chemical structure and biological activity, the mechanisms of drug action, and the processes involved in the discovery and development of new therapeutic agents. Students will gain an understanding of the chemical principles underlying drug design and function, as well as the strategies used in modern drug development.

Course Prerequisite: Basic understanding on organic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Able to corelate pharmacologic action with molecular structure of drug.	E
2	Recognize the drug physico-chemical and stereochemical features; Determine the pharmacophore	A

3	Describe the scientific mechanism of action, use and mode of application of the selected drugs based on their structure	U
4	Synthesis of the drugs and determine the reaction yield in laboratory	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	1	0	1	2	0
CO 2	3	2	0	0	1	0	2
CO 3	3	0	2	0	0	1	0
CO 4	0	1	0	3	0	0	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTORY MEDICINAL CHEMISTRY**	**12**
	1	Concepts of medicinal chemistry	
	2	Importance of chemistry in pharmacy	
	3	Molecular pharmacology	
	4	Physiochemical properties of drugs such as solubility, partition coefficient, ionisation, acidic/basic properties, stereochemical properties	

2		**THE DRUG CHEMISTRY**	**12**
	1	Introduction to different classes of drugs- drug action	
	2	Drug discovery and design- SAR and QSAR- Hansch analysis-Craig plot- Free Wilson analysis- drug delivery systems- Enzyme inhibitors in medicine.	
	3	Pharmacokinetics- drug absorption- distribution- metabolism and excretion- Role of nitric oxide in physiological states.	
	4	General methods of drug synthesis (with paracetamol as eg.)-synthesis and action of antibiotics (with penicillin as eg)-antiviral agents- general anaesthetics.	

3		**ADVANCED MEDICINAL CHEMISTRY**	**12**
	1	Applications of Electrophoresis- ultra-filtration-ultracentrifugation in purification- separation, and isolation- Introduction to herbal medicine- Introduction the chemistry of homeopathy- Introduction to nanomedicine.	
	2	Organic Medicinal Chemistry: Introduction- general principle of drug action-physico-chemical properties of organic medicinal agents- chemistry of prodrugs- drugs metabolism.	
	3	Chemistry of sedatives- hypnotic drugs (barbiturates and non-barbiturates- introduction to psycho active drugs.	
	4	Introduction to the chemistry of antibiotics	

4		**ACTION OF DRUGS**	**12**
	1	Drug receptors- drug receptor interactions - hydrogen bonding - Hydrophobic interactions- ionic interactions	

	2	Structure activity relationships- mechanism of drug action- Nonspecific action of drugs	

-

5	**TEACHER SPECIFIC MODULE -NANO PARTICLES IN MEDICINE**	**12**
	Directions: Nano particles in medicine ***or*** *Any 5 applications of nanoparticles in medicine (as per teachers' choice) can be included*	
	Suggestions-Types of nano particles used in medicine-organic, inorganic and carbon based- various kinds of nano systems in use-(nano shells—nano pores-tectodendrimers)-Protocol for nanodrug administration-(oral, nasal and ocular administration-) materials for use in diagnostic and therapeutic applications-gold nano particles-quantum dots-magnetic nano particles-	

Essential Readings:

1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson, Education
2. Basic Pharmacology Cox,F Butterworths
3. Medicinal Chemistry: classification-synthesis-explanation-mechanism of action-structure activity relationship (SARs)-usages-doses by Ashutosh Kar
4. Principles of organic Medicinal Chemistry by Nadendla, Rama Rao
5. Fundamentals of Medicinal Chemistry, G. Thomas, Wiley
6. Introduction to Medicinal Chemistry, G.L. Patrick, Oxford
7. Pharmacology and pharmacotherapeutics, Sataskar,R.SBhandakan, S.D and Ainapure S.S., Popular Prakashan, Mumbai
8. Medicinal Chemistry by Patrick,Graham
9. Nano: The essentials, Understanding Nanoscience and Nanotechnology by T Pradeep,McGraw hill Education(India) Private Ltd

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

KU6DSEPCH305: POLYMER CHEMISTRY -II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
V	DSC	300	**KU6DSEPCH305**	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: Polymer Chemistry is an advanced-level course designed to provide an in-depth understanding of the synthesis, characterization, properties, and applications of polymers. This course covers the fundamental principles of polymer science, including the chemistry of polymerization processes, the structure and morphology of polymers, and the physical and chemical properties of polymeric materials.

Course Prerequisite: General Chemistry, Organic Chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To provide an overview of polymer reactions and reactivity of polymers	U
2	To understand factors that influences the degradation of polymers.	U
3	Analyse the Molecular forces and chemical bonding polymers	An
4	Familiarize various types of inorganic polymers	A
5	Explore current research and developments in polymer chemistry	E

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

CO 1							
CO 2							
CO 3							
CO 4							
CO 5							

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**MOLECULAR FORCES AND CHEMICAL BONDING IN POLYMERS- I**	**12**
	1	Secondary bonding forces that exist in polymers - Tacticity in polymers- Isotactic, syndiotactic and atactic polymers.	
	2	Crystallinity and amorphous behaviour of polymers- Degree of crystallinity- Crystability.	
	3	Crystallites - Spherulites-Factors affecting crystallinity.	
	4	Effect of crystallinity on the properties of polymers.	

2		**MOLECULAR FORCES AND CHEMICAL BONDING IN POLYMERS II**	**12**
	1	Thermal transition in polymers- Tg and Tm - – Thermal transitions and associated properties.	
	2	Factors affecting Tg - Glass transition temperature and molecular weight - Importance of Tg	

	3	Plasticizers and their action on Tg - Determination of Tg- Dilatometric method.	
	4	Thermomechanical method – Calorimetric method.	
3	**INORGANIC POLYMERS**		**12**
	1	General properties – classification.	
	2	Boron based polymers - Borazine, Polymeric boron nitride.	
	3	Phosphorous based polymers -Polyphosphonitrilic chloride - polyphosphoric acids.	
	4	Silicon based polymers – Organo tin polymers.	
4	**POLYMER REACTIONS**		**12**
	1	Reactions involving hydroxyl, aldehydic, ketonic, carboxylic and amino groups- Hydrolysis, acidolysis, oxidation, hydrogenation, addition and substitution reactions.	
	2	Preparation of block and graft copolymers - Structure and applications of: Polymer drugs.	
	3	Preparation, properties and applications of ion exchange resins.	
	4	Polymer supported reactions- advantages- Merrifield's solid phase peptide synthesis- dendritic polymers (brief idea).	
5	**TEACHER SPECIFIC MODULE -PLASTIC WASTE MANAGEMENT AND RECYCLING**		**12**
	Plastic Waste management -Chemical recycling.		
	Types of recycling (1 °, 2°, 3° & quaternary).		
	Incineration – Pyrolysis- fuels from plastic waste- Recycling codes – development for recycled materials.		
	Pollution due to plastics- Water, Air, Soil pollution by polymers.		

Essential Readings:

1. Text book of polymer science - P.L Nayak and S.Lenka

2. Physical Chemistry of polymers - ATager
3. A text Book of Polymer Science - F. W.Billmeyer.
4. Polymer Science - V.R. Gowariker, N.V. Viswanathan, J.Sreedhar
5. Principles of Polymers Chemistry - P.J.Flory
6. Premamoy Ghosh, Polymer science& Technology, 3rd Edn., Tata McGrraw Hill Education Pvt. Ltd., New Delhi
7. G. Odian, Principles of polymerization, 3 rd edition, John Wiley &Sons.
8. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi
9. V. K. Ahluwalia& A. Misra, Polymer Science-A Text Book, AneBooks , India, New Delhi.
10. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi
11. Principles of polymerization - F.Rooriquez.
12. Polymer Chemistry - M.G Arora & M.Singh
13. Mechanical properties of polymers and composites - L.E. Nielsen, marcel,Dekker
14. Principles of polymerisation, P. Bahadhur, N.V. Sastry, Narosa Publishing House, New Delhi -2002

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar,Viva-Voce	12
Total		100

- **Employability for the Course:** Research and Development, Industrial Sectors, Quality Control and Assurance:

SEMESTER VII

KU7DSCCHE401: THEORETICAL CHEMISTRY: II

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	**KU7DSCCHE401**	4	75

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
3	2	0	35	65	100	2

Course Description: The course provides fundamental principles and experimental foundations that shaped quantum theory and also quantum vibrational and rotational motion, solving Schrödinger's equation for various systems. The course also covers representations of point groups and the application of the Great Orthogonality Theorem (GOT) to molecular spectroscopy and chemical bonding. Practical sessions utilizing computational chemistry tools will reinforce theoretical concepts through hands-on experiments and visualizations.

Course Prerequisite: Basics of quantum chemistry including operator algebra, eigen values and mathematical skills

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Enable students to understand the scientific fundamentals governing the behaviour of quantum systems.	U
2	A comprehensive understanding of the fundamental quantum mechanical models, providing insights into the behaviour of	A

	particles in confined spaces, harmonic potentials, and rotational motion, respectively	
3	Learning how to represent scientifically, symmetry operations as matrices and point groups in terms of reducible and irreducible representations	A
4	To analyze representations of point groups and use the Great Orthogonality Theorem to construct character tables and classify symmetry operations.	An
5	Apply skill in challenging computational chemistry problems	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**QUANTUM MECHANICAL MODELS**	**10**
	1	**Quantum Vibrational Motion:**–One-dimensional harmonic complete treatment with derivation – Wave functions – Hermite polynomials- Recursion relation–Energy levels –Important features of the problem –comparison with classical results	
	2	**Quantum Rotational Motion**–Planar rigid rotor (or particle on a ring)– Derivation of the Φ-equation– Energy levels.	
	3	**Quantum Rotational Motion**–One particle rigid rotator (non-planar rigid rotator or particle on a sphere- complete treatment with derivation of rigid rotor model of diatomic molecule): The wave equation in spherical polar coordinates, separation of variables, the Φ-equation and the Θ-equation and their solutions, Legendre and associated Legendre equations, Legendre and associated Legendre polynomials, Rodrigue's formula, spherical harmonics (imaginary and real forms), polar diagrams of spherical harmonics. Space quantization of angular momentum.	
2		**ROTATIONAL MOTION AND ONE ELECTRON SYSTEMS (Hydrogen like)**	**5**

	1	One electron quantum system: Potential energy of hydrogen-like systems, the wave equation in spherical polar coordinates, separation of variables, the R, Θ and Φ-equations and their solutions (with derivation).	
	2	Laguerre and associated Laguerre polynomials, wave functions and energies of hydrogen atom, orbitals, orthonormality of wave functions,	
	3	Radial functions and radial distribution functions and their plots, angular functions (spherical harmonics) and their plots.	

3	**REPRESENTATIONS OF POINT GROUPS**		**10**
	1	**Matrix representation of symmetry operations**– Representations of point groups – Matrix representation of point group and its characteristics basis for a representation– Representation based on the character of matrices.	
	2	Representations using vectors –Atomic orbitals positioned on atom in a molecule as basis (H_2O and butadiene as examples) – Cartesian coordinates positioned on each atoms of molecule as bases (H_2O as example)	
	3	Classification of representations: reducible representations and irreducible representations (IR) – construction of IR by reduction (qualitative demonstration only)	

<table>
<tr><td rowspan="3">4</td><td colspan="2">GREAT ORTHOGONALITY THEOREM AND ITS APPLICATIONS:</td><td>20</td></tr>
<tr><td>1</td><td>Great Orthogonality Theorem: Statement – consequences of GOT, derivation of characters of IR using GOT, construction of character tables of point groups (C_{2V}, C_{3V},C_{2h}, C_{4V} and C_3 as examples), nomenclature of IR – Mulliken symbols, symmetry species; Reduction formula –Derivation of reduction formula using GOT, reduction of reducible representations, (e.g., Γ_{cart}) using the reduction formula; Relation between group theory and quantum mechanics – Wave functions (orbitals) as bases for IR of point groups.</td><td></td></tr>
<tr><td>2</td><td>Applications of GOT to Molecular Spectroscopy: Molecular vibrations – symmetry species of normal modes of vibration, construction of Γ_{cart}– normal coordinates and drawings of normal modes (e.g., H_2O and NH_3), selection rules for IR and Raman activities based on symmetry arguments –determination of IR active and Raman active modes of molecules (e.g., H_2O, NH_3, CH_4, SF_6) – complementary character of IR and Raman spectra. Spectral transition probabilities – direct product of irreducible representations and its use in identifying vanishing and non-vanishing integrals, transition moment integral and spectral transition probabilities, overlap integrals and conditions for overlap.</td><td></td></tr>
<tr><td></td><td>3</td><td>Applications of group theory to chemical bonding: Hybridization - Treatment of hybridization in BF_3, CH_4 and PCl_5– Inverse transformation and construction of hybrid orbitals. Molecular orbital theory – NH_3, H_20 and Octahedral examples, classification of atomic orbitals involved into symmetry species, group orbitals, symmetry adapted linear combinations (SALC), construction with projection operator. (NH_3, H_20 and Octahedral as examples)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
</table>

<table>
<tr><td colspan="4"></td></tr>
<tr><td></td><td colspan="2">TEACHER SPECIFIC MODULE: PRACTICALS</td><td>30</td></tr>
<tr><td rowspan="8">5</td><td colspan="2">COMPUTATIONAL CHEMISTRY PRACTICALS:
Experiments using modern open source/free computational chemistry packages in computing different parameters of simple molecules (compulsory to do 1 to 5)</td><td>18</td></tr>
<tr><td>1</td><td>Calculation of the electronic energies (in kcal/mol) of global minimum conformation of simple molecules such as water, ammonia, methane and benzene using HF/STO-3G method.</td><td></td></tr>
<tr><td>2</td><td>Calculation of the resonance energy of benzene using HF/3-21G method.</td><td></td></tr>
<tr><td>3</td><td>Calculation of ionization energy and electron affinity of O_2 and N_2 molecules using HF/STO-3G method</td><td></td></tr>
<tr><td>4</td><td>Calculation of IR frequencies of vibrations in water and CO_2 molecules using HF/3-21G method.</td><td></td></tr>
<tr><td>5</td><td>Calculation of ring strain energy of cyclopropane using B3LYP/3-21G method.</td><td></td></tr>
<tr><td colspan="3">General Procedure for above Computational Chemistry Experiments: The software (Avagadro, Firefly/Gamess and Facio) for the above experiments are freely available and can be installed in windows OS. 1. Use Avagadro software to draw/ insert the structure and generate the input file for firefly/Gamess run.2. Set the firefly/gamess software path in Facio graphics software and run the input file 3. The output file can be analysed using facio.</td></tr>
<tr><td colspan="2">OPEN ENDED
Directions:
Use Virtual Labs and Online Tools (e.g., NanoHUB, PhET interactive simulation interface (phet.colorado.edu) of University of Colorado Boulder) for virtual experiments and labs related to quantum mechanics.</td><td>12</td></tr>
</table>

	Use softwares (like Excel, GNUPlot, Mathematica, Geogebra, SciLab) to do the following		
	1	Plotting particle in 1D and 3D box, Harmonic osciallator and Rigid rotor wavefunctions	
	2	Calculating energies of a particle in 1D and 3D-box, Harmonic osciallator and Rigid rotor	
	3	Visualizing probability densities and comparing different scenarios.	
	4	Demonstrating GMT based on matrix representations (Use SciLab / Mathematica)	
	5	Constructing GMT game with abstract elements using an excel sheet	

Essential Readings:

1. D. A. McQuarrie, "Quantum Chemistry", University Science Books,1983 (Viva books, 2003).
2. A.K. Chandra, "Introduction to Quantum Chemistry", 4th Edition, Tata McGraw-Hill, 1994.
3. I.N. Levine, Quantum Chemistry, 6th Edition, Pearson Education Inc., 2009
4. F.A. Cotton, "Chemical applications of Group Theory", 3rd Edition, John Wiley &SonsInc., 2003
5. Arthur M Lesk, "Introduction to Symmetry & Group theory for Chemists", Kluwer Academic Publishers,2004
6. Robert L. Carter, 'Molecular Symmetry and Group Theory", Wiley India Edition, 2005

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Skill	4
b)	Record	4
c)	Punctuality	2
Total		**100**

*****Average of best two test papers

Employability for the Course: The course enhances employability of the students by equipping them with essential knowledge and practical skills in Chemistry

KU7DSCCHE402: INORGANIC CHEMISTRY IV

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	**KU7DSCCHE402**	4	90

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	2	0	35	65	100	2

Course Description: This major paper describes the concepts of bonding in coordination compounds and spectral and magnetic properties of coordination compounds. Practical session deals with inorganic qualitative analysis including rare ions.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Apply the theories of bonding to predict the geometry of coordination compounds	A
2	Explain the spectroscopic features of complexes and interpret the spectra of complexes	A
3	Describe the magnetic behaviour of complexes and apply magnetic properties in the structural determination of complexes	A
4	Understand the various reaction mechanisms operative in inorganic complexes during substitution and electron transfer reactions.	U
5	Acquire skill in analysing inorganic mixtures containing rare earth elements and reporting	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**BONDING IN COORDINATION COMPOUNDS – II**		**8**
	1	Coordination numbers 2 to 12 and geometry – Consequences of CFT- Crystal field effect on ionic radii, lattice energies and hydration energy	
	2	Jahn teller effect – evidence for ligand field splitting – spectrochemical series.	

2	**BONDING IN COORDINATION COMPOUNDS – III**		**7**
	1	MOT in coordination compounds – MO energy level diagrams for octahedral, tetrahedral and square planar configuration with and without π bonding. Effect of π bonding in stability – nephelauxetic series – experimental evidence for metal-ligand.	
	2	Covalent bonding in complex. Comparison of three theories as applied to metal complexes.	

3	**SPECTRAL PROPERTIES OF COORDINATION COMPOUNDS**		**8**
	1	Spectroscopic ground states – term symbols for d^n ion. selection rules for d-d transitions – nature of spectral bands – (band shapes, intensities, width and spin orbit coupling)	
	2	Orgel diagram of transition metal complexes (d1 to d9 configurations) Tanabe Sugano diagrams, interpretation of spectra of spin paired and spin free octahedral, distorted octahedral, tetrahedral and square planar complexes.	

4.	**MAGNETIC PROPERTIES OF COORDINATION COMPOUNDS**		**7**
	1	Magnetic behaviours – susceptibility, measurements – Gouy method diamagnetic corrections. Spin only value – orbital contributions – spin orbit coupling, ferro and antiferro magnetic coupling – spin cross over system.	
	2	Applications of magnetic measurements to structural determinations of transition metal complexes.	

5	**TEACHER SPECIFIC MODULE -** INORGANIC QUALITATIVE ANALYSIS- III PRACTICAL. Directions: (Minimum 8 mixtures are to be recorded) and any two other experiments in teacher's choice.		**60**
	1.	1.Separation and identification of four metal ions Separation and identification of four metal ions of which two are rare, less familiar such as Tl, W, V, Se, Te, Ti, Ce, Th, Zr, Th, Mo, and Li (interfering acid radicals not present). Confirmation by spot test. **Open ended (suggestions)** a) Cerimetry -Fe (II), nitrate b) Estimation of dissolved oxygen by Winkler's method	

Essential Readings:

1. R Gopalan and V N Ramalingam, Concise Coordination Chemistry, Vikas publishing house Pvt Ltd
2. S F A Kettle, Coordination Chemistry, Thomas Nelson and sons
3. J C Bailer, Chemistry of coordination compounds, Reinhold
4. F Basolo R Johnson Coordination Chemistry, Benjamin Inc
5. D Banergea Coordination Chemistry Tata McGrow Hill
6. J E Huheey, E A Keiter, R L Keiter, O K Medhi, Inorganic Chemistry, Pearson.
7. A I Vogel, A Textbook of Qualitative Inorganic Analysis, Longman 5th edition, 1979.
8. V Ramanujam, Inorganic Semi micro-Qualitative analysis, 3rd edition, The National Publishing Company, Chennai 1974.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (35T+30P)**
Continuous Evaluation (CCA)		**35 (15T+20P)**
Theory		**15**
a)	Test Paper*	6
b)	Assignment	3
c)	Viva-Voce	3
d)	Seminar	3
Practical		**20**
a)	Test	16
b)	Record	4
Total		**100**

*Average of best two test papers

KU7DSCCHE403: ORGANIC CHEMISTRY IV

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCHE403	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course is intended to develop a deep understanding in students about the reaction intermediates, mechanisms of various organic reactions, aromaticity and principles of photochemical reactions.

Course Prerequisite: Basic knowledge about reaction intermediates, electron displacement in molecules, types of reagents, electrophiles, nucleophiles, bond fission and basic idea regarding the photochemical reactions and mechanism of organic reactions.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Associate the reaction conditions and reagents in the generation of intermediates and formulate a mechanism for the suggested reactions.	U
2	Analyze the structure-property relations in substitution and elimination reactions.	An
3	Understand various aromatic systems and their reactions and classify molecules based on the aromatic behaviour.	A

4	Distinguish between different photochemical reactions and understand the mechanism of natural photochemical reactions.	U
5	Acquire lab skills in the synthesis of organic compounds, determination of physical constants and purification techniques and in chromatographic techniques	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**REACTION INTERMEDIATES AND REARRANGEMENTS**	**12**
	1	**Reaction intermediates and Rearrangements** Structure, formation, and properties of carbenes, nitrenes, and arynes – singlet and triplet carbenes, nitrenes and arynes-Carbon free radicals: structure, formation, and stability	

	2	Structure, stability, and formation of Ylides, Enamines, 1,3-dithiane, Benzynes, and Enolates-Molecular rearrangement mechanism. **Carbon to carbon migration:** Wagner Meerwein, Pinacol, Wolff, Benzilic acid, Demjanove, Dienone-phenol, Hoffmann-Martius	
	3	**Carbon to nitrogen migration:** Hofmann, Curtius, Schmidt, Lossen, Beckmann-**Migration to electron-rich carbon:** Wittig, Wittig-Hormer, Favorski, Stevens, Neber Orton, Bamberger. **Migration to electron-deficient oxygen:** Baeyer, villager, Da~~r~~kin reaction	
	4	**Aromatic rearrangements:** Claisen, Benzidine, Fries, Von-Richter Sommlet-Hauser	

2	**SUBSTITUTION AND ELIMINATION REACTIONS**		**12**
	1	Aliphatic nucleophilic substitution reactions – saturated and unsaturated systems – Mechanism of nucleophilic substitution – S_N2, S_N1, S_Ni, Single Electron Transfer (SET)- Neighbouring group participation.	
	2	Non-classical carbocations, Substitution at allylic and vinylic carbon atoms-Effect of substrate structure, attacking nucleophile, leaving group, and reaction medium on reactivity and regioselectivity - Aliphatic Electrophilic Substitutions: S_E1 S_E2 and S_Ei mechanisms with suitable examples	
	3	Elimination Reaction: Mechanistic and stereochemical aspects of E1, E2, and E1cB eliminations-The effect of substrate structure, base, leaving group and reaction medium on elimination reactions. Elimination reaction in 4-t-Butylcyclohexyl tosylate (cis and trans), 2-Phenylcyclohexanol (cis and trans), Menthyl and neomenthyl chlorides, and benzene hexachlorides.	
	4	Saytzev vs. Hofmann elimination, Bredt's rule- α- elimination, pyrolytic syn elimination (Ei) – Chugaev reaction, and Cope elimination. Dehydration of alcohols, Dehalogenation of vicinal dihalides, and Peterson olefination	

3		**AROMATICITY AND AROMATIC REACTIONS**	**10**
	1	MO description of aromaticity and antiaromaticity. Homoaromaticity.Aromaticity of annulenes and heteroannulenes, fused ring systems, fulvenes, fulvalenes, azulenes, pentalenes, and heptalenes. Mesoionic compounds, metallocenes, cyclic carbocations, and carbanions.Effect of delocalized electrons on pKa	
	2	Aromatic Electrophilic Substitution: Arenium ion mechanism, substituent effect on reactivity in mono and disubstituted benzene rings, *ortho/para* ratio, *Ipso* substitution-Relationship between reactivity and selectivity	
	3	Aromatic Nucleophilic substitution: Addition-elimination (SNAr) mechanism, elimination-addition (benzyne) mechanism, *cine* substitution, S_N1 and SR_N1 mechanism	
	4	The effect of substrate structure, nucleophile, and leaving group on aromatic nucleophilic substitution-Nucleophilic Substitution of Pyridine-Chichibabin Reaction	

4		**PHOTOCHEMISTRY**	**11**
	1	Photochemical excitation of molecules, spin multiplicity, Jablonski diagram, photosensitization, and quenching- Photochemistry of carbonyl compounds: Norrish type- I cleavage of acyclic, cyclic, and β, γ- unsaturated carbonyl compounds-Norrish type- II cleavage, photo reduction, photoenolization	
	2	Photocyclo- addition of ketones with unsaturated compounds: Paterno-Büchi reaction, photodimerization of α, β- unsaturated ketones	
	3	Photo rearrangements: Photo –Fries, di- π- methane, oxa di- π- methane, aza di- π- methane, lumi ketone rearrangements. Barton and Hoffmann-Loeffler- Freytag reactions	

	4	Photo isomerization and dimerization of alkenes, photo isomerization of benzene and substituted benzenes, and photo-oxidation. Photochemistry of vision and photosynthesis	

<table>
<tr><td rowspan="3">5</td><td>TEACHER SPECIFIC MODULE</td><td>30</td></tr>
<tr><td>*Total 10 experiments to be done

A minimum of (five mixtures should be analysed and recorded, three preparations and any two experiment from chromatography to be carried out) Microscale analytical technique is preferred for carrying out the reactions</td><td></td></tr>
<tr><td>1) Analysis of organic binary mixtures (minimum 5 binary mixtures): Separation of the binary mixture using physical and chemical methods. Checking its purity by Boiling points and Melting points. Preparation of the derivative of the compounds. The following types are expected:
i) Solid-Solid
ii) Non-volatile liquid & Non-volatile liquid
iii) Water-soluble/insoluble solid and non-volatile liquid with compounds from the same or different chemical classes in all three categories.

2) Double-stage Preparation of organic compounds (minimum 3 compounds should be analyzed and recorded):
a) Preparation of p-nitroaniline from acetanilide:

Acetanilide----p-nitro acetanilide----p-nitroaniline

b) Preparation of Methyl orange from aniline:

Aniline---sulphanilic acid---methyl orange

c) Preparation of p-aminoazobenzene from aniline:

Aniline---diazoaminobenzene---p-aminoazobenzene

d) Preparation of m-nitroaniline from nitrobenzene:</td><td></td></tr>
</table>

	Nitrobenzene---m-dinitrobenzene---m-nitroaniline e) Preparation of Benzilic acid benzoin: Benzoin----benzil----benzilic acid f) Preparation of Benzanilide from benzophenone: benzophenone---benzophenone oxime—benzanilide g) Preparation of 2-phenyl indole from phenyl hydrazine: Phenyl hydrazine----acetophenone phenyl hydrazone----2-phenyl indole h) Preparation of caprolactam from cyclohexanone: Cycohexanone----cyclohexanone oxime---Caprolactum i) Preparation of m-nitrobenzoic acid from ethyl benzoate: Ethyl benzoate----ethyl m-nitrobenzene----m-Nitrobenzoic acid Purify the synthesized compound by means of recrystallization. (ii)Spot TLC, report the Rf value, and check the completion of the reaction and purity of the compound. **4)Chromatographic Analysis** 1. Setting up a thin layer plate, Iodine chamber for chromatographic separation 2. Setting up paper (both horizontal and vertical) chromatography 3. Column packing and elution in Column chromatography 4. Separation of simple organic compounds (o-nitrophenol and p-nitrophenol) using different chromatographic techniques 5. Separation of plant pigments using TLC, Paper and Column Chromatography	

Essential Readings:

1. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanism, Academic Press, 2002.

2. F.A. Carey, R.A. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5/e., Springer, 2007.
3. 3. J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2004.
4. R.O.C.Norman&J.M.Coxon, Principles of Organic Synthesis, 3/e, Nelson Thornes
5. J. March, M.B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6/e, Wiley, 2007.
6. Ahluwalia Mukherjee and Singh, Organic reaction mechanisms
7. Maya Shankar Singh, Advanced organic chemistry: reactions and mechanisms, Pearson
8. Peter Sykes, A guidebook to mechanism in organic chemistry, 6th eed Pearson
9. I L Finar, Organic Chemistry Volume 2, Pearson Education.
10. P.S. Kalsi, Organic reactions & their mechanisms, 3/e revised, New Age International Publishers.
11. Modern methods of organic synthesis, Carruthers,
12. P.S.Kalsi, Organic reactions & their mechanisms, 3/e revised, New Age International Publishers.
13. J. Sing and J. Sing, *Photochemistry and Pericyclic Reactions*, 3/e, New Age International, 2012.
14. A I Vogel, A textbook of practical organic chemistry, Longman
15. A I Vogel, Elementary practical organic chemistry, Longman
16. F G Mann and B C Saunders, practical organic chemistry, Longman Shriner and Others, Systematic identification of organic compounds
17. Dey, Sitharaman and Govindachari, A laboratory manual of organic chemistry
18. PR Singh, DC Gupta & KS Bajpai, Experimental organic chemistry vol I & II
19. Vishnoi, Practical organic chemistry
20. Fieser, Experiments in Organic chemistry
21. S Sadasivam and A Manickam, Biochemical methods, New Age International Publishers
22. J B Harbone, Phytochemical methods, Chapman and Hall, London
23. Joseph Sharma, Gunter Zweig, TLC and LC Analysis of international importance, Vol. VI and VII, Academic Press

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Test	8
b)	Record	2
Total		**100**

* Average mark of the best two written tests may be considered for internal mark.

KU7DSCCHE404: PHYSICAL CHEMISTRY- V

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	400	KU7DSCCHE404	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course description: The comprises of modules on advanced thermodynamics, phase equilibrium, statistical thermodynamics, concepts and applications of nanoscience , practicals on phase equilibrium and nano science**.**

Course Prerequisite: Knowledge about laws of thermodynamics, Phase rule and quantum chemistry.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Illustrate the concepts of the third law of thermodynamics and thermodynamic irreversibility.	U
2	Analyze phase transitions and phase diagrams of three component systems	An
3	Correlate the principles of quantum and statistical mechanics	A
4	Understand the methods of synthesis of nanomaterials and its characterization techniques	U

5	Acquire skill in advanced physical chemistry experiments and nano synthesis	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**THERMODYNAMICS III**		**11**
	1	Third law of thermodynamics- need for third law, Nernst heat theorem, determination of absolute entropies using third law, Residual entropy. entropy changes in chemical reactions. Thermodynamic equations of state.	
	2	Partial molar quantities - chemical potential-variation of chemical potential with T&P- determination of partial molar volume and enthalpy. Thermodynamic functions of ideal gases, real gases, and gas	

		mixtures- Entropy and free energy of mixing. Excess thermodynamic functions.	
	3	Thermodynamics of irreversible processes with simple examples. The general theory of nonequilibrium processes. Entropy production. The phenomenological relations. Principle of microscopic reversibility, Onsager reciprocal relations	
	4	Application to the theory of diffusion, thermo-osmosis, and Thermoelectricity (Seebeck effect, Peltier effect, and Thomson effect).	

2	**PHASE EQUILIBRIUM**		**8**
	1	Phase rule -Physical equilibria involving phase transition-criteria for equilibrium between phases	
	2	Three component system- graphical representations-solid liquid equilibria Ternary solution with common ion-Hydrate formation-compound formation	
	3	Liquid-liquid equilibria-one pair of partially miscible liquids-two pairs of partially miscible liquids-three pairs of partially miscible liquids.	

	STATISTICAL THERMODYNAMICS		18
	1	Distinguishable and Indistinguishable particles, phase space, Ensemble, Macrostates, and microstates. Stirlings approximation- Thermodynamic probability -Derivation of Maxwell-Boltzmann distribution law	
	2	Partition function- physical significance- total partition function; Separation of Molecular partition function - Translational, Rotational, vibrational, electronic and nuclear partition function. Rotational temperature- Fundamental vibrational temperature-Thermal de-Broglie wavelength.	
	3	Heat capacity of gases- Classical and quantum theories-Equipartition principle - Heat capacity of Hydrogen – Ortho and Parahydrogen.	

	4	The atomic crystals: Einstein's theory of atomic crystal - Debye's modification of Einstein's model.	

4		**CONCEPTS AND APPLICATIONS OF NANO SCIENCE**	**7**
	1	Nanomaterials – Classification based on dimensions	
	2	Synthesis – Top down and bottom up-chemical precipitation, mechano-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and solgel method, Hydrothermal synthesis (brief study)	
	3	Important methods for the characterization of nanomaterials – Scanning electron microscopy (SEM)-transmission electron microscopy (TEM).	
	4	Synthesis and applications of Quantum dots-Carbon nanotubes and Graphene (brief study)	

5	**TEACHER SPECIFIC MODULE-PRACTICALS** Minimum 3 experiments must be done. Experiment in nano synthesis is open ended	**30**
	a) Solid and liquid equilibria: construction of phase diagram of simple eutectics, systems with congruent melting points, and solid solutions. Determination of the composition of unknown mixtures. Analytical and synthetic methods for the determination of solubilities and heat of solution b) Partially miscible liquids: critical solution temperature, the influence of impurities on the miscibility temperature (KCl, NaCl, and /or succinic acid). Determination of the composition of unknown mixtures. c) Completely miscible systems: construction of phase diagram of a two-component liquid system. Zeotropic and azeotropic	

	d) Three-component systems: with one pair of partially miscible liquids. Construction of phase diagrams of tie lines. Compositions of homogenous mixtures.	
	Synthesize nano particles of metals or metal oxides/sulphides (**open ended**)	
	Suggestion: Sol -gel method- (ZnO, MgO)	

Essential Readings:

1. S.Glasstone-“Thermodynamics for chemists”–Affiliated East West publication.
2. Rastogi and Misra- “An Introduction to chemical thermodynamics-6thedition”– Vikas publishing
3. I.Pregogine- “Introduction of Irreversible to thermodynamics process”-Interscience
4. Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis by M. Hillert
5. Phase Diagrams: Materials Science and Technology, Volume III” by P. Villars and L.D. Calvert
6. M.C.Gupta-“Elements of Statistical Thermodynamics-New age international.
7. L.KNash- “Elements of Statistical Thermodynamics-AddisionWesley publishing
8. KistinandSorfuran-“A course on statistical thermodynamic”-Academic 1971.
9. D.A. McQuarie-“Statistical thermodynamic”-HarperandRow1973.
10. Winston Revie and Herbert Uhlig Corrosion and corrosion control:(Wiley Edited by Sheir,Jarmanand Burstein Corosion Control Volume 2

12.Nanosciece and nanotechnology: V. S. Muraleedharan and A. Subramania, Ane Book Pvt Ltd.

13.Nano; The Essentials: T. Pradeep, Mc Graw-Hill education

14.Lewis and Randal-“Thermodynamics”-McGraw-Hill.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical10		
a)	Test	8
b)	Record	2
Total		**100**

KU7DSCCHE405: PHYSICAL CHEMISTRY - VI

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VII	DSC	405	**KU7DSCCHE405**	4	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
60	-		30	70	100	2

Course Description: Course comprises modules on Electro Chemistry, statistical thermodynamics, quantum statistics and solid state

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Contextualize the relation between quantum mechanics and thermodynamics	U
2	Apply the molecular partition functions	A
3	Derive and compute thermodynamic functions from partition functions	U
4	Develop an idea of different properties of solids, focusing on electric and magnetic properties	A
5	To understand about the climatic changes and atmospheric parameters	U

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ELECTROCHEMISTRY-I**		**8**
		Introduction- the nature of electrolytes– Ionic mobilities- ion activity- ion-ion and ion -solvent interaction. Equilibrium properties of electrolyte solutions. Electrolytes of the first and second kind, - Influence of pressure and temperature onion conductance-Walden's equation- Abnormal ion conductance-	4
		a) Derivation of Debye-Huckel Onsager equation- the validity of Debye-Huckel-Onsager equation for aqueous and non-aqueous solution- Deviation from Onsager Equation-Conductance ratio and Onsager equation-Dispersion of conductance at high frequencies-Triple ion conductance minima	4

2	**ELECTROCHEMISTRY-II**		**10**
		Equilibria in electrolytes-Association constant Ion-association-dissociation constant--- Activities and activity coefficient in electrolytic solutions. -Debye-Huckel limiting law and its various form, qualitative and quantitative tests of Debye-Huckel limiting equation	4
		Osmotic coefficient- solubility product principle-solubility in the presence of common ion-Activity coefficient and solubility measurement	2
		Butler Volmer equation for simple electron transfer reaction-Transfer coefficient- Exchange current density Rate constants- Tafel equation and its significance	4

3	**STATISTICAL THERMODYNAMICS -II AND QUANTUM STATISTICS**		**18**
	1	Partition function and thermodynamic functions- Partition function and equilibrium constants - Equation of state – Sackur Tetrode Equation-Statistical formulation of the third law of thermodynamics	6
	2	Need for quantum statistics, Bose-Einstein statistics: Bosons-Bose Einstein distribution law, Bose-Einstein condensation-liquid helium	6
	3	Fermi- Dirac statistics: Fermions- Fermi- Dirac distribution law-application to electrons in metals- Thermionic emission. Comparison of three statistics	6

4	**SOLIDSTATE**		**12**
	1	Perfect and imperfect crystals. crystal defects-point defects-Schottky and Frenkel defects-nonstoichiometric defects. Classification -point defects, line and plane defects, vacancies-.	4
	2	Thermodynamics and calculation of number of defects of Schottky and Frenkel defects and formation of colour centres, non-stoichiometric defects	4
	3	Identification of unit cells from systematic absence in diffraction pattern-structure of sirnple lattice - X-Ray intensities-structure factor and its relation to intensity and electron density-phase problem	4

5	**TEACHER SPECIFIC MODULE**	**12**
	Directions: Photochemistry and photocatalysis or any other topic relevant to the course can be included	
	PHOTOCHEMISTRY &PHOTOCATALYSIS	

	Photochemistry – consequences of light absorption – The Jablonski diagrams – Radiative and nonradiative transition – Light absorption by solutions – Lambert – Beer Law – Laws of photochemistry – The Grotthus – Draper law – Stark – Einstein law – Quantum efficiency /Quantum yield – Experimental determination of quantum yield – High and low quantum yield - Photochemical rate law – Energy transfer in photochemical reactions – Photo sensitization-application in photosynthesis (brief idea only) - quenching – Chemiluminescence – Lasers-Colorimetry - Instrumentation of photocolorimeter -applications -Photo catalysis	

Essential Readings:

1. Bockris and Reddy-"Modern electrochemistry"-Springer
2. S.Glasstone-"Theoretical electrochemistry"-East-West Books
3. L.I.Anthropov-"Theoretical electrochemistry"-Mir publishers
4. M.C.Gupta-"Elements of Statistical Thermodynamics-New age international
5. L.K Nash-"Elements of Statistical Thermodynamics-Addision Wesley publishing
6. KistinandSorfuran- "A course on statistical thermodynamic"-Academic 1971
7. D.A. McQuarie- "Statistical thermodynamic"-HarperandRow1973
8. D.K. Chakraharth- "Solid state chemistry"-New age publication
9. I.V. Azaroof-"Introduction to solids"-McGraw Hill.
10. Lesley E.Smart and Elaine A.Moore."Solid state chemistry an introduction" Third edition, 2005. Taylor and Francis group.
11. A.R.West, Solid State Chemistry and its Applications, (1984) John Wiley and Sons, Singapore

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of best two test papers

SEMESTER VIII

KU8DSCCHE403: PHYSICAL CHEMISTRY –VII

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSC	400	KU8DSCCHE403	4	75

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture / Tutorial	Practical/ Internship	CE	ESE	Total	
3	2	35	65	100	2

Course Description: The course comprises of modules on reaction kinetics, electroanalytical instrumentation, corrosion, applied electrochemistry and physical chemistry practicals

Course Prerequisite: Knowledge on chemical kinetics, corrosion

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand various theories of chemical kinetics and its applications in different reactions.	U
2	Understand the theory and applications of various electroanalytical techniques.	U
3	Evaluate advanced theoretical models of corrosion	E
4	Understand the chemistry of batteries, super capacitors, LED etc	U
5	Acquire skills in physical chemistry practicals.	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	1	3	0	3	1	1
CO 2	3	1	3	0	1	3	0
CO 3	3	0	3	2	2	3	2
CO 4	3	1	3	2	0	3	2
CO 5	3	0	3	0	2	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**REACTION KINETICS**		**17**
	1	Review of basic principles-complex reactions-reversible-parallel-consecutive and branching reactions-principles of microscopic reversibility	
	2	Theories of reaction rates-collision theory-steric factor-potential energy surfaces- Transition state theory-Erying equation-comparison of two theories	
	3	Thermodynamic formulation of reaction rates- Significance of ΔG^*, ΔH^*, ΔS^* volume of activation- Effect of pressure and volume on the velocity gas reaction	

	4	Unimolecular reaction-Lindmann Hinshelwood mechanism and RRK theories-Fast reaction-relaxation, flow method-flash photolysis-Magnetic and resonance method- Theoretical calculation of energy of activation	

2	**ELECTROANALYTICAL INSTRUMENTATION**		**10**
	1	Voltammetry -Amperometry, biamperometry	
	2	Dropping Mercury Electrode, Polarization – Concentration polarization, Half wave Potential and Diffusion current (Significance), Ilkovic equation, Advantages of polarographic analysis – Applications	
	3	Cyclic voltammetry	
	4	Electrogravimetry	

3	**CORROSION**		**8**
	1	Thermodynamics of corrosion and electrode potentials. EMF of a cell-measurement- emf calculation of half-cell potential-Nernst equation	
	2	Basis of Pourbaix diagrams- Diagrams of water, Fe, and Al. Limitations of Pourbaix diagrams	
	3	Kinetics of corrosion- Polarization and corrosion rate. Measurement of corrosion rate. Measurement of polarization- causes of polarization. Calculation of IR drops in an electrolyte. Influence of polarization on corrosion rate.	
	4	Polarization diagram of corroding metals. Calculation of corrosion rate from polarization data. Theory of cathode protection. Passivity	

4	**APPLIED ELECTROCHEMISTRY**		**10**
	1	Energy storage devices: Batteries- Working of Lithium-ion battery.	
	2	Basics of supercapacitors, Classification with examples	
	3	Electrostatic double layer capacitors (EDLC) and Psuedo capacitors-working and principle	

5	**TEACHER SPECIFIC MODULE-PHYSICAL CHEMISTRY PRACTICALS-V**	**30**
	Directions: Total 5 experiments to be done. Two from kinetics and any 3 from Polarimetry and spectrophotometry according to teacher's choice	
	1.Chemical kinetics a) Saponification of ethyl acetate – determination of specific reaction rate, $K_2S_2O_8$, and KI system b) Iodination of acetone in acid medium – determination of the order of reaction with respect to iodine and acetone **2.Polarimetry** a) Determination of specific and molar optical rotations of glucose, fructose, and sucrose b) Determination of the concentration of a glucose solution c)Inversion of cane sugar in the Presence of HCl-Study of the Kinetics d)Determination of the specific rate of the reaction e) Determination of concentration of HCl **3) Spectrophotometry** a) Verification of the Beer Lamberts law b) Determination of equilibrium constants of acid-base indicators	

	c)Determination of concentration of a solution of $K_2Cr_2O_7$ (or $KMnO_4$) d)Simultaneous determination of Mn and Cr in a solution of $KMnO_4$ and $K_2Cr_2O_7$ e) Investigation of complex formation between Fe (III) and thiocyanate	

Essential Readings:

1 Physical Chemistry – A molecular Approach: Mc Quarrie, J. D. Simon, Viva Books Pvt Ltd.

2. Fundamentals of molecular spectroscopy: C. N. Banwell and E M Mc Cash, Mc Graw -Hill

3. A Textbook of Physical chemistry: K. L. Kapoor, Volume 4, Macmillan India Ltd.

4. Physical Chemistry, I. N. Levine, Tata Mc Graw Hill.

5.Elements of Physical chemistry: Puri, Sharma and Pathania, Vishal Publishing Co.

6.Physical Chemistry, K. J. Laidler, John H.Meiser.

7.Physical Chemistry: P.W. Atkins, Oxford University Press.

8. Chemical Kinetics: K J Laidler, Pearson publications

9) Instrumental methods of analysis: H Kaur, Pagathi publisher

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**65 (50T+15P)**
Continuous Evaluation (CCA)		**35 (25T+10P)**
Theory		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Viva-Voce	5
d)	Seminar	5
Practical		**10**
a)	Test	8
b)	Record	2
Total		**100**

*Average of the best two test papers

DISCIPLINE SPECIFIC ELECTIVE COURSES

KU8CHEDSE401- FORENSIC CHEMISTRY & TOXICOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECHE401	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
60	0	30	70	100	2

Course Description: This paper comprises of five modules. First four modules describe the theory contents and the fifth module which is the teacher specific module. A total of SIXTY hours comprising of 48 lecture/ instructional and 12 hours has been allocated for teacher specific module. No laboratory works included

Course Prerequisite: Basic idea about the analytical chemistry and instrumentation techniques. Some basic knowledge on separation techniques.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the role and limitations of forensic chemistry in criminology including cosmetics and drugs	U
2	Acquire knowledge on different instrumental techniques in forensic science.	A
3	Understand the concept of toxicology, analysis techniques in toxicological cases and managing such cases	U
4	Describe the various toxicological analysis such as poisons, lethal drugs and explosion residue analysis etc	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
-CO 1	3	1	3	0	0	3	0
CO 2	3	3	1	0	1	0	3
CO 3	3	0	3	1	0	3	1
CO 4	3	1	3	0	1	3	2
CO 5	3	0	3	0	0	3	0

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION TO FORENSIC CHEMISTRY**	**14**
	1	Role of Forensic Chemist- Types of Cases which require Chemical Analysis- Sampling of Evidence- Presumptive Tests (Colour/Spot Tests)- Microcrystal Tests	
	2	Limitations of Forensic Samples- Elemental Analysis (Organic and Inorganic)-Instrumental Methods and Equipment- Examination of Contact Traces.	
	3	Introduction to Cosmetics and Detective Dyes- Collection, Sampling, Analysis and Forensic Importance- Analysis of Illicit Liquors including Methyl and Ethyl Alcohol.	
	4	Drugs of Abuse: Introduction, Drug Addiction and its Problems- Classification of Drugs of Abuse, Analgesics, Depressants, Stimulants, Hallucinogens and Narcotics.	

2		**INSTRUMENTATION FOR FORENSIC ANALYSIS**	**12**
	1	Instrumental Methods- Sample preparation- calibration of instruments for accuracy and reproducibility of results in forensic analysis- method validation technique and requirements- procurement of standard samples.	
	2	Forensic applications of TLC, HPTLC, HPLC, GC, FT-IR, AAS, GC-MS, UV-visible spectrophotometer with emphasis over standard operational procedures (SOPs) for test samples.	

	3	Physical, Biological and Chemical Methods- Non-destructive testing probes including radiography, X-ray-radiography, Surface penetrations method (SEM and Laser Probes), Fluoroscopy.	
	4	Clinical methods: ELISA, RIA and immune-diffusion, analysis of glucose, bilirubins, total cholesterol, creatinine, blood urea nitrogen and barbiturates in biological fluids, DNA-finger printing	

3	**MANAGEMENT OF TOXICOLOGICAL CASES**		**10**
	1	Introduction, Principles of Management of Poisoning Cases- Duties of a Doctor in Poisoning Cases- Signs and Symptoms of Common Poisons, Types of antidotes.	
	2	Examination and grouping of blood stains and seminal stains- Data retrieval and automation techniques for forensic examination with reference to presence of drugs, glasses, paints, oils and adhesives at crime spot.	
	3	Detection of poisoning in the Dead- Selection, Collection and Preservation of Viscera for various Types of Poisons- Choice of Preservatives, Containers and Storage.	
	4	Different Methods of Extraction, Isolation, Identification, Estimation of Poisons from Biological Specimens.	

4	**FORENSIC TOXICOLOGY**		**12**
	1	Role of the Toxicologist- Significance of Toxicological findings- Poisons, definition, Classification based on their Origin- Physiological Action and Chemical Nature.	
	2	Analysis of various types of poisons (corrosive, irritant, analgesic, hypnotic, tranquillizer, narcotic, stimulants, paralytic, antihistamine, domestic and industrial.	

	3	Explosive and explosion residue analysis- Lethal drug analysis- Drug Abuse in Sports: Introduction, Common prohibited substances, Analytical approach. Arson: Introduction, Legal Definition.	
	4	Importance of physiological tests in forensic toxicology- Analysis of Fire Scene Evidence- Instrumental Methods for Fire Debris Analysis- Analysis of Petroleum Products in Adulterant Cases.	

5	**TEACHER SPECIFIC MODULE**	**12**
	Toxicology -Irrespirable Gases Carbon monoxide-properties-sources-signs and symptoms-postmortem findings-circumstances of poisoning. Carbondioxide- properties-sources-signs and symptoms- postmortem findings-circumstances of poisoning. Hydrogen sulphide- properties-sources-signs and symptoms- postmortem findings-circumstances of poisoning.	

Essential Readings:

1. Brown, W. Drinking, Drugs & Driving Drunk: How Different Drugs Affect the Driving Experience 2nd ed. William Gladden Foundation Press: (2011).
2. Connors, K.A. A textbook of Pharmaceuticals Analysis 2nd ed. Wiley: New York; (1975).
3. Clarke, E.G.C. and Moffat, A.C. Clarke's Isolation and Identification of Drugs: In Pharmaceuticals, Body Fluids and Postmortem Material. Pharmaceutical Press: (1986).
4. Crown. D.A. The Forensic Examination of Paints and Pigments. Thomas (1968).
5. Sunshine, I. Methods for Analytical Toxicology. CRC Press: USA; (1975).
6. Swarbrick, J. Clarke's Isolation and Identification of Drugs, 2nd ed. Pharmaceutical Press: London; (1986).
7. Turner, W. Drugs & Poison (Police Evidence Library). Aqueduct: (1965).
8. Froede, R.C. The Laboratory Management of the Medico-Legal Specimen. Annals of Clinical & Laboratory Science, 6(3), (1976).
9. Forensic medicine and toxicology by Dr.P.C Ignatius

10. W.J. Welcher (Ed.), Scott's Standard Methods of Chemical Analysis, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.
11. Peter Fordham, Non-destructive Testing Techniques, 1st edition (1968), London Business Publications Ltd., London
12. W. Horwitz, Official Methods of Analysis, 11th Edition (1970), Association of Official
13. Analytical Chemists, Washington DC.
14. K. Simpson and B. Knight, Forensic Medicine, 9th Edition (1985), Edward Arnold Publishers Ltd., London.
15. Cunliffe, F. Criminalistics and Scientific Investigation (Prentice-Hall series in criminal justice). Prentice Hall: (1980).
16. Hodgson, E. A Textbook of Modern Toxicology 4th ed. John Wiley & Sons: Canada; (2010).
17. Klaassen, C. Casarett& Doll's Toxicology: The Basic Science of Poisons 8th ed. Mc Graw Hill: (2013).
18. Curry, A.S. Poison Detection in Human Organs. Springer:(1976).
19. Curry, A.S. Advances in Forensic Chemical Toxicology. CRC Press:(1972).
20. Curry, A.S. Analytical Methods in Human Toxicology: Part II. Wiley VCH:(1986).
21. Gosselin, R.E.; Hodge, H.; Smith, R.P. and Gleason, M.N. Clinical Toxicology of
22. Commercial Products: Acute Poisoning 4th ed. Williams & Wilkins: Baltimore; (1969).
23. Matsumura, F. Toxicology of Insecticides. Springer: New York; (1985).
24. Maehly, A. and Stromberg, L. Chemical Criminalistics. Springer: New York; (2011).
25. Lundquist, F. and Curry, A.S. Methods of Forensic Science. Inderscience Publisher: California; (1963)

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

***Average of best two test papers**

KU8DSECHE402: COMPUTATIONAL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	**KU8DSECHE402**	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: Computational Chemistry is an interdisciplinary course that merges principles of chemistry, physics, and computer science to understand and predict the behaviour of chemical systems using computational techniques. This course is designed for students with a background in chemistry and an interest in applying computational methods to solve chemical problems.

Course Prerequisite: General Chemistry, Physical Chemistry, Basic programming skills

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the theoretical foundations of computational chemistry. Classify and analyze the importance of quantum mechanics in understanding molecular behaviour.	U
2	Demonstrate proficiency in the use of basis sets and molecular orbitals in computational chemistry	An

3	Understand the foundations of Understand the foundations of DFT and utilize it to study the properties of molecular systems	U
4	Conduct computational spectroscopy to predict vibrational, electronic, and NMR spectra.	C
5	Prepare input programs in Gaussian / GAMESS / ORCA or other format for various calculations	A

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	0	3	1	0	3	0
CO 2	3	3	0	2	2	0	3
CO 3	3	2	3	0	0	3	0
CO 4	3	1	3	1	1	3	0
CO 5	3	3	0	0	1	0	3

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**COMPUTATIONAL CHEMISTRY – I**	**16**
	1	Theoretical foundations of computational chemistry – Historical development and role in modern chemistry	

	2	Theory, computation &modelling – Definition of terms – Need of approximate methods in quantum mechanics	
	3	Computable quantities – Structure, potential energy surfaces and chemical properties – Cost and Efficiency	
	4	Classification of computational methods- Hartree – Fock Method-Ab initio methods	
	5	Hartree – Fock method- Self Consistent Field (SCF) treatment of polyatomic molecules– Closed shell systems– restricted HF calculations– Open shell systems– ROHF and UHF calculations– The Roothan– Hall equations– Koopmans theorem– HF limit and electron correlation	
	6	Introduction to post-HF methods	

2	**COMPUTATIONAL CHEMISTRY – II**		**6**
	1	Semiempirical methods- the basic principle of SCF-SE methods – Neglect of diatomic differential overlap approximation (NDDO) – intermediate Neglect of differential overlap approximation (INDO) – complete Neglect of differential overlap	
	2	Approximation (CNDO) – parameterization – modified intermediate Neglect of differential overlap (MINDO) – modified NDDO and MNDO models – Austin model 1(AM1)	

3	**COMPUTATIONAL CHEMISTRY – III**		**10**
	1	Density Functional Theory (DFT) - Introduction – Representability problems – Hohenberg-Kohn theorems – Kohn-Sham theory – reduced density matrix methods – local density approximation application – generalized gradient approximation	

	2	Hybrid functionals – performance and properties of density functional methods. Comparison between DFT and HF	

4		**COMPUTATIONAL CHEMISTRY – IV**	**16**
	1	Basis sets: Hydrogen-like, Slater-type & Gaussian type basis functions, classification of basis sets – minimal, double zeta, triple zeta, split-valence, polarization and diffuse basis sets – contracted basis sets, Pople-style basis sets: Nomenclature, calculation of number of basis functions and primitives used in a given basis set – correlation consistent basis sets, basis set superposition errors (BSSE).	
	2	Molecular Mechanics: Basic principles – developing force field – the stretch energy – the bending energy – torsional energy – the Van der Waals energy – the electrostatic energy – cross terms – parameterizing the force field – geometries and frequencies calculated by MM – strength and weakness of MM – Force fields in molecular docking.	

5	**TEACHER SPECIFIC MODULE-** COMPUTATIONAL CHEMISTRY – V	**12**
	Directions: Molecular dynamics or any other topic relevant to the course according to teacher's choice can be included.	
	Molecular Dynamics (MD): Basic principles – Calculation of simple thermodynamic properties–energy, heat capacity, pressure and temperature, phase space, periodic boundary conditions, monitoring the equilibration, analyzing the results of a simulation, error estimation – MD using simple models – continuous potentials, finite difference methods, choosing the time step Applications - Prediction of molecular properties using computational chemistry – Equilibrium molecular geometry – Applications in vibrational spectroscopy: calculating IR and Raman frequencies of molecules – Applications in UV and NMR spectroscopy – Applications in chemical thermodynamics Understanding molecular geometry input (Z-matrix input)	

	– Writing Z-matrix input of simple molecules with $Natom$< 12 – Preparing computational chemistry input program in Gaussian / GAMESS/ ORCA or other format to calculate various molecular properties such as single point energy, geometry optimization, frequency calculation, etc.	

Essential Readings:

1. Leach AR. Molecular Modelling: Principles and Applications. 2nd ed. Harlow England: Prentice Hall.

2. Cramer CJ. Essentials of Computational Chemistry: Theories and Models. 3rd ed. Somerset: Wiley.

3. Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons ltd.

4. David Young, Computational Chemistry- A Practical Guide for Applying Techniques to Real World Problems, Wiley -Interscience

5. TamásVeszprémi and MiklósFehér, Quantum Chemistry: Fundamental and applications, Springer-India

6. Errol G. Lewars, Computational Chemistry: Introduction to the theory and applications of molecular quantum mechanics, 2nd edn., Springer

7. I.N. Levine, Quantum Chemistry, 6th Edition, Pearson Education Inc

8. Szabo A Ostlund NS. Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory. Mineola NY: Dover Publications.

9. W. Koch, M.C. Holthausen, A Chemist's Guide to Density Functional Theory, Wiley-VCH Verlag. 10. David B Cook, Handbook of computational quantum chemistry, Oxford University

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

***Average of best two test papers**

KU8DSECHE403 – CERAMICS, COMPOSITES AND INORGANIC POLYMERS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECHE403	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	70	30	100	2

Course Description: The course comprises of modules on Ceramics, Composites, Inorganic Polymers and material for special purposes.

Course Prerequisite: Elementary idea on polymer chemistry and inorganic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Identify and distinguish the normal materials and ceramics	E
2	Explain different types of processes involved in ceramic material preparation	A
3	Understanding of the advanced ceramic materials and its properties	U
4	Evaluate the property specific ceramic materials	A
5	Understand the basics of polymer composites	U

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	2	2	2	0	0	2	1
CO 2	2	2	2	0	0	2	1
CO 3	3	2	3	0	0	3	2
CO 4	3	2	3	0	0	3	2
CO 5	2	2	2	0	0	2	1

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**CERAMIC MATERIALS-I**		**12**
	1	Traditional and new ceramics – structure of ceramic – atomic interaction and types of bond	
	2	phase equilibria in ceramic systems – one component and multicomponent systems – use of phase diagrams in predicting material behaviour	
	3	Electrical, magnetic and optical properties of ceramic materials- Chemical reaction at high temperature and processesing of ceramics – high temperature materials – crystalline ceramic materials – oxide, carbide, nitride, graphite and clay materials and their structures.	

2	**CERAMIC MATERIALS- II**		**12**
	1	Polymorphism – nanocrystalline ceramic materials – structure and structural requirements for stability – mode of formation.	
	2	Silicate and nonsilicate glasses – Hydrogen bonded structures	
	3	Thermal properties of ceramics- high temperature materials- Mechanical properties- creep, fatigue, crack growth, electrical conductivity.	
	4	Magnetic properties- Hysteresis curves- magnetic ceramics and their applications- optical properties- scattering, opacity.	
	5	Super conducting materials- Metallic and ceramic super conducting materials – theories of super conductivity – Meissner effect – high temperature super conductors- their structure and applications.	

3	**COMPOSITES**		**12**
	1	Introduction- classification of composites according to the matrix- classification of composites according to the reinforcement.	
	2	Synthesis techniques- properties and applications of ceramic matrix composites- polymer matrix composites and metal matrix composites.	
		Composite Strengths- dispersion and particulate strengthened composites- Fibers as reinforcements.	
		Composite Interfaces- Bonding Mechanisms- other Interfacial properties	

4	**INORGANIC POLYMERS**		**12**
	1	Polyphosphazenes- Introduction, classification, bonding, synthetic routes, characterization, and biomedical applications.	

	2	Organosilicon polymers- polysiloxane preparation, structure and applications.	
	3	Synthesis and chemical modification of polysilanes- application of polysilanes as photoresists and photoinitiators.	
	4	Organometallic polymers- Introduction, structure & bonding, synthetic routes, and applications.	

5	**TEACHER SPECIFIC MODULE-MATERIALS FOR SPECIAL PURPOSES**	**12**
	Directions: Module on materials for special purposes or any other topic relevant to the course can be propose.	
	Production of ultra-pure materials – zone refining, vaccum distillation and electro refining- Ferroelectric and piezo electric material- general properties – classification of ferroelectric materials – theory of ferroelectricity – ferro electric domains – applications- Piezo electric materials and application Metallic glasses- preparation- properties and applications-magnetic material – ferri and ferro magnetism – metallic magnets – soft, hard and super conducting magnets – ceramic magnets.	

Essential Readings:

1.W D Kingery, H K Dowen and R Duhlman, Introduction to ceramics, John Wiley

2. F H Nortion, Elements of ceramics, Addison-Wesley pub.co

3. C J Brinker and G W Sherer, Sol-gel science, the physics and chemistry of sol-gel processing, Academic press, Newyork 1990

4. A G Guy, Essentials of material Science, McGraw Hill

5. M J Starfield and Shrager, Introductory materials science, McGraw Hill

6. V Raghavan, A first course in material science, Prentice Hall Pvt Ltd, New Delhi

7. J H Shackelford, An introduction to material science for engineers, McMillian Pub.co, New Delhi

8. W F Smith, Foundation of material science and engineering, McGraw Hill Book Co 2000 23

9. M W Barsoum, Fundamentals of ceramics, McGraw Hill Book co 1997

10. S K Hagra Chaudhary, Material science and engineering, Indian book dist co. Kolkata

11. Sharp R S, Research Techniques in Non-destructive testing, Volume II, Academic PRESS, Newyork, 19973

12. J Kraut Kramer and H Kraut Kramer, Ultrasonic testing of materials, George Allen and Union limited, London, 1969

13. Analytical techniques for thin films in treatise on material science and technology, Vol 27, Acad, Press Inc, Newyork, 1991

14. S V Subramanian and E S Rajagopal, High temperature superconductor, Wile Eastern Ltd, 1988

15. M Tinkham, Introduction to superconductivity, McGraw Hill, Kogakusha, Ltd, 1975

16. A V Narlikar and S N Edbote, Superconductivity and superconducting materials, South Asian Pub, nEw Delhi 1983

17. Dekker, Electronic engineering materials, A J Prentice Hall of India Pvt Ltd, 1985

18. C M Srivastava and C Srinivasan, Science of engineering materials, Wiley Eastern Ltd 1987

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of the best two test papers

KU8DSECHE404: ADVANCED NANOMATERIAL SYNTHESIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECHE404	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description: This course focuses on different methods used for the synthesis of nanomaterials. The course is divided into four modules. In the first module, different physical methods used for the synthesis of nanomaterials are discussed. The second module deals with different chemical methods and the third one discusses about the biological methods for synthesis of nanomaterials. The module deals with lithographic techniques.

Course Prerequisite: Elementary idea on inorganic chemistry

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Synthesize nanomaterials using physical, chemical and biological approaches.	A
2	Understand the functionalization of nanoparticles for specific applications	U
3	Form the nanocomposites for tuning their functional properties.	An
4	Fabricate the device structures using lithographic techniques	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**PHYSICAL METHODS FOR SYNTHESIS OF NANOMATERIALS**	**18**
	1	Inert gas condensation-Principle, advantages and disadvantages, arc discharge – synthesis of CNTs and fullerenes, laser ablation-principle, Coloumb explosion.	
	2	Laser pyrolysis- Principle, advantages and disadvantages- layer deposition, ball milling-principle, grinding media, Spray pyrolysis.	
	3	Ion implantation, Physical Vapour deposition - Principle, evaporation and sputtering, molecular beam epitaxy.	
	4	Chemical vapour deposition method- homogeneous and heterogeneous process- transport phenomenon- reaction kinetics- types of CVD- Electrospinning processing parameters- factors affecting the process.	

2	**CHEMICAL METHODS FOR SYNTHESIS OF NANOMATERIALS - I**		**8**
	1	Chemical methodologies- their advantages- nanoparticles- 1D-nanostructures-Nanowires, nanotubes and nanorods, Nanoparticles through homogeneous & heterogenous nucleation in solution.	
	2	Precipitation, chemical reduction, hydrothermal synthesis- isothermal and temperature gradient methods, Solvothermal synthesis.	

3	**CHEMICAL METHODS FOR SYNTHESIS OF NANO - MATERIALS – II**		**7**
	1	Template based synthesis, Electrochemical synthesis, Sonochemical synthesis cavitation, Polyol method, Sol-gel synthesis- reactions and catalysts.	
	2	Micelles and Microemulsion assisted synthesis- principle and parameters that affect size and shape of nanostructured products, Thermal decomposition, Langmuir Blodgett (LB) method.	

4.	**BIOLOGICAL METHODS FOR SYNTHESIS OF NANOMATERIALS**		15
	1	Use of bacteria, fungi, actinomycetes and algae for nanoparticle synthesis- natural synthesis of magnetic nanoparticles using magnetotactic bacteria – magnetosomes,	
	2	Viruses as components for the formation of nanostructured materials – common virus types used, scaffolds, specific features of plant viruses, functionalizing scaffolds.	
	3	Role of plant derivatives in nanoparticle synthesis- Nanoparticle synthesis with the help of enzymes- biocatalystic enlargement.	
	4	Cofactor-assisted Nanoparticle synthesis- DNA-assisted synthesis of nanoparticles- Nanomaterial synthesis from industrial or agricultural wastes.	

5	**TEACHER SPECIFIC MODULE - LITHOGRAPHIC TECHNIQUES FOR FABRICATION OF NANOMATERIALS**		**12**
	1.	Basics of micro and nano lithography processes- Optical Lithography-Proximity- contact and projection printing- Materials and methods.	
	2.	Electron beam lithography- Rastorscan and vector scan- Pros and cons-proximity effects.	
	3.	X-ray lithography- processes, advantages and disadvantages- geometric effects- Focused ion beam lithography- Near field Scanning.	
	4.	AFM lithography – Bias assisted, and force assisted methods- Dip pen lithography- Diffusive and Liquid Inks.	

Essential Readings:

1. Applications by Guozhong Cao, Imperial college Press, (2006). Publisher: World Scientific Publishing Company.

2. Introduction to Nanoscience and Nanotechnology, Chattopadhyay K.K, Prentice Hall India Learning Private Limited

3. An introduction to Electrospinning and Nanofibers j Seeram Ramakrishna, Kazutoshi Fujihara, Wee Eong Tee, Teck Cheng Lim, Zaveri Ma, World Sci. Pub. Ltd. Singapore, 2005.

4. Springer Handbook of Nanotechnology - Bharat Bhusan Publisher: Springer- Verlag (2006)

5. Nanoscience and Nanotechnology: Fundamentals of Frontiers, Shubra Singh M.S. Ramachandra Rao, Wiley

6. Fabrication And Application of Nanomaterials, S Bandyopadhyay, McGraw Hill.

7. Nanomaterials: Mechanics and Mechanisms, Ramesh K.T Springer (India) Pvt. Ltd.

8. Nanomaterials And Nanocomposite: Synthesis Properties Characterization Techniques And Applications, Rajendra Kumar Goyal, T&F India.

9. An Introduction to Nanomaterials and Nanoscience, Asim K Das and Mahua Das, CBS Publication

10. Nanotechnology: An introduction to synthesis, properties and applications of nanomaterials, Thomas Varghese, K.M. Balakrishna, Atlantic Publishers and Distributors

11. Nanostructure and Nanomaterials, Parthasarathy B.K. Isha Books

12. Advances in Nanomaterials and Composites, Ravindra Singh Rana. Rajesh Purohit Priyanka Verma, Saraswati Rana, Deepen Banoriya, Walnut Publication.

13. A Textbook Of Nanoscience, Rakesh Kumar & Kamala Pati Tiwary, S.K. Kataria & Sons.

14. Textbook of nanosciene and nanotechnology, Murthy Raj, Shankar Rath Murd, Orient Blackswan Private Limited.

15. Springer Handbook of Nanotechnology - Bharat Bhusan Publisher: Springer- Verlag (2006)

16. Introduction to Nanoscience & Nanotechnology, Gabor L. Hornyak, Harry F. Tibbals,Joydeep Dutta, John J. Moore, CRC Press,

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d	Viva-Voce	6
Total		**100**

*Average of the best two test papers

KU8DSECHE405: THEORETICAL ASPECTS OF ADVANCED CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	4000	KU8DSCCHE305	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	2

Course Description:

This course delves into the theoretical aspects of advanced chemistry, focusing on topics such as quantum mechanics, spectroscopic data interpretation, and molecular structure analysis. Students will learn to apply quantum mechanics principles to solve complex chemistry problems, interpret spectroscopic data to determine compound structures, and evaluate electronic and molecular structures using advanced methods. Additionally, the course will develop research evaluation skills to critically assess contemporary literature in quantum chemistry and inorganic spectroscopy.

Course Prerequisite:Basic quantum chemistry and spectroscopy knowledge

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop a strong understanding of quantum mechanics principles to solve complex problems in chemistry.	U

2	Analyze and interpret spectroscopic data to determine the structure and properties of inorganic compounds.	E
3	Utilize approximate methods like variation and perturbation techniques to solve quantum mechanical problems	C
4	Evaluate electronic and molecular structures using advanced quantum chemical and spectroscopic methods.	A
5	Critically assess contemporary research literature involving quantum chemistry and inorganic spectroscopy.	E

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	2	1	0	2	1
CO 2	3	2	2	1	0	2	1
CO 3	1	0	2	2	1	0	2
CO 4	1	0	1	2	1	0	2
CO 5	3	3	2	2	1	0	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**ADVANCED QUANTUM CHEMISTRY**		
	1	Free particle in one-dimension: – Particle in a one-dimensional box with one finite potential wall – Average position and momentum of	

		particle in a box – Spectroscopy of particle in a box – Particle in a rectangular well (no derivation), Significance of the problem, Introduction to tunnelling	
	2	Electron spin and atomic structure: The postulate of spin by Uhlenbeck and Goud smith – Spin operators and Spin functions – construction of spin orbitals from spatial orbitals and spin functions – Pauli's anti-symmetry principle – Slater determinants – Spin-orbit interactions	
	3	Need of approximate methods in quantum chemistry: Variation method- variation theorem with proof illustration of variation theorem using a trial function. Variation treatment for the ground state of helium atom; Perturbation method: time-independent first order-correction to the energy and wave function	
	4	Atomic term symbols – Hund’s rules for ground electronic terms – Russel-Saunder’s coupling schemes. Spectroscopic term symbols for diatomic molecules	

2	**CHEMICAL BONDING**		**17**
	1	Born – Oppenheimer approximation, Essential principles of the MO method – MO treatment of Hydrogen ion (H2+ ion) and Hydrogen molecule, Valence bond treatment of the ground state of hydrogen molecule	
	2	Hybridization and geometry of molecules – methane, ethene, acetylene (bond angle, dihedral angle, bond length, and bond energy)	
	3	HMO theory of ethylene, butadiene, and benzene (aromaticity, bond order, charge density, and free valence calculations)	
	4	Ab Initio calculations – basic principles — basis sets – STO and GTO. Introduction to SCF methods – Hartree Theory and Hartree – Fock’s SCF	

3	**PHYSICAL METHODS IN INORGANIC SPECTROSCOPY- I**		**7**
	1	Study of inorganic compounds by the following diffraction methods – X-ray diffraction, neutron diffraction	
	2	Mossbauer spectroscopy: Doppler shift and recoil energy, isomer shift and its interpretation, quadrupole interactions, effect of magnetic field on Mossbauer spectra, applications to metal complexes, metal carbonyls, Fe-S cluster and tin compounds, etc. Partial quadrupole splitting and geometry of the complexes	

4	**PHYSICAL METHODS IN INORGANIC SPECTROSCOPY- II**		**8**
	1	Raman spectra and selection rules polarized and depolarized Raman lines, resonance Raman spectroscopy, use of symmetry to determine the number of active infrared and Raman lines, Application of Raman and Infrared selection rules to the determination of inorganic structures.SERS in Inorganic compounds	
	2	NMR Spectroscopy- Contact Shift and Psuedo Contact shift, Contrast Agents. Applications of NMR spectroscopy to inorganic compounds	
	3	Applications of Mass spectroscopy to inorganic compounds	

5	**TEACHER SPECIFIC MODULE** **TEACHER SPECIFIC MODULE-** ***(Suggestion)*: Physical methods in Inorganic Spectroscopy- III or any other relevant topic**	
	* Electronic paramagnetic resonance spectroscopy: Electronic Zeeman effect, Zeenian Hamiltonian and EPR transition energy. EPR spectrometers, presentation of spectra. Shift operators and the second order effect. Hyperfine splittings in isotropic systems, spin polarization mechanism and McConnell's relations Anisotropy in g-value, EPR of triplet states, zero field splitting, Kramer's rule, survey of EPR spectra of first row transition metal ion complexes- Nuclear Quadrupolar Resonance (NOR) Spectroscopy: Quadrupolar moment, energy lends of a quadrupolar	

	nuclease and effect of asymmetry parameters and energy lends. Effect of an external magnetic field, selected examples (any 3 examples) Electronic Spectroscopy- Calculation of Dq B and ß for complexes (Any 4 examples).	

Book References

1. Atkins, P., & Friedman, R., 2010. Molecular Quantum Mechanics. Oxford University Press.
2. Banwell, C. N., & McCash, E. M., 1994. Fundamentals of Molecular Spectroscopy. McGraw-Hill.
3. Brisdon, A. K., 1998. Inorganic Spectroscopic Methods. Oxford University Press.
4. Engel, T., 2006. Quantum Chemistry and Spectroscopy. Pearson Education.
5. Griffiths, D. J., & Schroeter, D. F., 2018. Introduction to Quantum Mechanics. Cambridge University Press.
6. Levine, I. N., 2009. Quantum Chemistry. Pearson Education.
7. Szabo, A., & Ostlund, N. S., 1996. Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory. Dover Publications.
8. Solomon, E. I., & Lever, A. B. P., eds., 1999. Inorganic Electronic Structure and Spectroscopy, Volume I: Methodology. John Wiley & Sons.

Web References

1. Khan Academy, Quantum Mechanics,www.khanacademy.org/science/physics/quantum-physics
2. MIT OpenCourseWare, Quantum Chemistry, ocw.mit.edu/courses/chemistry/5-61-physical-chemistry-fall-2017/index.htm
3. ChemLibreTexts, Physical Chemistry, chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Map%3A_Physical_Chemistry_(McQuarrie_and_Simon)
4. Royal Society of Chemistry, Spectroscopy Guides, www.rsc.org/learn-chemistry/resources/spectroscopy

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**70**
Continuous Evaluation (CCA)		**30**
Theory (CCA)		**30**
a)	Test Paper*	12
b)	Assignment	6
c)	Seminar, Viva-Voce	12
Total		100

*Average of the best two test papers

KU8DSECHE406: RESEARCH METHODOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VIII	DSE	400	KU8DSECHE406	4	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
4	0	30	70	100	3

Course Description: This course introduces research methodology, exploring research types, problem formulation, design principles, data collection and analysis, and scientific reporting. It covers ethics in research, including scientific misconduct and publication standards, emphasizing intellectual honesty and integrity. Practical guidance on literature review, thesis writing, and effective communication enhances students' research skills and prepares them for academic and professional research environments.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand various research types and methodologies, distinguishing between descriptive, analytical, applied, and fundamental research approaches effectively.	U
2	Develop skills to define and formulate research problems, utilizing extensive literature reviews and constructing well-grounded research hypotheses.	An

3	Gain proficiency in research design principles, data collection methods, and statistical analysis using relevant tools and software.	E
4	Master the structure and components of scientific reporting, including thesis writing, ethical considerations, and effective oral presentations.	C

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION AND TYPES OF RESEARCH**		**6**
	1	Motivation and objectives – Research methods vs Methodology.	
	2	Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.	

2		**RESEARCH FORMULATION**	**15**
	1	Defining and formulating the research problem-Selecting the problem - Necessity of defining the problem.	
	2		
	3	Importance of literature review in defining a problem – Literature review- Primary and secondary sources – reviews, treatise, monographs-patents – web as a source	
	4	Development of working hypothesis	

3		**RESEARCH DESIGN AND DATA ANALYSIS**	**12**
	1	Research design – Basic Principles- Need of research design –– Features of good design.	
	2	Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods	
	3	Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation	

4		**REPORTING AND THESIS WRITING**	**15**
	1	Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance- Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables, Bibliography, referencing and footnotes	
	2	Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication.	

5	**TEACHER SPECIFIC MODULE-** *RESEARCH ETHICS or any other topic relevant to the course can be included*		**12**
	1	Ethics-definition, scientific conduct- Ethics with respect to science and research, Intellectual honesty and research integrity	
	2	Scientific misconducts-falsification, fabrication and plagiarism (ffp) Redundant publications- duplicate and overlapping publications.	
	3	Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME etc. Conflicts of interest (Definition only).	
	4	Publication misconduct (Definition). Predatory publishers and journals.	
	5	Open access publications and initiatives. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder etc.	
	6	Use of plagiarism software like Turnitin, Urkund and other open-source software tools. Databases (Indexing And Citation) And Research Metrics (Impact Factor of Journal, h-index)	

Essential Readings:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.
2. Kothari, C.R., 1990. *Research Methodology: Methods and Techniques*. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. *Research Methodology*, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. *Research Methods: the concise knowledge base*, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. *Law relating to patents, trade marks, copyright designs and geographical indications*. Universal Law Publishing.

Additional Reading

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. *Research Methods: A Process of Inquiry*, Allyn and Bacon.
2. Carlos, C.M., 2000. *Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options*. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, *"Proposal Writing",* Sage Publications.
4. Day, R.A., 1992.*How to Write and Publish a Scientific Paper,* Cambridge University Press.
5. Fink, A., 2009. *Conducting Research Literature Reviews: From the Internet to Paper.* Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 *Practical Research: Planning and Design,* Prentice Hall.
7. Satarkar, S.V., 2000. *Intellectual property rights and copy right*. Ess Publications.

Web References:

1. American Psychological Association (APA), Research Methodology, www.apa.org/research/methodology
2. National Institutes of Health (NIH), Research Methods Resources, www.nih.gov/research-training/research-methods
3. SAGE Publications, Research Methods, www.sagepub.com/research-methods
4. Elsevier, Researcher Academy, www.researcheracademy.elsevier.com
5. ResearchGate, Research Design and Methods, www.researchgate.net/research-design-methods

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation		**70**
Continuous Evaluation		**30**
a)	*Test Paper	12
b)	Assignment	6
c)	Seminar	6
d)	Viva-Voce	6
Total		**100**

*Average of the best two test papers

MULTI DISCIPLINARY COURSES

KUIMDCCHE101: CHEMISTRY IN SERVICE TO MAN

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	MDC	100	**KUIMDCCHE101**	3	45

<table>
<tr><th colspan="2">Learning Approach (Hours/ Week)</th><th colspan="3">Marks Distribution</th><th rowspan="2">Duration of ESE (Hours)</th></tr>
<tr><th>Lecture/ Tutorial</th><th>Practical/ Internship</th><th>CE</th><th>ESE</th><th>Total</th></tr>
<tr><td>3</td><td>0</td><td>25</td><td>50</td><td>75</td><td>1.5</td></tr>
</table>

Course Description: This multidisciplinary course consists of topics covering chemistry in everyday life which includes polymers, glass, cement, cosmetics, medicines, and water treatment. The course will create interest in studying the role of chemistry in overall development.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To provide knowledge about the structure, properties and uses of plastics &polymers	U
2	To appreciate the scientific role of chemistry in industry and agriculture	A
3	To analyse the effect of fertilizers and pesticides and use them judiciously	An
4	Learn the judicious use of drugs	E
5	To analyse the scientific causes of water pollution and suggest the best water treatment method	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1		**PLASTICS & POLYMERS**	**12**
	1	Polymers- Types of polymers -natural & synthetic polymers-characteristics and examples.	
	2	General characteristics and applications of polymers such as Polythene (LDPE &HDPE), polypropylene, PVC, Poly styrene, Poly vinyl acetate, PET, Teflon, Terrylene, Nylons (Nylon 6 and Nylone 66), PMMA and Bakelite	
	3	Artificial fibres -examples Plastics- Thermoplastics and thermosetting plastics- Characteristics and example- Elastomers, Natural and synthetic rubbers-Vulcanization, Characteristics and uses of Buna, Butyl, Chloroprene, SBR, Silicone & Thiokol rubbers	
	4	Biodegradable polymers-examples-benefits of biodegradable plastics. Importance of plastic recycling	

2		**FERTILIZERS & INSECTICIDES**	**6**
	1	Natural, synthetic mixed and NPK fertilizers – examples- making of NPK mixture - Impact of excessive use of fertilizers on environment – Bio fertilizers – plant growth hormones	
	2	Pesticides and their classification- examples- Excessive use of pesticides. Environmental hazards- Safe handling of pesticides. Insect repellants-Pheromones	

3	**CEMENT, GLASS, FUELS& BATTERIES**		**10**
	1	Cement- Classification – Portland cement – Raw materials – manufacture – setting and hardening	
		Glass – Different types – manufacture – raw materials – manufacture of ordinary glass – annealing	
		Definition and classification of fuels – Characteristics of good fuel – Combustion - Calorific value – wood- coal – origin of coal- - petroleum- origin –fractional distillation –different fractions, their composition & uses	
	2	Natural gas, Biogas & LPG – their composition and uses. Pollution due to burning of fossil fuel Batteries and fuel cells – Different types – Applications in modern life	
4	**COSMETICS and MEDICINAL CHEMISTRY**		**8**
	1	Cosmetics – Cleansing cream,cold cream, bleaching &vanishing creams, perfumes, talcum powder, toothpaste, deodorants, lipstick –ingredients. Harmful chemicals in cosmetics	
	2	Drugs- classification- Sulpha drugs - mode of actions, examples and uses. Antibiotics Discovery, examples and importance. Misuse of antibiotics.	
		Antipyretics, analgesics and anti-inflammatory agents, narcotic analgesics Anesthetic, Antiseptic, Anti histamines and tranquillizers, - examples, and abuse. Disinfectant & germicides examples, importance and uses	

5	**TEACHER SPECIFIC MODULE -WATER TREATMENT**		**9**
	1	Water sources – specifications of drinking water- impurities in water- characteristics imparted by impurities – Hardness – Disadvantages of hard water in domestic and industrial use Softening methods-lime soda, zeolite and ion exchange methods (principle only)	
	2	Drinking water or municipal water- methods of purification- removal of microorganisms- Desalination of brackish water-electro dialysis, reverse osmosis- Importance of dissolved oxygen, BOD & COD-Municipal Sewage treatment	

Essential Readings:

1. J Barrett: Chemistry in your environment-User friendly, Simplified Science.
2. Howard L White: Introduction to Industrial Chemistry
3. David M Targarden: Polymer Chemistry – Introduction to an indispensible science.
4. M.S.Yadav: Synthetic drugs
5. Samuel Delvin: Dyes and Pigments
6. Alexander Findlay: Chemistry in the service of man
7. S. K Honda: Principle of pesticide chemistry
8. M.M.Chakrabarthy: Chemistry and Technology of oils and fats
9. Shalini Sareen: Chemotherapeutic agents
10. P.K.Ray: Pollution and health
11. Vanessa Good ship: Introduction to plastic recycling
12. Randy Schmetter and Perry Romanoswski: Beginning cosmetic chemistry.
13. V Jain: Organic polymer chemistry
14. V K Selva raj: Advanced polymer chemistry
15. Jr Charles E Carraher: Introduction to polymer chemistry
16. Shashi Chawla: A Textbook of Engineering Chemistry

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar,Viva-Voce	10
Total		75

*Average of the best two test papers

KUIMDCCHE102: ENVIRONMENTAL STUDIES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	MDC	100	**KUIMDCCHE102**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: This multidisciplinary course give insight to the learners about environmental segments, air pollution, soil pollution, water pollution, etc. The course also consists of renewable energy sources and importance of biotechnology in environmental protection.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To provide knowledge about the environmental segments, their structure and composition.	U
2	To create scientific awareness regarding the source, effects and sink of pollutants in the environment.	C
3	To study about the energy recourses, the role of fuel consumption in environmental pollution, importance of energy management and search for eco-friendly and non-conventional energy sources.	A
4	To inculcate among the student's importance of environmental protection, & environment friendly lifestyle for a better living and better future	C

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		ENVIRONMENTAL SEGMENTS	**6**
	1	Lithosphere: soil formation – components of soils. Hydrosphere: Hydrological cycle, water and river water composition. Fresh water – surface water and ground water	
	2	Biosphere- Atmosphere-regions of Atmosphere- temperature and composition in different regions – Troposphere, stratosphere, Mesosphere, Thermosphere	

2		**AIR POLLUTION**	**8**
	1	Sources – pollutants –CO, NOx, Sox, Hydrocarbons, Particulates. Effect on ecosystem	
	2	Ozone layer –importance, Ozone Depletion-Control measures- Acid rain-control of acid rain	
	3	Greenhouse effect-global warming, -photochemical smog- effect pollution on plants and human beings- Control of air pollution	
	4	Noise Pollution – physiological response to noise, Noise categories- effect of noise – biological effects	

3		**WATER POLLUTION& SOIL POLLUTION**	**14**
	1	Sources –Industrial effluents- agriculture discharge - oil spills-heavy metal -pesticides-biomagnifications and bioaccumulations	

	2	Experimental determination of dissolved oxygen in water, chemical oxygen demand (COD) and biochemical oxygen 76 76 demand (BOD)- control of water pollution- ISI/BIS standards of drinking water. 6hours	
	1	Sources by industrial and urban wastes, radioactive pollutants, plastics heavy metals.Poisoning by heavy metals – Mina- matha&itai-Itai diseases. Control of soil pollution - Solid waste Management.	
	2	Thermal pollution definition-sources of thermal pollution, harmful effect of thermal pollution prevention of thermal pollution	

4	**ENERGY SOURCES**		**8**
	1	fossil fuels, nuclear fission- Solar energy – use of solar energy in spaceheating and water heating.	
	2	Production of electricity using solar energy. Solar trough collections-solar pond solar energy for driving vehicles, Power from indirect solar energy – Hydro power- wind power- Biomass energy	

5	**ENVIRONMENT AND PUBLIC HEALTH (Teacher Specific Module)**		**9**
	1	Climate and health-Hazardous products – occupational hazards - infectious diseases- water borne diseases, vector borne diseases -Risks due to chemicals in food, cancer and environment.	
	2	Biotechnology and its application in environmental protection - biological de-odourisation, biological purification of contaminated air.	

Essential Readings:

1. Textbook of Environmental Studies for undergraduate courses – Erach Bharucha

2. Essential Environmental studies- S. P. Misra – S. N. Pandey
3. Environmental chemistry and pollution control – S.S Dara
4. Environmental chemistry- Peter O' Neill
5. Environmental chemistry – B.K. Sharma edition)
6. Fundamental concepts of environmental chemistry – G.S Sodhi
7. Environmental Chemistry. A.K D

Assessment Rubrics

Evaluation Type		Marks
End Semester Evaluation (ESE)		50
Continuous Evaluation (CCA)		25
Theory (CCA)		25
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU2MDCCHE101: CHEMISTRY OF COSMETICS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
1	MDC	100	**KU2MDCCHE101**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: Cosmetic plays an important role in our everyday lives as they make an individual's appearance more attractive and boost one's self-esteem and confidence. Keeping in view the tremendous potential which the cosmetic industry has today around the globe, this course will be useful for introducing students of Chemistry honours to the world of cosmetic chemistry. This has been designed to impart the theoretical and practical knowledge on basic principles of cosmetic chemistry, manufacture, formulation of various cosmetic products.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	By the end of this course, the students will be able to Learn basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products.	C
2	Learn the use of safe, economic and body-friendly cosmetics.	A
3	Prepare new innovative formulation for real life challenges.	C

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**COSMETICS**		7
	1	Cosmetics- Definition, History, Classification, Ingredients, Nomenclature, Regulations.	

2	**FACE PREPARATION& SKIN PREPARATION**		14
	1	Face Preparation: Structure of skin, Face powder, Compact powder, Talcum powder, composition, methods of preparation	
		Skin Preparation: Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream, composition, methods of preparation	

3	**HAIR PREPARATION**		8
	1	Hair preparation: Structure of hair, classification of hair, Hair dye-classification – temporary, semi-permanent, demi permanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners, composition, methods of preparation	

4	**COLORED PREPARATION**		**7**
	1	Coloured preparation: Nail preparation Structure of nail, Nail lacquers, Nail polish remover Lipsticks, composition, methods of preparation	

5	**TEACHER SPECIFIC MODULE- PERSONAL HYGIENE PRODUCTS**		**9**
	1	Personal hygiene products: Antiperspirants and deodorants, composition, methods of preparation-Oral hygiene products, mouth wash, flavours and essential oils	

Essential Readings:

1. Barel, A.O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press.
2. Garud, A.; Sharma, P.K.; Garud, N. (2012),Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
4. Butler, H. (2000),Poucher's Perfumes, Cosmetic and Soap, Springer
5. Kumari, R.(2018),Chemistry of Cosmetics, Prestige Publisher.

Additional Resources:

1. Flick,E.W.(1990),Cosmetic and toiletry formulations, Noyes Publications / William Andrew Publishing.

2. Natural Ingredients for Cosmetics; EU Survey 2005

3. Formulation Guide for cosmetics; The Nisshin OilliO Group, Ltd.

4. Functional Ingredients & Formulated Products for Cosmetics & Pharmaceuticals; NOF Corporation

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU2MDCCHE102: CHEMISTRY IN EVERYDAY LIFE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
2	MDC	100	**KU2MDCCHE102**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship Tutorial	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: The present MDC deals with theory and hands on experience for the manufacture of various hygiene products such as soap, dish wash, hand wash, and shampoo. They will be able to understand the food quality and the adulterants in it.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	The learner will get insight about the scientific cleaning action of soaps and detergents.	U
2	They will categorise the ingredients of soap, shampoo, shaving cream and face cream.	An
3	Students will be able to manufacture the hygiene products such as soap, hand wash, dish wash and detergent powders to acquire life skill.	C
4	Learner will be able to understand the harmful food additives. They will formulate experiments to find out the same.	C

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**SOAPS AND DETERGENTS**	**7**
	1	Cleansing Agents: Soaps - Hard and soft soaps - Alkali content – TFM - Detergents (classification) – Cleaning action - Advantages and disadvantages of soaps and detergents	
2		**OTHER CLEANSING AGENTS**	7
	1	Shaving creams, Shampoos: Ingredients and functions - Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos). Toothpaste: Composition and health effects.	
		COSMETICS	**10**
3	1	Cosmetics: Hair dye: Chemicals used and its harmful effects. Face and skin powders: Types, ingredients and functions-Cleansing creams: Cold creams, vanishing creams and bleach creams	
	2	Perfumes, antiperspirants, Sunscreen preparations, nail polishes, lipsticks, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics	

4	**FOOD**		**12**
	1	Common Adulterants in Different Foods: Milk and milk products, vegetable oils, cereals, tea, coffee powder, chili powder and beverages.	
	2	Food Additives and food preservatives – Commonly used permitted and non-permitted food colours	
	3	Artificial sweeteners – Taste enhancers - Artificial ripening of fruits and its side effects	
	4	Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits	

5	TEACHER SPECIFIC MODULE		**9**
	1	Manufacturing of hand wash, dish wash, face wash and detergent powder/Any other relevant topics of teacher's choice (HANDS ON TRAINING)	

Essential Readings:

1) 1. B.K. Sharma, Industrial Chemistry, 11th Edition, Goel publishing House, Meerut, 2000.

2) Lillian Hoagland Meyer, Food Chemistry, 1st Edition, CBS Publishers & Distributors, New Delhi, 2004.

3) Brian A. Fox, Allan G. Cameron and Edward Arnold, Food Science, Nutrition and Health, 6th Edition, Edward Arnold, London, 1995.

4) . M.S.R. Winter, A Consumer's Dictionary of Cosmetic Ingredients, 7th Edition, Three Rivers Press, New York, 2009.

5) 6. Alexander Findlay: Chemistry in the service of man

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU2MDCPCH103: PLASTIC WASTE MANAGEMENT AND BIODEGRADABLE POLYMERS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
II	MDC	100	**KU2MDCPCH103**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: The course comprises modules on materials like paints, lubricants, adhesives, pigments, biopolymers, pollution due to polymers , plastic waste management and a teacher specific module.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand the manufacture of paints and varnishes	U
2	Understand recent advances in polymers	U
3	Evaluate the various methods of plastic waste management and apply it in daily life.	A
4	To understand factors that influence the degradation of polymers.	U
5	To learn about biopolymers	

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)*

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**PAINTS, LUBRICANTS, ADHESIVES AND PIGMENTS**	9
	1	**Paints:** Classification**,** primary constituents and manufacturing of paint. Emulsion paint - constituents and advantages. Latex paints and fire-retardant paints. Solvents and thinners.	
	2	**Lubricants:** Properties and classification, additives for lubricating oil, lubricants of mineral origin, lubricating grease and solid lubricants.	
	3	**Adhesives:** The Process of Bonding- Classification and preparation of adhesives, synthetic resin adhesives, and rubber-based adhesives, uses of adhesives	
	4	**Pigments**: Characteristics and uses of titanium dioxide, ultra marine blue and red lead	
2		**BIOPOLYMERS AND BIODEGRADABLE POLYMER**	9

	1	Preparation, properties and applications of cellulose derivatives: cotton and rayon:	
	2	cellulose plastics: cellulose acetate, cellulose nitrate & regenerated cellulose	
	3	Structure and applications of starch, shellac, chitin and chitosan.	
	4	Commercial applications of natural polymers- Biopolymers - biodegradable polymers - Polymers in medical field.	
3	**POLLUTION DUE TO PLASTICS**		9
	1	Water, Air, Soil pollution by polymers	
	2	Polymer degradation - Type of degradation - Thermal degradation - factors affecting thermal stability – Polymer degradation involving substituent groups-	
	3	mechanical degradation– Degradation by ultrasonic waves - Photodegradation - Photostabiiizers	
	4	Degradation by high energy radiation - Oxidative degradation — antioxidants -	
4	**PLASTIC WASTE MANAGEMENT AND RECYCLING**		9
	1	Plastic Waste management -Chemical recycling	
	2	Types of recycling (1 °, 2°, 3° & quartemary)	
	3	-incineration – Pyrolysis- fuels from plastic waste.	
	4	Recycling codes – development for recycled materials.	

5	**TEACHER SPECIFIC MODULE - ADVANCES IN POLYMERS**	9
	High temperature polymers - Conducting polymers- Polymers used as adhesive and coatings, liquid crystalline polymers, Vulcanization of rubber.	

References

1.B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut

2.Industrial chemistry B.N Chakrabarthy

3.Polymer Chemistry - M.G Arora & M. Singh

4.Principles of polymerisation, P. Bahadhur, N.V. Sastry, Narosa Publishing House, New Delhi – 2002

5.Polymer Chemistry - Properties and applications, Andrew Peacock, Allison calhoun,Hanser Publishers, Munich 2006

6.Nabil Mustafa - "Plastic waste management" - Marcel Dekker Inc – 1993

7.Chandra. R and Adab. A. Rubber and Plastic waste, CBS Publishers & Distributers, New Delhi 1994

8. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

9. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU3MDCCHE101: NANOMATERIALS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	MDC	100	KU3MDCCHE101	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
3	-	25	50	75	1.5

Course Description: The present MDC deals with the study of history and developments of nanotechnology. Laboratory and theoretical understandings of various methods for the synthesis of nano materials were included.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To make an objective judgment of the scientific importance and technological potential of developments in micro- and nanotechnologies.	U
2	To perform a range of scientific activities related to Nanoscience and Nanotechnology.	C
3	To prepare the student to take the challenge of meeting national needs and international needs.	An
4	Acquire skill in synthesising nano materials for challenging real life problems	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7
CO 1	3	2	3	2	2	2	2
CO 2	3	2	2	2	2	3	2
CO 3	3	1	3	2	1	3	2
CO4	3	2	3	2	2	3	2

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**DEFINITION AND SCOPE OF NANO SCIENCE**		**8**
	1	Nanotechnology- Definition, History-Timeline and Milestones, Overview of different nanomaterials available.	
	2	Potential uses of nanomaterials in electronics, robotics, computers, sensors in textiles, sports equipment, mobile electronic devices, vehicles and transportation. Medical applications of nanomaterials.	

2	**NANO CHEMISTRY**		**10**
	1	Novel physical chemistry related to nanoparticles such as colloids and clusters: different equilibrium structures, quantum effects, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state	
	2	Exploitation of self-assembly and self-organization to design functional structures in 1D, 2D or 3D structures-Examples to emphasize on self-assembled monolayers	

3	**SYNTHESIS OF NANOMATERIALS**		**10**
	1	Nanomaterials (Nanoparticles, nanoclusters, quantum dots synthesis): Preparation and Characterization: "Top-Down" and "Bottom-Up" approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis	
	2	Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sono chemical synthesis; Electrochemical synthesis, Photochemical synthesis, Synthesis in supercritical fluids, current state-of-the-art.	
4	**APPLICATIONS OF NANOMATERIALS**		**8**
	1	Solar energy conversion, storage and catalysis-Nanoelectronics, nano sensors, nanomedicine, nanobiotechnology	
	2	computational nanotechnology, Nano magnetism, Carbon Nanotubes, Nanodevices, Spintronics, self-cleaning nanoparticles	

5	**TEACHER SPECIFIC MODULE**		**9**
	1	NANO SYNTHESIS**:** Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microwave heating synthesis-Biosynthesis of nanoparticles	

Essential Readings:

1. G.L.Hornyak, J.Dutta, H.F.Tibbals, A.K.Rao, Introduction to Nanoscience, CRC Press, 2008.

2. A.Nabok, Organic and Inorganic Nanostructures, Artech House 2005.

3.C.Dupas, P.Houdy, M.Lahmani, Nanoscience: Nanotechnologies and Nanophysics,Springer-Verlag Berlin Heidelberg 2007

4. Hari Singh Nalwa, Nanostructured Materials and Nanotechnology, Academic Press,2002
5. Nanotechnology- Richard Brooker,EARL Boyson- Wiley Dream Tech India
6. Advances in Nanoscience and Nanotechnology- Dr.AshuthoshSharma,Dr.BellariCSIR Publication 2004
7. Nanotechnology (Malayalam) – Anwar Sadath- DC Books
8. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge, UK 2005.
9. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
10. 'Handbook of Theoretical and Computational Nanotechnology, Eds. Michael Rieth.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar,Viva-Voce	10
Total		75

KU3MDCCHE102: DRUGS – USE & ABUSE

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	MDC	100	**KU3MDCCHE102**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: This MDC course consists of Definitions, Classifications and examples of drugs- Roots of drug administrations and their metabolism. The module also consists of synthetic drugs, their mode of action, finally use and abuse of drugs.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Impart scientific knowledge regarding the history, classification uses of different drugs.	U
2	To analyse the mode of action of drugs and understand the dose response relationship	An
3	To make the students aware about the side effects of modern drugs.	E
4	To create awareness regarding both misuse of drugs and its harmful effectsto safeguard life.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**INTRODUCTION**	**6**
	1	Drugs- Definitions, Classifications and examples of drugs- Roots of drug administrations, Enteral, parenteral and topical routes.	
	2	Bioavailability of drugs -Advantage and disadvantage of various routes of administrations	

2		**PHARMACOKINETICS AND PHARMACO DYNAMICS**	**11**
	1	Definition of Pharmacokinetics- A brief explanation of Absorption, Distribution Metabolism (Biotransformation) and Excretion-First pass metabolism. Definition of Pharmaco dynamics.	
	2	Modes of drug action, Receptors- Agonist, Antagonist and Inverse agonists. Types of receptors (Brief explanation of types of receptors) , Dose response relationship ,Lethal Dose , EC 50 or ED 50 Therapeutic index , Types of Drug interactions , Drug tolerance, Placebo , Adverse drug reactions	

3		**SYNTHETIC DRUGS**	**10**
	1	Examples of Antipyretics, analgesics and anti-inflammatory agents. A brief explanation of their mode of action. Anti biotics- Discovery and its importance. Examples of antibiotics – Antibiotic misuse. Anti histamines- examples, Anaesthetics, anti-malarial, Diuretics and anti-ulcer drugs.	

	2	Chemotherapy Drugs acting on Central Nervous System, Drugs acting on Peripheral Nervous System. Cardiovascular drugs classification and examples	
4	**DRUGS OF ABUSE**		**9**
	1	Classification of drugs of abuse –Narcotic analgesic CNS Stimulants examples and effects, Depressants, Hallucinogens examples and effects, Sedatives	
	2	Hypnotics example and effects, Opioids, Cannabis and Inhalants examples and effects-Drug dependence, withdrawal symptoms, tolerance and addiction	

5	**TEACHER SPECIFIC MODULE-** **Directions:** Miscellaneous drugs or any other topic relevant to the course according to teacher's choice can be included		**9**
	1	Antiseptics and disinfectants, Vaccines, chelating agents, Vitamins and Minerals, Enzymes and Hormones, Treatment in poisoning.	

Essential Readings:

1. Drugs – G.L. David Kurupadanam,Vijayaprasad, KVaraphiipatrasad Rao et.al.
2. Medical Pharmacology- Padmaja Udayakumar
3. Essentials of Medicinal Pharmacology - Tripathi
4. Medicinal Chemistry – Ashuthosh Kar
5.Dispensing Pharmacy –Kapoor & Gunn
6. A Textbook of Forensic Pharmacy – B.M. Mithal.
7. A Textbook of Organic and Pharmaceutical Chemistry - Wilson & Gisvold.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

SKILL ENHANCEMENT COURSES

KU4SECCHE101: GREEN METHODS IN CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	100	KU4SECCHE101	3	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/Tutorial	Practical/ Internship	CE	ESE	Total	
2	2	30	45	75	1.5

Course Description: The course comprises of modules on introduction to green chemistry, green methods and a teacher specific module on preferred use of renewable raw materials

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Design and develop materials/ processes that reduce the use and generation of hazardous substances in industry	A
2	Describe how injudicious use of chemicals can have an adverse/potentially damaging effect on humans and the environment	U
3	Propose ideas for innovative approaches to environmental and societal challenges.	A

4	Critically analyse the existing traditional chemical pathways/processes and creatively think about bringing environmentally benign reformations in these protocols	An
5	Convert biomass into valuable chemicals through green technologies.	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**GREEN CHEMISTRY**		**10**
	1	Green chemistry-Introduction-significance-12 principles	
	2	Introduction to the prevention of waste/ byproducts and waste/ pollution prevention hierarchy-Provide the scheme for the traditional as well as	

		green method for the synthesis of ibuprofen and ask students to compare the amount and hazards of waste generated in both the processes	
	3	Principle and calculation of atom economy. Use of molecular model kit to simulate the reaction Preparation of propene by two methods can be studied (I) Hoffman elimination (II) Dehydration of propanol The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy	

2	**GREEN METHODS-I**		**16**
	1	Prevention/ minimization of hazardous/ toxic products reducing toxicity a) Nitration of salicylic acid using green method Ca $(NO_3)_2$ b) Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts (c) Preparation of dibenzalacetone by cross aldol condensation reaction using base catalysed green method (d) Acetylation of primary aromatic amine using the green method	
	2	Microscale analysis: In analysis of organic compounds	
	3	Double burette method in volumetric analysis	

3	**GREEN METHODS-II**		**12**
	1	Use of Green solvents and comparison of greenness of solvents	

		(a) Explain about supercritical fluids with special reference to carbon dioxide. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice (b) Introduction to water as a solvent for chemical reactions. Preparation of Manganese (III)acetylacetonate using green method (c) Advantages and applications of solventless processes in organic reactions (i) Benzil- Benzilic acid rearrangement in solid State under solvent-free Condition (ii) Mechanochemical solvent free, solid–solid synthesis of azomethine using p- toluidine and o-vanillin/p-vanillin	

4	**GREEN METHODS-III**		**10**
	1	Alternative sources of energy: use of microwaves and photochemical energy (a) Photoreduction of benzophenone to benzo pinacol in the presence of sunlight. (b) Microwave assisted ammonium formate-mediated Knoevenagel reaction: p-anisaldehyde, ethyl cyanoacetate, ammonium formate	

5	**TEACHER SPECIFIC MODULE -PREFERRED USE OF RENEWABLE RAW MATERIALS**	**12**
	Directions: Illustrate the preparation of materials from renewable sources rather than depleting sources	
	Preparation of biodiesel from waste cooking oil and characterization.	

Essential Readings:

1.Sidhwani, I.T; Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India PvtLtd

2. Lancaster, M. (2016), Green Chemistry: An Introductory Text, 3rd Ed., RSC Publishing.

3. Matlack, A.S. (2010), Introduction to Green Chemistry, 2nd Ed., CRC Press.

4.Alhuwalia, V.K.; Kidwai, M.R. (2012), New Trends in Green chemistry, Kluwer Academic Publishers, Springer.

5. Anastas, P.T., Warner, J.C. (2014), Green Chemistry, Theory and Practice, Oxford University Press.

Practicals:

1.Kirchoff, M., Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment, American Chemical Society, Washington DC.

2.Sharma, R.K., Sidhwani, I.T., Chaudhari, M.K. (2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.

3.D.L., Lamponam, G.H., Kriz, G.S.W. (2006), Introduction to organic Laboratory Technique- A Microscale approach, 4 th Edition, Brooks-Cole Laboratory Series for Organic chemistry.

4.Sidhwani, I.T.; Saini, G.; Chowdhury, S. Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from Sidhwani, I.T; Sharma, R.K. (2020), An Introductory Text on Green Chemistry, Wiley India PvtLtd.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**45 (35T+10P)**
Continuous Evaluation (CCA)		**30 (15T+15P)**
Theory		**15**
a)	Test Paper*	9
b)	Assignment	3
c)	Viva-Voce	3
Practical15		
a)	Record	5
b)	Viva-Voce	5
c)	Skill	5
Total		**75**

*Average of the best two test papers

KU4SECCHE102: FUEL CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	100	KU4SECCHE102	3	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
2	2	30	45	75	1.5

Course Description: The course comprises of modules on history of fuels, coal, petroleum and petrochemical industries, gases and lubricants and a teacher specific module giving hands on experience through practical sessions, field visits, surveys and presentations**.**

Course Prerequisite:

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Students would be able to understand the different types of fuels obtained from renewable, non-renewable and artificial sources.	U
2	Classify the various types of fuels like liquid, solid and gaseous fuels available.	U
3	Understand the scientific Importance of renewable fuel sources.	U
4	Scientific knowledge on various types of fuels such as coal, petroleum and non-petroleum, petrochemicals and their uses will be enhanced after studying the course.	A

5	Knowledge on lubricants and their applications and properties	U
6	Develop skill in checking quality of lubricants.	A
7	Able to evaluate different fuels and their advantages and disadvantages and arrive at the most appropriate fuel choice which is environmentally benign.	E

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**HISTORY OF FUELS**		**7**
	1	Review of energy sources (renewable and non-renewable). History of solid, liquid and gaseous fuels	
	2	Definitions and properties of solid fuels, Definitions and properties of liquid and gaseous fuels	
	3	Production and Consumption pattern of fuels Various measurement techniques	

2	**COAL**		**7**
	1	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value-Introduction of coal, uses of coal (fuel and non-fuel) in various industries (at least three examples), its types and composition, carbonization of coal	
	2	Coal gas, producer gas and water gas—composition and their uses, uses of coal-tar based chemicals	
	3	Requisites of a good metallurgical coke, Coal liquefaction and Solvent refining	

3		**PETROLEUM AND PETROCHEMICAL INDUSTRY**	**8**
	1	Composition of crude petroleum, Refining and different types of petroleum products and their applications	
	2	Fractional distillation (principle and process), Cracking (thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, biofuels derived from biomass),	
	3	Fuel from waste, synthetic fuels (gaseous and liquids), clean fuels,	
	4	Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene	

4		**GASES AND LUBRICANTS**	**8**
	1	Natural gas and LPG, Producer gas, Water gas, Hydrogen, Acetylene	
	2	Classification of lubricants, lubricating oils (conducting and non-conducting) -Solid and semisolid lubricants, synthetic lubricants	
	3	Properties of lubricants (viscosity index, cloud point, pore point) and their determination	

5		**TEACHER SPECIFIC MODULE**	**30**
		Laboratory practices& **a)** Study of properties of lubricants-viscosity index, cloud point, pore point **b)** distillation process **c)** Preparation of hydrogen gas, any 2 simple methods **d)** Hydrogen a clean and versatile fuel-presentation **Open ended** (any 2 from **e,f** and **g)** **e)** Field visit (fuel from waste) and report	

		f) Surveys to compare the advantages and disadvantages of CNG and LPG **g)** Setting of biogas plant / surveys to experience its advantage as a fuel source for domestic purposes.	

Essential Readings:

1.Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2.Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3.Sharma, B.K.& Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996)
4.Vermani, O. P.; Narula, A. K. (2004), Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.
5.Bhatia, S. C. (2004), Chemical Process Industries, Vol. I & II, CBS Publishers, New Delhi.
6.Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications.
7.A. Bahl and B.S. Bahl, Advanced Organic Chemistry, 1st Multicolour Edition, S. Chand &Company, New Delhi, 2010 3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra,
8.A Textbook of Organic Chemistry, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**45 (35T+10P)**
Continuous Evaluation (CCA)		**30 (15T+15P)**
Theory		**15**
a)	Test Paper*	9
b)	Assignment	3
c)	Viva-Voce	3
Practical15		
a)	Record	5
b)	Viva-Voce	5
c)	skill	5
Total		**75**

***Average of best two test papers**

KU4SECPCH103: POLYMER SCIENCE AND LATEX TECHNOLOGY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	100	**KU4SECPCH103**	3	60

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
2	2	30	45	75	1.5

Course Description: The course comprises modules on natural, synthetic and commercial polymers, latex technology and a teacher specific module on polymer and latex analysis

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Develop a good understanding about different types of polymers	U
2	Describe various methods used for latex technology and compounding of rubber.	U
3	Develop skill in preparing polymers	A
4	Acquire practical skill to identify different types of plastics and rubbers	A
5	Acquire skill in latex analysis	A

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**NATURAL & SYNTHETIC POLYMERS**		**10**
	1	Natural rubber - structure and properties of NR and Gutta percha	
	2	Manufacture, general properties and applications of SBR, Polyisoprene, Polybutadiene, Butyl rubber-Ethylene propylene rubber- Neoprene rubber	
	3	Specialty rubbers: Silicon rubbers- Nitrile rubbers- polyacrylic rubbers- polyurethane rubbers-	
	4	Hypalon, reclaimed rubber- foam rubber.	
2	**COMMERCIAL POLYMERS -I**		**5**

	1	Properties and applications of the following plastics - LDPE, HDPE, polypropylene, polystyrene	
	2	PVC, PTFE, PMMA, PAN, Polyacrylic acid, Polyamides -Nylon 6,6 and Nylon 6.	
3	**COMMERCIAL POLYMERS -II**		**5**
	1	Aromatic polyamides - Nomex, Kevlar- Polyesters –PET and Glyptal Polycarbonates - Polysulphones – PPO	
	2	Phenolic resins-Novalac formation - Resole formation. Urea formaldehyde, Melamine formaldehyde resins.	
4	**LATEX TECHNOLOGY**		**1 0**
	1	Rubber latex -Latex processing - Preserved field Latex-Latex concentration by processes like centrifuging and creaming	
	2	Preparation of Ribbed Smoked Sheets –Superior processing rubbers	
	3	Rubber processing - Mastication & compounding – additives used – manufacture techniques of rubber goods from latex -dipping - casting and moulding-	
	4	Latex foam rubber. Vulcanization -Sulphur vulcanization and non-Sulphur vulcanization. Unique properties of Rubber	
5	**TEACHER SPECIFIC MODULE -POLYMER AND LATEX ANALYSIS**		**30**

	1.Identification of Plastic and Rubbers (5 samples) 2.Preparation of Polymer - PMMA, Polyacrylamide, Polyaniline, Phenol formaldehyde resin, Urea formaldehyde resin, Aniline - formaldehyde resin. 3.Latex Analysis-Determination of Dry Rubber Content 4.Total solid content & Ammonia Content of latex **Open ended** 5.Relative Viscosity measurement of Polymer solutions or 6.Determination of molecular weight by Viscometer - polyvinyl Alcohol	

Reference

1.Textbook of polymer science - P.L Nayak and S. Lenka

2.Physical Chemistry of polymers - A Tager

3.A textbook of Polymer Science - F. W. Billmeyer.

4.Polymer Science - V.R. Gowariker, N.V. Viswanathan, J. Sreedhar

5.Principles of Polymers Chemistry - P.J. Flory

6.Polymer Chemistry - M.G Arora & M. Singh

7.Principles of polymerisation, P. Bahadhur, N.V. Sastry, Narosa Publishing House, New Delhi – 2002

8.Experiments in polymer science, D.G Hundiwale, V.D. Athawale, U. R Kapadi, V.V. Gite New age International Pvt. Ltd - New Delhi - 2009

9.Polymer Chemistry - Practical approach in Chemistry, F.J. Davis, Oxford University press.

Assessment Rubrics:

Evaluation Type	Marks
End Semester Evaluation (ESE)	**45 (35T+10P)**
Continuous Evaluation (CCA)	**30 (15T+15P)**
Theory	**15**

a)	Test Paper*	9
b)	Assignment	3
c)	Viva-Voce	3
Practical		**15**
a)	Record	5
b)	Viva-Voce	5
c)	skill	5
Total		**75**

KU5SECCHE301: COSMETICS AND PERSONAL CARE PRODUCTS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
IV	SEC	100	**KU5SECCHE301**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	-	25	50	75	1.5

Course Description: Cosmetics and personal care products have much importance in modern society and is particularly important in the era of climatic change. This course provides awareness of personal care products, uses, harmful effects, caution about overuse and chemistry behind the 'Cosmetics'.

Course Prerequisite: Basic idea about the natural products of plant and animal origin which helps to protect the skin and hair.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Comprehensive understanding on Cosmetics to identify the best quality personal care products and the scope of cosmetic industry	An
2	A good understanding about the constitution of various cosmetics to analyse them to use judiciously	A
3	Learn the chemistry employed in personal care products and major constituents in cosmetics and explain harmful side effects of cosmetics and their cautious and judicious usage in daily life.	A

4	Identify the quality of cosmetic products by learning testing, packaging and labelling there by acquiring skill.	A
5	Analyse the different dental products, compare the qualities of synthetic and herbal products to choose them wisely.	A

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION TO COSMETICS**		**8**
	1	Introduction, history of cosmetics, product types - aerosol, emulsion, gel, non-aerosol, solution and stick., cosmetic regulations and laws -	
	2	Quality control. Testing-clinical testing, consumer testing, Draize test, efficacy testing, RIPT, salon testing	

	3	Herbal cosmetics - herbs used in cosmetics, hazardous chemicals in cosmetics	
	4	Cosmetic packaging and labelling, how to read PCP (Personal Care Product) label	
	5	Food, Drug and Cosmetic Act (FD&C Act), Fair Packaging and Labeling Act (FPLA)- Cosmetic industry - a boon for Indian economy.	

2		**PERFUMES & HAIR CARE PRODUCTS& SKIN CARE PRODUCTS**	**15**
	1	Types of perfumes- raw materials in perfumery-production of natural perfumes, -flower perfumes-Deodorants-anti-perspirants.	
	2	Hair care and nutrition, shampoos – principal constituents – thickeners and foam stabilizers – perfumes – preservatives - conditioning agents – anti-dandruff shampoos	
	3	Hair cream – composition – hair gels - hair dyes – types – constituents - dye removals.	
	4	Skin care basics and routine- acne on skin, prevention and remedies-skin cleansers - face wash – classifications- toners – cold cream – cleansing milk	
	5	moisturizers – hand and body lotions - skin tan – sunscreen lotions – constituents, exfoliants, tattoos and tattoo ink - How safe are they	

3		**COLOUR COSMETICS**	**7**
	1	Pigments/coloring agents and dyes-lakes and tones-history of pigments and dyes in cosmetics. Lipstick – constituents- manufacturing methods – evaluation of lipsticks - lip glosses	
	2	Nail polish – formulation - manufacture-nail polish remover	

	3	Face powder- constitution, facial masks, color coding in cosmetics, harmful effects of color cosmetics.	

4	**DENTAL PRODUCTS**		**6**
	1	Structure of tooth, dental hygiene, dental caries, oral care product - product categories – toothpaste – tooth powder – oral rinses – mouth washes –	
	2	Dental sealants, dental floss-tooth whiteners-comparison between synthetic and herbal oral products.	

5	**TEACHER SPECIFIC MODULE** Direction: Any topic relevant to the course as per teacher's choice can be included	**9**
	Suggestion: Eye cosmetics, Essential oils	

Essential Readings:

1. Modern Technology of Cosmetics, Asia Pacific Press Inc, New Delhi, 2004.
2. E. Stocchi: Industrial Chemistry, Vol 1, Ellis Horwood Ltd. UK, 1990.
3. P.C Jain, M. Jain: Engineering Chemistry, 16th edition, Dhanpat Rai & Sons, Delhi, 2015.
4. Sharma B.K & Gaur H, Industrial Chemistry, Goel Publishing House, Meerut (1996).

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		**75**

KU6SECCHE102: SPECTROSCOPIC TECHNIQUES IN CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
VI	SEC	100	**KU6SECCHE102**	3	60

Learning Approach (Hours/ Week)			Marks Distribution			Duration of ESE (Hours)
Lecture	Practical/ Internship	Tutorial	CE	ESE	Total	
2	2	NIL	30	45	75	1.5

Course Description: Advanced course in spectroscopic techniques for various analysis

Course Prerequisite: Preliminary understanding on basic spectroscopy is preferred.

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand theory and instrumentation of UV-Vis and fluorescence spectroscopy. Also, get hands-on experience on these instruments.	E
2	Get insight into the theory and instrumentation of IR spectroscopy. Also get experience in IR spectrum analysis.	E
3	Get insight into the theory and instrumentation of NMR spectroscopy. Also get experience in NMR spectrum analysis.	E
4	To understand the scientific application of mass spectroscopy in structural analysis	E
5	Understand the scientific importance of various photoelectron spectroscopy	An

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**UV-VISIBLE AND FLUORESCENCE SPECTROSCOPY**		**18**
	1	Chromophores and effect of conjugation on the spectrum. Visible spectrum and colour in compounds	
	2	Instrumentation of UV-VIS spectroscopy	
	3	Analysis of various aromatic compounds such as coumarin, porphyrins, anthracene, Eriochrome black T, phenolphthalein etc. Calculation of molar extinction coefficient and the λ_{max}	
	4	Phenomena of Fluorescence, Jablonski Diagram, Characteristics of Fluorescence Emission, The Stokes Shift, Mirror-I mage rule,Exceptions to the Mirror-Image Rule, Fluorescence lifetime, quantum yield and quenching	
	5	Instrumentation for Fluorescence Spectroscopy	
	6	Experimental analysis of red-shift, blue shift and fluorescence quenching of emission using suitable molecules. Demonstration of importance of fluorescence titration using suitable examples. Job's plot and binding ratio calculation (Teacher specific part)	

2	**IR SPECTROSCOPY**		**15**
	1	The Infrared Absorption Process, Uses of the Infrared Spectrum, The Modes of Stretching and Bending, Bond Properties and Absorption Trends	
	2	Instrumentation and Preparation of Samples for Infrared Spectroscopy	
	3	Features of spectra of hydrocarbons, aromatic compounds, phenol and alcohol, carbonyl compounds and amines	
	4	Analysis of IR spectrum of crotonaldehyde, benzaldehyde, benzoic acid, *N*-methyl acetamide and *N*-methylaniline	
	5	IR spectral analysis of common drug molecules such as paracetamol, amoxicillin, metformin and diclofenac (Teacher specific part)	

3	**NMR SPECTROSCOPY**		**12**
	1	Chemical environment, shielding and chemical shift. Local diamagnetic shielding and magnetic anisotropy	
	2	The Origin of Spin–Spin Splitting, Pascal's Triangle, The Coupling Constant in ^{1}H NMR. Decoupling	
	3	Instrumentation, sample preparation and various NMR solvents	
		^{13}C NMR-theory, chemical shift, proton-coupled and ^{13}C Spectra Comparison of ^{1}H and ^{13}C NMR	
	4	Prediction of ^{1}H and ^{13}C NMR spectrum of bromo-ethane, 2-bromo propane, acetyl benzoate, anthracene, o-xylene, m-xylene and p-xylene	
	5	Interpretation of molecular structures of various molecules (Teacher specific part)	

4	**MASS SPECTROSCOPY**		**8**
	1	Ionization Methods a) Electron Ionization (EI),b) Chemical Ionization (CI), c) Desorption Ionization Techniques (SIMS, FAB, and MALDI), d) Electrospray Ionization (ESI)	
	2	Mass Analysis a) The Magnetic Sector Mass Analyzer, b) Double-Focusing Mass Analyzers, c) Quadrupole Mass Analyzers, d) Time-of-Flight Mass Analyzers	

	3	Structural Analysis and Fragmentation Patterns a) Alkanes, b) Cycloalkanes, c) Alkenes, d) Alkynes, e) Aromatic Hydrocarbons, d) Alcohols and Phenols, e) Ethers, f) Aldehydes, g) Ketones, h) Esters, i) Carboxylic Acids, j) Amines (Teacher specific part)	
5	**PHOTOELECTRON AND RELATED SPECTROSCOPIES**		**7**
	1	Photoelectron spectroscopy; Experimental methods, Sources of monochromatic ionizing radiation, Electron velocity analysers, Electron detectors, Resolution. Various types of photoelectron spectroscopy (UV and X-ray PES)	
	2	Auger electron spectroscopy; Experimental method, Processes in Auger electron ejection, Examples of Auger electron spectra	
	3	X-ray fluorescence spectroscopy; Experimental method, Processes in X-ray fluorescence, Examples of X-ray fluorescence spectra	

Essential Readings:

1. J. Michael Hollas (2004), Modern Spectroscopy, John Wiley & Sons Ltd
2. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan (2009), Introduction to Spectroscopy, Fourth Edition.
3. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, Third Edition, Springer.

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**45 (35T+10P)**
Continuous Evaluation (CCA)		**30 (15T+15P)**
Theory		**15**
a)	Test Paper*	9
b)	Assignment	3
c)	Viva-Voce	3
Practical		**15**
a)	Record	5
b)	Viva-Voce	5
c)	skill	5
Total		**75**

VALUE ADDED COURSES

KU3VACCHE101 SAFE LABORATORY PRACTICES IN CHEMISTRY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
3	VAC	100	**KU3VACCHE101**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: The course provides necessary guidelines on proper handling of equipment and chemicals, precautions to be taken for avoiding accidents and first aids in case of emergency to maintain a secure environment for experimentation.

Course Prerequisite: **NIL**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand safety measures in laboratory and professional ethics	U
2	Understand the scientific importance of personal protective equipment	U
3	Safely handle, store, use and dispose waste in scientific way	A
4	Develop good laboratory practices	C

Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**SAFETY ASPECTS IN CHEMICAL LABORATORY**	**12**
	1	Introduction to laboratory safety–safety guidelines, common chemistry laboratory practices; safety and hazard symbols. Safe handling & storage and waste management — Chemical storage and handling - Strategies to reduce the amount of toxicity of chemical waste generated in the laboratory? - Proper waste disposal- how to deal with accidents; DON'Ts in the lab	
	2	Material Safety Data Sheet (MSDS)- What is MSDS? MSDS of frequently used laboratory chemicals	
	3	Regulatory framework – Overview of safety regulations and standards (OSHA, EPA) – Laboratory safety manual – Policies and Procedures – Action Plan for implementing safety practices	
	4	Safe handling & storage and waste management — Chemical storage and handling - Strategies to reduce the amount of toxicity of chemical waste generated in the laboratory? - Proper waste disposal- how to deal with accidents; DON'Ts in the lab	

2		**Personal protective equipment**	**6**
	1	Eye protection, Protective apparel, Respirators, Laboratory hoods, Fire extinguishers, Safety showers and Eyewash facilities, other first aid at chemistry laboratory	

3		**PROCEDURES FOR WORK WITH HAZARDOUS SUBSTANCES**	**11**
	1	Hazards in the laboratory – Types of hazards in laboratory– Chemical hazards, Physical hazards, biological hazards, Radiation hazards - Factors determining the impact of hazards.	
	2	Classes of hazardous substances - Carcinogens, Reproductive Toxins, Corrosive Substances, Irritants, Sensitizers (allergen),	
	3	Flammable and explosive substances - General procedures for work with flammable and explosive substances.	
	4	General procedures for work with toxic substances	
4		**SPECIAL HANDLING PROCEDURES FOR SOME COMMON HAZARDOUS SUBSTANCES**	**7**
	1	Special handling procedure for some common hazardous substances in chemistry laboratory - Benzene, Carbon Monoxide, Carbon Tetrachloride, Chlorine, Chloroform, Hydrogen Sulfide, Nitrogen Dioxide, Mercury.	
	2	Prior approval requirements - Restricted chemicals requiring prior approval	

5	**TEACHER SPECIFIC MODULE** LABORATORY DEMONSTRATIONS			**9**
	1	Laboratory demonstration of safe handling & storage and waste management — Chemical storage and handling- Proper waste disposal- how to deal with accidents-Special handling procedure for some common hazardous substances in chemistry laboratory - Benzene, Carbon Monoxide, Carbon Tetrachloride, Chlorine, Chloroform, Hydrogen Sulfide, Nitrogen Dioxide, Mercury		

Essential Readings:

1. Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, D.C
2. Improving Safety in the Chemical Laboratory, Young, J. A. Ed., Wiley,
3. Fire Protection Guide on Hazardous Materials. National Fire Protection Association, Quincy, MA (adopted edition).
4. Laboratory Safety: Principles and Practices. Fleming, D. O. et al. American Society for Microbiology. Washington, D.C. (latest edition)
5. Chemical Hazards of the Workplace. Proctor, N. and J. Hughes. J.B. Lippincott Co., Philadelphia, PA (latest edition).
6. CRC Handbook of Laboratory Safety, Steere, N. ed. CRC Press, Inc., Boca Raton, FLA (latest edition)

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU3VACPCH102: POLYMERS & POLYMER COMPOSITES

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
III	VAC	100	**KU3VACPCH102**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	-	25	50	75	1.5

Course Description:

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand different types of polymers and their nomenclature	U
2	Distinguish between different types of polymerisation techniques	U
3	Familiarize the special topics in polymer science like blends & composites	U
4	Analyze the plastic processing and processing techniques and suggest the suitable one for different types of plastics	An
5	Comprehensive understanding about the quality checking parameters of polymers	U

***Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)**

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	**UNIT**	**DESCRIPTION**	**HOURS**
1	**INTRODUCTION TO POLYMERS**		**9**
	1	Basic concepts- historical development- Present status - Basic concept of monomers- Functionality.	
	2	Nomenclature of Polymers – Common names- Source based names- Structure based names- Linkage based names- Trade names- Abbreviations-	
	3	Classification of polymers and characteristic features of each- Natural and synthetic polymers-Organic and Inorganic Polymers- Thermoplastics and Thermosetting Plastics.	
	4	Elastomers, Fibers and Liquid Resins-Addition polymers and	

		Condensation polymers- Linear, Branched and Cross- linked polymers - Homopolymers and Copolymcrs- Types of copolymers- Alternate, Graft, Block and Random copolymers	

2	**TECHNIQUES OF POLYMERIZATION**		**9**
	1	Bulk polymerization - & Solution polymerization - - Advantages and disadvantages of these techniques	
	2	Suspension polymerization & Emulsion polymerization - Advantages and disadvantages of these techniques	
	3	Melt polycondensation – Solution polycondensation- Interfacial condensation	
	4	Batch and Continuous process – comparison	

3	**PLASTIC PROCESSING**		**9**
	1	Basic principles of processing - shape and size -processing parameters – their effects and behaviour - Rheology of ideal fluids and polymers	
	2	Polymer compounding - additives –fillers- Plasticizers – antioxidants- Flame retardants- stabilizers - colourants etc.	
	3	Processing techniques: Injection moulding - Compression moulding - Transfer moulding -Blow moulding - Extrusion moulding - Rotational moulding	
	4	Calendaring – Foaming – Laminating – Coating – Casting - Spinning and Thermoforming	
4	**SPECIAL TOPICS IN POLYMER SCIENCE**		**9**
	1	Blends & Composites - properties and examples	
	2	Application in engineering, biochemical, agriculture, defence and aerospace	

	3	Nanocomposites – properties and applications	
	4	Specialty polymers -Bio medical polymers-Conducting polymers, engineering polymers- applications.	
5		**TEACHER SPECIFIC MODULE -TESTING OF POLYMERS AND POLYMER PRODUCTS or any other relevant topic**	**9**
		Need for testing - Need for Standards and specification	
		National and International standards - Organizations like ASTM, BIS, BS, DIN, ISO etc. Mechanical properties:	
		Short term strengths - Tensile properties- compression properties- flexural properties, shear properties	
		Long term strength - dynamic stress and strain properties and their measurements – creep- stress relaxation - fatigue properties. resilience.	

Reference

1. Textbook of polymer science - P.L Nayak and S. Lenka
2. Physical Chemistry of polymers - A Tager
3. A textbook of Polymer Science - F. W. Billmeyer.
4. Polymer Science - V.R. Gowariker, N.V. Viswanathan, J. Sreedhar
5. Principles of Polymers Chemistry - P.J. Flory
6. Rubber Technology and manufacture - C.M. Blow
7. Handbook of rubber Test method - Plastic test method - R.P. Brown
8. Principles of polymerization - F. Rooriquez.
9. Polymer Chemistry - M.G Arora & M. Singh
10. Mechanical properties of polymers and composites - L.E. Nielsen, marcel, Dekker
11. Principles of polymerisation, P. Bahadhur, N.V. Sastry, Narosa Publishing House, New Delhi - 2002

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU4VACCHE101: FOOD ADDITIVES, CONTAMINATION AND SAFETY

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
4	VAC	100	**KU4VACCHE101**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: This VAC course is designed to enrich the students with deep understanding about the chemistry of food additives, their applications and to learn methods for detecting and controlling contamination in food production and distribution.

Course Prerequisite: **NIL**

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	Understand and describe applications of various food additives in food processing and preservation.	U
2	To identify and prevent potential sources of food contamination	An
3	To know the Safe and scientific measures of food additives	U
4	Interpret and adhere to regulatory requirements and international standards for food safety for a healthy society	E
5	Utilize laboratory techniques for detecting and analysing contamination in food samples	C

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1		**FOOD ADDITIVES**	**12**
	1	Introduction - Need of food additives in food processing and preservation. Characteristics and classification of food additives.	
	2	Antimicrobial agents. -Nitrites, sulphides, sulphur dioxide, sodium chloride, hydrogen peroxide Antioxidants - Introduction, mechanism of action, natural and synthetic antioxidants, technological aspect of antioxidants.	
	3	Sweeteners- Introduction, importance, classification- natural and artificial, chemistry, technology and toxicology, consideration for choosing sweetening agents.	
	4	Colours- Introduction, importance, classification- natural, artificial, and natural identical, FD&C Dyes and Lakes. polymeric colours.	

2		**FOOD CONTAMINATION & ADULTERANTS**	**12**
		Contamination in Food: Physical, chemical contaminants- heavy metals, pesticide residues, agrochemicals, Antibiotics and Veterinary Drug residues, environmental pollutants, radionuclides, solvent residues, NOTS (Naturally Occurring Toxic Substances).	

		Contaminants formed during processing & packaging – nitrosamines, acrylamide, alloys, benzene, dioxins, furans, persistent organic pollutants, polymers, PAH (Polycyclic Aromatic Hydrocarbons) in smoked foods, food. fumigants, autoxidation products.	
		Food adulteration - Common adulterants in foods and tests to detect common adulterants.	

3	**FOOD SAFETY, RISKS AND HAZARDS**		**6**
	1	Food safety – Introduction to food safety. food-borne illness and contaminants –Consumer concerns and issues - Food safety standards and regulations	
	2	Food risks and hazards - Food related hazards (Chemical, Biological, Physical) - interaction of additives with food ingredients and their toxicological aspects.	
4	**ADULTRATION OF COMMON FOODS AND METHODS OF DETECTION**		**6**
	1	Adulteration methods of detection adulterants in the following foods- Milk, Oil, Grain, Sugar, Spices and Condiments, Processed food, Fruits and Vegetables.	

5	**TEACHER SPECIFIC MODULE -LABORATORY DEMONSTRATIONS**		**9**
	1	Laboratory demonstrations on the methods of detection of adulterants in the following foods- Milk, Oil, Grain, Sugar, Spices and Condiments, Processed food, Fruits and Vegetables.	

Essential Readings:

1. Principles of Food Chemistry. Deman, Springer, 3rdedition

2. Food Colours, Emerton, V, Blackwell Publishing.

3. Sweeteners, Wilson, R., Blackwell Publishing.

4. Food Chemistry, Fennema OR., Marcel Dekker.

5. Food Quality Management Technological and Managerial principles and practices, Pieternel A, Luning. & Willem, J. Marcelis., Wageningen

6. Handbook of analysis and quality control for fruit and vegetable products, Ranganna, S., &Ranganna, S., New Delhi: Tata McGraw-Hill

7. Food analysis, Nielsen, S. S.

8. Vogel's textbook of quantitative chemical analysis, Vogel, Arthur I. Harlow, Essex, England, New York: Longman Scientific & Technical; Wiley

Assessment Rubrics:

Evaluation Type		Marks
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		**25**
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		75

KU4VACCHE102: WATER QUALITY ANALYSIS

Semester	Course Type	Course Level	Course Code	Credits	Total Hours
4	VAC	100	**KU4VACCHE102**	3	45

Learning Approach (Hours/ Week)		Marks Distribution			Duration of ESE (Hours)
Lecture/ Tutorial	Practical/ Internship	CE	ESE	Total	
3	0	25	50	75	1.5

Course Description: The objective of this VAC course is to provide proficiency in various analytical methods used for water quality analysis. Identify and determine various contaminants in the water and to protect public health from water contamination.

Course Prerequisite: NIL

Course Outcomes:

CO No.	Expected Outcome	Learning Domains
1	To understand the chemical composition of natural water.	U
2	Apply scientific knowledge to determine the presence of various contaminants in the water.	A
3	Analyze drinking water quality of the samples collected from the locality for assuring water quality to the society	An

****Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)***

Mapping of Course Outcomes to PSOs

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

COURSE CONTENTS

Contents for Classroom Transaction:

MODULE	UNIT	DESCRIPTION	HOURS
1	**INTRODUCTION**		**6**
	1	National drinking water policy and standards – Definition and importance of water quality. Water contamination and Health risk. Waterborne disease. WHO Guidelines for drinking water quality	

2	**CHARACTERISTICS OF WATER**		**10**
	1	Sources of water – characteristics of water – Acidity, alkalinity, hardness, free chlorine, chlorine demand, calcium, magnesium, iron, manganese, zinc, ammonia, nitrate, sulfate and fluoride, DOC, BOD, COD and their importance.	
	2	Disadvantages of hard water – Softening methods – desalination of Brackish water: Distillation, Electrodialysis and reverse osmosis.	

3	**WATER QUALITY ANALYSIS- I**		**6**
	1	Theoretical principle of determination of total alkalinity of water, total hardness of the water sample, pH of ground and wastewater	
4	**WATER QUALITY ANALYSIS- II**		**14**
	1	Theoretical principle of determination of Dissolved oxygen of wastewater-Chemical oxygen demand of wastewater- salinity of the given water sample- turbidity of various water sample.	

	2	Detection and measurement of various contaminants using spectrophotometric method such as nitrate, chloride, fluoride, iron, micro-pollutants	
5	**TEACHER SPECIFIC MODULE- LABORATORY DEMONSTRATIONS**		**9**
	1	COD determination of water sample. - Turbidity of water sample. pH measurement of ground water Spectrophotometric determination of iron in drinking water.	

Essential Readings:

1. Environmental Chemistry, Anil K De.

2. Water Quality Concepts, Sampling, and Analyses-Y. Li, K. Migliaccio

3. Handbook of Methods in Environmental Studies, Vol.l Water and Wastewater Analysis-S. K. Mait

4. Water Chemistry, Mark M. Benjamin

5. Water Quality: Guidelines, Standards and Health, Stephen Pedley.

Assessment Rubrics:

Evaluation Type		**Marks**
End Semester Evaluation (ESE)		**50**
Continuous Evaluation (CCA)		**25**
Theory (CCA)		25
a)	Test Paper*	10
b)	Assignment	5
c)	Seminar, Viva-Voce	10
Total		**75**

*Average of best two test papers