SANSKARAM UNIVERSITY
JHAJJAR

CBCS and LOCF and NEP-2020 Based
Curriculum and Syllabi
Of
M.Sc. Chemistry

(w.e.f. 2024)

DEPARTMENT OF CHEMISTRY
SCHOOL OF ALLIED AND BASIC SCIENCES

Approved by : **BOS** **Academic Council**
Approval Status :
Approval Date :

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VISION AND MISSION

i) Vision and Mission of the Department

Vision

To establish a world-class teaching and research reputation of the department that contributes society through its innovative, creative and scholarly approach.

Mission

To educate the students by adopting highest academic and professional standards to meet the global competency in the field of chemical sciences.
To establish and maintain a high quality of support, research facilities, multidisciplinary and skill-based learning opportunities to our staff, students and researchers to orient them to world class creative and innovative minds.

1. BACKGROUND

i) NEP-2020 and LOCF an integrated Approach

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Sanskaram University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in 1st meeting of the NEP committee of the University held on 18th April,2024. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasizing upon—integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian

knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical , vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester- wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and

Appendices. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the Universityhas decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

ii) About Chemistry

Chemistry is the science of matter and its transformations. It addresses fundamental questions about the observable matter, ranging from its components, structure, properties and interconversions. As a system of knowledge, Chemistry not only explains the existence and behavior of matter around and within us, but also empowers us to manipulate the matterinto new and improved forms for our use. From the ancient practices of rasayan vidya and alchemy, modern chemistry has grown over centuries into a formidable science that touchesall aspects of human life. Humanity's progress in the last three centuries is pivoted on the contributions of chemistry, chemical industry and associated endeavors. The range of influence of chemistry in our life spans from essentials such as food (agrochemicals, preservatives), shelter (cement, metals, alloys, polymers) and health (drugs, cosmetics, soap, toothpaste), to advancements such as textiles (polymers, leather), beverages (flavoring andfermentation), crime fighting (forensics), weaponry (explosives), space travel (fuel) and cosmology (element detection). The list can go on endlessly. The most visible contribution of chemistry to civilization is achieved by the advancements in modern medicine that was fuelled by organic chemistry. This led to significant improvements in the living standards, extension of human average life span and fighting of dangerous diseases such as cancer andmicrobial infections.

Chemistry is placed centrally between the other two major branches of science, namely physics and biology. Therefore, it is often called the *central science*. It influences the developments in these two broad realms of science as much as it is influenced by the discoveries in them. The fundamental importance of chemistry and chemical industry in

sustaining human civilization demands for a steady supply of trained and skilled manpower. Thus, it is unsurprising that it is an essential and integral department in higher education institutions. Education in chemistry not only imparts the technical know-how about structure, reactions and properties of matter, but also empowers the learner to raise fundamental questions about various natural phenomena, address local issues and come up with sustainable solutions, identify areas of life where intervention of chemistry can bring about progress and imbibe and spread the spirit of free enquiry and scientific temper.

iii) About the Programme (Nature, Extent and Aims)

The Post-Graduate Programme in Chemistry will impart advanced knowledge of basic and applied chemical sciences to the graduates. It will prepare the students for taking up challenging assignments in academia and industry and also empower them with skill and knowledge for generating employment for their own and others. The Programme introduces the students to advanced developments in chemical sciences as well as in the field of other allied sciences, by providing them multidisciplinary and interdisciplinary courses. The design of choice-based curriculum can enrich students with analytical and problem-solving capabilities. It is designed to bring out the best of the abilities of each student, allow them to sharpen the scientific temper and be abreast with the contemporary developments in the area.

The programme includes a balanced combination of Core, Electives and Skill based Courses. The courses are designed in such a way to cover the entire spectrum of chemical sciences from fundamentals (that will bring admitted students from various backgrounds to a common level) to most recent advancements in the field (that will make them ready to take up challenging assignments in the real world).

The M.Sc. (Chemistry) Programme is of two years duration which is divided into four semesters. The teaching and learning in the Programme will involve theory (lectures), practicals, tutorial and seminar-based classes. During the whole programme about 40 % syllabus of each course may be delivered via online mode and with a blended teaching- learning approach.

The curriculum will be taught through formal lectures with the aid of pre-made presentations, audio and video tools whenever necessary. Other teaching aids can also be used as and when

required. The additional requirements like industrial visits, summer training and project work are also incorporated into the curriculum.

The Aims of the programme include

- To inculcate basic and advanced knowledge of chemical sciences among students.
- To provide higher education, disciplinary and inter/multi-disciplinary research- oriented knowledge to the students to make them lifelong learners.
- To provide a learned, skilled and creative pool of graduates who are ready to take up challenging assignments in different kinds of chemical industries, research institutions and academia.
- To mould responsible, proactive citizens who are equipped with scientific thinking and skills to address problems of their locality
- Adequate blend of theory, computation and hands-on experiments.
- Modernized lab courses – close to recent/current research.

iv) Qualification Descriptors (possible career pathways)

On successful completion of the M.Sc. Chemistry Programme, students of the department are expected to be ready to take up opportunities all around the world in areas that demand skills in chemical and allied sciences. As the chemical industry is enormously vast and diverse, numerous opportunities and challenges await the graduates. The graduates are expected to satisfactorily address the professional expectations, maintain a work-life balance and lead productive and meaningful lives. Some of the possible career paths for thepostgraduate students may be:

1. Teaching and Research in academia

2. Research scientists in pharmaceutical and other chemical and material industries

3. Research scientists in other allied sciences

4. Entrepreneurship in chemical science-based ventures

5. Administrative Assignments in various government and private agencies

6.Chemist/Scientist/Technician assignments in any of the following industries: pharmaceutical, polymers, petrochemicals, materials sciences, nanotechnology, fuels, non- conventional energy, renewable resources, agrochemicals, fermentation and processing, paints and pigments,

metallurgy, packaging, cosmetics, cements, natural products, forensics, explosives, and any other various allied branches of chemistry.

2. PROGRAMME OUTCOMES (POs)

The overall aims of the programme may be achieved by addressing its various components that are incorporated into the curriculum as described below. Each of these components is designed to lead to specific outcomes that are desired after the successful completion of theprogramme.

PO-No.	Component	Outcomes
PO-1	Basic Knowledge	Capable of delivering basic disciplinary knowledge gained during the programme.
PO-2	In-depth Knowledge	Capable of describing advanced knowledge gained during the programme.
PO-3	Critical thinking and Problem-Solving abilities	Capable of analyzing the results critically and applying acquired knowledge to solve the problems.
PO-4	Creativity and innovation	Capable to identify, formulate, investigate and analyzethe scientific problems and innovatively to design and create products and solutions to real life problems.
PO-5	Research aptitude and global competency	Ability to develop a research aptitude and applyknowledge to find the solution of burning research problems in the concerned and associated fields at global level.
PO-6	Holistic and multidisciplinary education	Ability to gain knowledge with the holistic and multidisciplinary approach across the fields.
PO-7	Skills enhancement	Learn specific sets of disciplinary or multidisciplinary skills and advanced techniques and apply them for betterment of mankind.
PO-8	Leadership and Teamwork abilities	Ability to learn and work in a group and capable of leading a team even.

3. PROGRAMME SPECIFIC OUTCOMES (PSOs)

PO-9	Environmental and human health awareness	Learn important aspects associated with environmentaland human health. Ability to develop eco-friendly technologies.
PO-10	Ethical thinking and Social awareness	Inculcate the professional and ethical attitude and ability to relate with social problems.
PO-11	Lifelong learning skills and Entrepreneurship	Ability to learn lifelong learning skills which are important to provide better opportunities and improve quality of life. Capable to establish independent startup/innovation center etc.

The post graduates shall be able to realise the following specific outcomes by the end of program studies:

Number	**Programme Specific Outcomes**
PSO-1	To acquire a thorough knowledge about basic theoretical concepts and experimental aspects of chemistry.
PSO-2	To fully develop the skills for using the earned knowledge within different branches of chemistry.
PSO-3	To develop the attitude for identifying and solving problems usingchemistry
PSO-4	To develop the capability to search, acquire and apply recent developmentsin research field of chemical sciences to problems
PSO-5	To develop an overview of the role of chemical sciences and chemical industry in sustaining civilization
PSO-6	To develop the skill to adopt the learned principles in various settings and innovate with the importance of sustainability in mind, if necessary

4. Postgraduate Attributes

On completion of the post graduate programme in chemistry, students are expected to be equipped

with the skills of creative, critical and rational thinking associated with chemistryand its use for human society. The following attributes are expected from the students of M.Sc. Chemistry:

No.	P.G. Attributes
PGA-1	Disciplinary knowledge and solid foundation
PGA-2	Creative, critical and reflective Thinking PGA-
PGA-3	Attitudes and values
PGA-4	Principle and practical aspects of different instruments
PGA-5	Research skills
PGA-6	Think beyond which were never thought before
PGA-7	Information/digital literacy
PGA-8	Team work

5. STRUCTURE OF MASTER'S COURSE

The M.Sc. (Chemistry) Programme is of *two years* duration which is divided into four semesters. The programme under Choice-Based Credit System (CBCS) includes a balanced combination of *Core*, *Electives* and *Skill Courses* (**Table 1**).

As per P.G. Ordinance of Sanskaram University, total credit requirement for completion of the programme shall be 96 (±4).

Total credit requirement of the present P.G. programme is **96**, however, 4 additional credit may be earned by the interested students from Swachh Bharat Internship (2 Credit) and sixweeks industrial summer training course (2 Credit) (**Programme Structure**).

Table 1

Sr. No.	Types of Courses	Nature	Total Credit 98 (2 optional)	% (approx)
1	Core Courses (CC)	Compulsory Courses	48	49
2	Elective Courses (EC)	Discipline Specific Elective Courses	32	33
		Discipline Centric Elective Courses	4	4
		Generic Elective Courses	8	8
3	Skilled-based courses/ Self-study based courses	Discipline Centric Skill Courses	4	4
			96	96
4	Swachh Bharat Internship at Institute Level	Elective Optional for interested students	96 + 2 = 98	
5	Industrial Summer Training	Optional for interested students	98 + 2 = 100 Maximum credit =100	

NOTE: MOOC courses (SWAYAM) having similarity more than 75% with the core course may be offered to the students. For elective courses (whatever nomenclature may be used), the students may opt from the MOOC courses provided these courses are not in the list of core course (SWAYAM) keeps changing, the department is authorized to finalize the list of MOOC courses for each semester based on the above criteria.

PROGRAMME STRUCTURE

Choice Based Credit System (CBCS) Based Course Structure of M.Sc. Chemistry Programme (2 Years) in Consonance with NEP-2020 and LOCF

YEAR 1

Semester-I

Course	Credit	Hrs.
IC-I (CC)	4	4
ICP-I (CC)	2	4
OC-I (CC)	4	4
OCP-I (CC)	2	4
PC-I (CC)	4	4
PCP-I (CC)	2	4
DCEC*	2	2
GEC§	4	4
Total Credit and Hrs.	**24**	**30**

IC-I: Inorganic Chemistry-I
ICP-I: Inorganic ChemistryPractical-I
OC-I: Organic Chemistry-I
OCP-I: Organic ChemistryPractical-I
PC-I: Physical Chemistry-I
PCP-I: Physical ChemistryPractical-I

*Can be chosen from the list ofcourses available
§GEC (Generic elective course)will be available for students from other Departments

Semester-II

Course	Credit	Hrs.
IC-II (CC)	4	4
ICP-II (CC)	2	4
OC-II (CC)	4	4
OCP-II (CC)	2	4
PC-II (CC)	4	4
PCP-II (CC)	2	4
DCSC*	2	2
GEC§	4	4
Seminar (Research paper based) (CC)	2	2
Total Credit and Hrs.	**26**	**32**

IC-II: Inorganic Chemistry-II
ICP-II: Inorganic Chemistry Practical-II
OC-II: Organic Chemistry-II
OCP-II: Organic Chemistry Practical-II
PC-II: Physical Chemistry-II
PCP-II: Physical Chemistry Practical-II
Seminar (Research paper based) (CC)
*Can be chosen from the list ofcourses available
§GEC (Generic elective course) will be available for students fromother Departments

Note:

1) A 02 Credit Summer Training (Optional) Self-study/Skill-based Course of six weeks will be available to interested students at the end of Semester-II.
2) A 02 Credit Elective Course on the basis of Swachh Bharat Internship Programme will be available to all students. The course can be allotted to the interested students in a batch- wise manner to earn max 02 credits in the duration of two years.
3) Students may choose option 2 in Sem-III on the basis of their interest in consultation with concerned faculty member(s). The students shall continue the dissertation work under the supervision of the same faculty member(s) to carry out second part of the dissertation in semester-IV.
4) **Choice Based Credit System (CBCS) based M.Sc. Chemistry programme will be awarded with a minimum of 96 credit (compulsory), although it can be a maximum of 100 credit.**

6. SEMESTER-WISE COURSES AND CREDIT DISTRIBUTION

A. LIST OF COURSES OFFERED BY DEPARTMENT OF CHEMISTRY

Sr. No	Course No	Course Name	Course Code	Course Type	Credit	Semester
CORE COURSES (CC)						
1	CH-01	Inorganic Chemistry-I		CC	04	I
2	CH-02	Organic Chemistry-I		CC	04	I
3	CH-03	Physical Chemistry-I		CC	04	I
4	CH-04	Inorganic Chemistry Practical-I		CC	02	I
5	CH-05	Organic Chemistry Practical-I		CC	02	I
6	CH-06	Physical Chemistry Practical-I		CC	02	I
7	CH-07	Inorganic Chemistry-II		CC	04	II
8	CH-08	Organic Chemistry-II		CC	04	II
9	CH-09	Physical Chemistry-II		CC	04	II
10	CH-10	Inorganic Chemistry Practical-II		CC	02	II
11	CH-11	Organic Chemistry Practical-II		CC	02	II
12	CH-12	Physical Chemistry Practical-II		CC	02	II
DISCIPLINE CENTRIC ELECTIVE COURSES (DCEC)						
1	DCEC 1	Reaction Mechanism: Structure and Reactivity		DCEC	02	I
2	DCEC 2	Nuclear Chemistry		DCEC	02	I
DISCIPLINE CENTRIC SKILL-BASED COURSES (DCSC)						
1	DCSC 1	Computational Chemistry		DCSC	02	II
2	DCSC 2	Analytical Techniques in Chemistry		DCSC	02	II
SWACHH BHARAT INTERNSHIP PROGRAMME (ELECTIVE)						
1	DCSC 3	Activities at Department and University Level		DCSC	02	I-IV
SUMMER TRAINING (OPTIONAL)						
2	DCSC 4	Summer Training (6 weeks)		DCSC	02	At end of Sem-II
GENERIC ELECTIVE COURSE (GEC) [FOR STUDENTS OF OTHER DEPARTMENTS]						
1	GE 1	Chemistry for Biologists		GEC	04	I
2	GE 2	Chemistry of Materials		GEC	04	I

3	**GE 3**	Medicinal Chemistry		**GEC**	**04**	**II**

B. GEC COURSE

- Various available GEC courses can be selected from other Departments.

7. COURSE-LEVEL LEARNING OUTCOMES

INORGANIC CHEMISTRY-I

Course No: CH-01	**Course Name:** Inorganic Chemistry-I				**Course Code: 081401001**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: Basic understanding of coordination chemistry, geometries and bonding models of coordination compounds.					
Course Objectives	*To provide students with basic understanding of symmetry, coordination chemistry, magnetic properties of coordination complexes, metal carbonyl/nitrosyl and metal clusters.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Knowledge of molecular symmetry and point groups **CO2:** Understanding bonding models in coordination compounds **CO3:** Application the theories and models of chemical bonding in coordination compounds **CO4:** Understanding of skeleton electron pairs in non-transition compounds **CO5:** Introduction to metal carbonyls, nitrosyls and related compounds **CO6:** Scope of inorganic compounds						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**MOLECULAR SYMMETRY, POINT GROUPS AND CHARACTER TABLES** Symmetry elements and symmetry operations, symmetry groups with examples from inorganic compounds, groups of very high symmetry, molecular dissymmetry and optical activity, molecular symmetry for compounds having coordination number 2 to 9, matrix representations of symmetry operators and their products. The great orthogonality theorem and its importance, character tables and there use in spectroscopy.	15
II	**BONDING MODELS** Valence bond theory, electroneutrality principle and its limitations. Crystal field theory, splitting of *d*-orbitals in octahedral, tetragonal, square planar and tetrahedral ligand environments. Ligand field theory, molecular orbital theory. MO treatment of simple diatomic (homo & hetero) and polyatomic systems. Spectroscopic electronegativity, concept of chemical hardness (η). Walsh diagrams (triatomic systems).	15

III	**CHEMISTRY OF NON-TRANSITION ELEMENTS** Structures and acidic behaviour of boron halides, Types and nomenclature of boron hydrides (boranes), Wade's polyhedral skeleton electron pair theory (PSEPT). W. N. Lipscomb's STYX rules and semi-topological structures of boranes. Preparation, and properties of boron hydrides, carboranes, metalloboranes and metallocarboranes. Preparation, structure and properties of boron-nitrogen, phosphorous-nitrogen, phosphorus-oxygen, sulphur-nitrogen compounds, silicates, interhalogens, chlorofluorocarbons, pseudohalides and noble gas compounds.	15
IV	**METAL CARBONYLS, NITROSYLS AND CLUSTERS** Molecular orbital diagram of carbonyl, classification of metal carbonyls, bonding in metal carbonyl, valence electron count (EAN rules), preparation and properties of mononuclear and polynuclear carbonyl complexes, bond lengths and stretching frequencies, carbonylate ions, carbonyl hydride complexes, isolobal fragments, structure and important reactions of transition metal nitrosyls. Bonding, preparation and properties of dinuclear metal cluster (dirhenium complex $[Re_2Cl_8]^{2-}$ ions), trinuclear and hexanuclear metal clusters.	15

Suggested Readings:

1. G. L. Miessler, P. J. Fischer and D. A. Tarr, Inorganic Chemistry, 5th Edition. *Pearson*, 2014.
2. B. N. Figgis and M. A. Hitchman, Ligand Field Theory and Its Applications, *Wiley-India*, 2010.
3. J. E. House, Inorganic Chemistry, *Academic Press*, 2008.
4. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 4thEdition. *Pearson Education*, 2006.
5. F. A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 6thEdition. *John Wiley*, 2006.
6. D. F. Shriver, P.W. Atkins and C.H. Landgord, Inorganic Chemistry, 3rd Edition. *Oxford University Press*, 1998.
7. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, 2ndEdition. *Butterworth- Heinemann*, 1997.
8. J. D. Lee, Concise Inorganic Chemistry, *Chapman & Hall Ltd*., 1991.
9. F. A. Cotton, Chemical Applications of Group Theory, 3rd edition. *John Wiley & Sons*, 1990.

INORGANIC CHEMISTRY PRACTICAL-I

Course No: CH-04	**Course Name:** Inorganic Chemistry Practical-I				**Course Code: 081401001 P**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 50		**Examination Duration:** 6 Hrs.					
		Pre-requisite of course: Knowledge of bonding models in coordination compounds, handling of glassware and plastic ware in laboratory.					
Course Objectives	*To impart knowledge about water analysis and preparation of popular coordination complexes.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Analysis of water samples available routinely **CO2:** Determination DO, COD and BOD in water samples **CO3:** Determination of solid impurity and turbidity present in water samples **CO4:** Preparation of coordination complexes **CO5:** Appreciate the morphology and color of coordination complexes **CO6:** Basic knowledge of inorganic preparation						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	**Contents**	**Contact Hrs.**
I	**WATER ANALYSIS** 1. Determination of dissolved oxygen, DO of a given water sample. 2. Determination of chemical oxygen demand, COD of a given water sample. 3. Determination of biological oxygen demand, BOD of a given water sample. 4. Determination of total suspended solids and total dissolved solids. 5. Determination of turbidity of a water sample by nephlometer. 6. Determination of presence of Ca^{2+}, Mg^{2+}, Fe^{3+} and Fe^{2+} ions of a given water sample.	25
II	**PREPARATIONS AND RELATED COMPLEMENTARY WORK (ANY SIX)** 1. Reinecke Salt 2. $VO(acac)_2$ 3. $Mn(acac)_3$ 4. Prussian Blue/Turnbull's Blue 5. $Hg[Co(NCS)_4]$ 6. Potassium trioxalatoferate (III) Trihydrate 7. Potassium trioxaltochromate (III) 8. Cis, trans-dichlorobis(ethylenediammine)cobalt(III)chloride.	35

Suggested Readings:

1. J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Analysis, revised, 5thEdition.*ELBS*, 1989.
2. G. Svehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, 5thEdition.Longman, 1979.
3. Marr and Rocket, Practical Inorganic Chemistry, *Van Nostrand Reinhold*, 1972.

ORGANIC CHEMISTRY-I

Course No: CH-02	Course Name: Organic Chemistry-I				Course Code: 081401002		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: Basic knowledge of chemical bonding, theories of bonding, stereochemistry, reaction mechanisms and reactive intermediates.					
Course Objective	*To provide the basics in Organic Chemistry at the beginning of the semester. At the end of this course, students will gain the knowledge about the nature of bonding in organic molecules, delocalized chemical bonding, aromaticity, stereochemistry, such as conformation and configuration, RS and EZ notations and mechanistic aspects of aliphatic and aromatic nucleophilic substitution and electrophilic aromatic substitutions and elimination reactions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Advanced understanding of the concepts delocalisation, conjugation and aromaticity **CO2**: Advanced knowledge of supramolecular chemistry and non-covalent bonding **CO3**: Advanced knowledge of conformational analysis, dynamic stereochemistry and asymmetric synthesis **CO4**: In-depth understanding of all classes of nucleophilic substitution reactions **CO5**: Fundamental and advanced knowledge elimination reactions and its stereochemical aspects **CO6**: Detailed mechanistic knowledge of aromatic substitution reactions						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**NATURE OF BONDING IN ORGANIC MOLECULES** Delocalized chemical bonding-conjugation, cross conjugation, resonance, rules of resonance, effect on reactivity, hyperconjugation, tautomerism; Energy level of π–molecular orbitals, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Hückel's rule, annulenes, anti-aromaticity, homo-aromaticity; bonding in fullerenes. Fundamentals of Supramolecular Chemistry, Bonds weaker than covalent- addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.	15
II	**STEREOCHEMISTRY** ***Conformational analysis*:** Simple alkanes, cycloalkanes, A values, decalins, conformational lock, ring strain, effect of conformation on reactivity.	15

	***Chirality*:** Basic principles, molecules with more than one chiral center, threo and erythroisomers, Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes); Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus. Methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis: basic principles, chiral pool, auxiliary, substrate, reagent and catalyst controlled.	
III	**ALIPHATIC NUCLEOPHILIC SUBSTITUTION AND ELIMINATION REACTIONS** ***a) Aliphatic Nucleophilic Substitution Reactions:*** The S_N2, S_N1, mixed S_N1 and S_N2 and SET Mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds. Classical and nonclassicalcarbocations, phenonium ions, norbornyl system, common carbocation rearrangements. The S_N^i mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity. ***b) Elimination Reactions:*** The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium.	15
IV	**AROMATIC SUBSTITUTION REACTIONS** ***a) Aromatic Electrophilic Substitution:*** The arenium ion mechanism, orientation and reactivity. The *ortho/para* ratio, *ipso* attack, orientation in other ring systems. Friedel-Crafts reaction, Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction. ***b) Aromatic Nucleophilic Substitution:*** The S_N^{Ar}, diazonium salts and benzyne mechanisms. Reactivity–effect of substrate structure, leaving group and attacking nucleophile. The *von* Richter, Sommelet-Hauser and Smiles rearrangements.	15

Suggested Readings:

1. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition. (Revised by S. P. Singh and Om Prakash). *TRINITY Press*, An Imprint of Laxmi Publications Pvt. Ltd., 2015.
2. R. N. Boyd, R. T. Morrison and S. K. Bhattcharjee, Organic Chemistry, 7thEdition. *Pearson*, 2014.
3. M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 7thEdition. *Wiley*, 2013.
4. J. Clayden, N. Geeves and S. Warren, Organic Chemistry, *Oxford University Press*, 2012.
5. E. L. Eliel and S. H. Wilen, Stereochemistry of Organic Compounds, *Wiley India*, 2008.
6. F. A. Carey and R. J. Sundburg, Advanced Organic Chemistry PART A, *Springer* 2007.
7. P. Y. Bruice, Organic Chemistry, 7thEdition. *Pearson,* 2007.
8. D. Nasipuri, Stereochemistry of Organic Compounds, Second Edition. *New Age International*, 2005.
9. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, *Longman*, 1985.

ORGANIC PRACTICAL-I

Course No: CH-05	**Course Name:** Organic Chemistry Practical-I				**Course Code: 081401002 P**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 50		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Basic idea of chemical laboratory safety and good practices; basic skills such as weighing, measuring, titrating, cleaning etc.					
Course Objective	*To acquire experimental skills important for various separation and purification techniques, functional group identification and drying of organic solvents. At the end of this course, students will learn the various purification methods, chromatographic separation and identification of organic compounds, solvent drying and functional group detection in organic compounds. Students would be familiarized with quantitative analysis of organic compounds to estimate the percentage of given functional groups.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Safe laboratory conduct and good practices **CO2:** Purification techniques for solids such as crystallisation, sublimation and chromatography **CO3:** Purification techniques for liquids such as distillation and chromatography **CO4:** Qualitative analysis of unknown samples to determine the functional groups **CO5:** Tests to determine the various elements present in an organic compound **CO6:** Quantitative analysis of compounds to estimate the percentage of functional groups						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**ISOLATION AND PURIFICATION TECHNIQUES** Laboratory Safety Crystallization, recrystallization and sublimation Distillation: Simple, Steam and Vacuum Solvent Extraction Drying of ethanol/ acetone/ diethylether/THF Paper Chromatography Thin Layer Chromatography	30
II	**ANALYSIS OF ORGANIC COMPOUNDS** QUALITATIVE ANALYSIS: Chemical Tests: Chemistry and Applications Extra elements detection (N, S, X = Cl, Br, I) Functional group detection (in mono functional compounds) QUANTITATIVE ANALYSIS:	30

	Estimation of alcoholic/phenolic/amino groups in the given organic compound	

Suggested Readings:

1. K. L. Williamson and K. M., Masters Macroscale and Microscale Organic Experiments, 7th Edition. *Cengage Learning*, 2017.
2. R. K. Bansal, Laboratory Manual in Organic Chemistry, *Wiley*, 2006.
3. B. S. Furniss and others, Vogel's Text Book of Practical Organic Chemistry, 5e Paperback, *Pearson*, 2003.
4. D. Pasto, C. Johnson and M. Miller, Experiments and Techniques in Organic Chemistry, *Prentice Hall*, Instructor's Edition, 1992.
5. H. T. Clarke revised by B. Haynee, A Hand book of Organic Analysis-Qualitative and Quantitative, *Edward Arnold, London*, 1975.
6. H. Middleton, Systematic Qualitative Organic Analysis, *Edward Arnold, London*, 1959.

PHYSICAL CHEMISTRY-I

Course No: CH-03	Course Name: Physical Chemistry-I						Course Code: 081401003
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** **3** Hrs.					
		Pre-requisite of course: Knowledge of basic chemistry up to UG level.					
Course Objectives	*To provide students with a basic understanding of thermodynamics, fugacity, phase rule, essentials of chemical kinetics and principle of quantum mechanics. This course will strengthen the fundamentals of Physical Chemistry, especially thermodynamics and quantum chemistry.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of physical chemistry. **CO2**: Use of thermodynamics and chemical kinetics in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important methods. **CO5**: Development of alternate and new theoretical methods. **CO6**: Use of advanced and recent technologies in physical chemistry.						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION TO PHYSICAL CHEMISTRY AND CLASSICAL THERMODYNAMICS** Logarithmic relations, Curve sketching and linear graphs, calculation of slopes, terms of mean and median, Precision and accuracy in chemical analysis, types of error, standard deviation, Numerical Problems. ***Classical Thermodynamics:*** Its Laws, Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities like entropy, enthalpy, free energy; Gibb`s-Duhem equation; Clausius-Clapeyron equation, Nernst heat theorem, Chemical potential and Work Function.	15
II	**ACTIVITY, FUGACITY, PHASE RULE** Concepts of fugacity, fugacity of gases and its determination. Activity and activity coefficient, choice of standard states, determination of activity coefficient for solute and solvent. ***Phase Rule:***	15

	Phase Rule and its determination, application, Phase diagram for one component system, for two completely miscible components systems like Pb-Ag system, KI+ H_2O system, Bi-Cd system, Ferric chloride + water system, Sodium chloride + water system, Na_2SO_4-H_2O system.	
III	**CHEMICAL KINETICS-I** ***Introduction to Chemical Kinetics*:** Methods of determining rate laws, Arrhenius equation and its theory, Collision theory, and activated complex theory. ***Chain Reactions*:** Hydrogen-bromine reaction, Pyrolysis of acetaldehyde, Decompositions of ethane. Photochemical reactions (hydrogen-bromine and hydrogen-chlorine reactions). General treatment of chain reaction (hydrogen- bromine reactions), Apparent activation energy of chain reactions, Chain length, Rice-Herzfeld mechanism of organic molecules decomposition (acetaldehyde).	15
IV	**PRINCIPLES OF QUANTUM MECHANICS** Introduction to Quantum Mechanical Approach, Quantum Mechanical operators, Eigenvalues of Quantum Mechanical operators, Hermitian operator, Ladder operator, commutation relations, postulates of quantum mechanics and Uncertainty Principle. Dirac delta function, Uncertainty in position and momentum, Schrödinger equation for finding wave function of a particle, Energy of a particle in One-Dimension box, Extension to Schrödinger equation for finding wave function in a three-dimensional box, Energy of a particle in Three-Dimension box, Energy levels, Eigenvalue, concept of degeneracy and selection rules.	15

Suggested Readings:

1. J.P. Lowe, and K. Peterson, Quantum Chemistry, *Academic Press*, 2019.
2. H. K. Moudgil, Textbook of Physical Chemistry, *PHI Publication House*, New Delhi, 2015.
3. P. Atkins and J. Paula, Atkins' Physical Chemistry, 10th Edition. *Oxford University Press,* 2014
4. I. N. Levine, Quantum Chemistry, 7th Edition. *Pearson Education*, 2013.
5. I. N. Levine, Physical Chemistry, 6th Edition. *Tata Mcgraw-Hill Education*, 2011.
6. D. Mcquarie and J. Simon, Physical Chemistry-A molecular approach, 1stEdition.*Viva*, 2010.
7. R. K. Prasad, Quantum Chemistry, *New Age International*, 2010.
8. A. K. Chandra, Introductory Quantum Chemistry, *Tata McGraw-Hill*, 2008.
9. K. J. Laidler, Chemical Kinetics, 3rd Edition. *Pearson Education*, 2007.
10. E. Kreyszig, Advanced Engg. Mathematics, *John Wiley & Sons, Inc*. 2006.

PHYSICAL CHEMISTRY PRACTICAL-I

<table>
<tr><td>Course No:
CH-06</td><td colspan="3">Course Name:
Physical Chemistry Practical-I</td><td colspan="4">Course Code: 081401003 P</td></tr>
<tr><td>Batch:
2024 onwards</td><td>Programme:
M.Sc. Chemistry</td><td>Semester:
I</td><td>L
0</td><td>T
0</td><td>P
4</td><td>Credit
2</td><td>Contact Hrs. per Week: 04
Total Hrs.: 60</td></tr>
<tr><td colspan="2">Total Evaluation Marks: 50</td><td colspan="6">Examination Duration: 6 Hrs.
Pre-requisite of course: Knowledge of solution preparation, safety measure in chemistry practical laboratory and basic practical knowledge up to UG level.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To train students with introductory physical chemistry practical like adsorption, saponification value, molecular weight determination, surface tension, viscosity, distribution law and thermochemistry.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the following:
CO1: Basic understanding of practical physical chemistry.
CO2: Use of surface tension, viscosity, adsorption in daily life.
CO3: Skills for analyzing and developing new sustainable methods.
CO4: Skills for developing industrially important practical methods.
CO5: Development of alternate analytical methods.
CO6: Use of advanced and recent techniques in experimental chemistry.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8">NOTE:
Depending on availability of time and equipment some experiments may be added/deleted.</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">HANDS ON TRAINING IN PHYSICAL CHEMISTRY EXPERIMENTS
Partial Molar Quantities
● To determine the partial molar volume of urea and ethanol in aqueous solution from density measurements.
Adsorption
● To determine the adsorption isotherms of acetic acid from aqueous solution and I_2 from alcoholic solution by charcoal.
● To investigate the adsorption of oxalic acid from aqueous solution by activated charcoal and to examine the validity of Freundlich & Langmuir’s adsorption isotherms.
Acid and Saponification Value
● To find out the acid value of a given sample.
● To find out the saponification value of given vegetable oil.
Molecular Weight of Polymer
To determine the molecular weight of a given polymeric solution by viscosity and Rast method.</td><td>30</td></tr>
</table>

II	**BASICS PHYSICAL CHEMISTRY EXPERIMENTS**	30
	Surface Tension/Interfacial Tension ● To find surface tension/interfacial tension between two immiscible liquids. ● To determine the percentage composition of a given mixture of two liquids say CCl_4 and Toluene by surface tension method. Viscosity ● To find viscosity and coefficient of viscosity of unknown liquids by Ostwald's viscometer method. ● To determine the percentage composition of given unknown mixture by viscosity method. *Distribution Law* ● To study the distribution of benzoic acid, I_2, succinic acid between organic liquid and water at room temperature and show that whether BA, I_2, Succinic acid dimerizes in organic liquid or water. Thermochemistry ● To determine the heat of neutralization of sulphuric acid using Dewar's vacuum flask as the calorimeter. ● To determine the heat of ionization of a weak base i.e. NH_4OH using calorimeter.	

Suggested Readings:

1. B. Viswanathan and P. S. Raghavan, Practical Physical Chemistry, *M V Learning*, 2017.
2. Shoemaker and Garland, Experiments in Physical Chemistry, *McGraw Hill*, 2015.
3. B. D. Khosla, V. C. Garg and Adarsh Gulati, Senior Practical Physical Chemistry, *R. Chand & Co.*, New Delhi, 2014.
4. Saroj Kumar Maity, Naba Kumar Ghosh, Physical Chemistry Practical, *New Central book Agency*, 2012.
5. G. P. Mathews, Experimental Physical Chemistry, 1stEdition. *Oxford University Press*, 1995.
6. A. M. James and F. E. Prichard, Practical Physical Chemistry, *Lomgman*, 1994.
7. B. P. Levitt, Findley's Practical Physical Chemistry, 9thEdition. *Longman Group Ltd.*, 1993.
8. J. B. Yadav, Advanced Practical Physical Chemistry, *Goel Publishing House*, 1991.
9. R. C. Das and B. Behara, Experimental Physical Chemistry, *Tata McGraw Hill*, 1984.

DISCIPLINE CENTRIC ELECTIVE COURSES (DCEC)

REACTION MECHANISM: STRUCTURE AND REACTIVITY

Course No: CH-43	**Course Name:** Reaction Mechanism: Structure and Reactivity						**Course Code:081401004**
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I	**L** 2	**T** 0	**P** 0	**Credit** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50		**Examination Duration:** 2Hrs.					
		Pre-requisite of course: Basic and advance knowledge of Physical Organic Chemistry.					
Course Objective	*To provide a basic and advanced knowledge of physical organic chemistry including a better understanding of a reaction mechanism, kinetic and non-kinetic methods, the different types of reactive intermediates involved during a chemical reaction, and kinetic and thermodynamically controlled reactions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Fundamental understanding of a reaction mechanism. **CO2**: Basic idea of a reactive intermediate involved during a chemical reaction. **CO3**: Basic knowledge of a kinetic and thermodynamic controlled product formation. **CO4**: Basic knowledge of kinetics and non-kinetics method to study a reaction mechanism. **CO5**: Idea about the correlation of stereochemistry and mechanism **CO6**: Advanced knowledge about general physical organic chemistry principles						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one part. Question 1 will be of 8 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 2 hours.

Unit No.	Contents	Contact Hrs.
I	**FUNDAMENTALS OF REACTION MECHANISMS** Fundamentals of stereoelectronic effects and reactivity, acids and bases, reaction types, intermediates and transition state, effect of temperature and catalysts.	7
II	**REACTIVE INTERMEDIATES** Introduction to structure, formation, stability and reactions of carbocations, carbanions, free radicals, radical anions, radical cations, arynes, carbenes and nitrenes.	8
III	**CHEMICAL EQUILIBRIA AND REACTIVITY** Thermodynamic and kinetic control of reactions, Correlation of reactivity with structure, linear free energy relationships, Hammond's postulate, Curtin-Hammett principle.	7

IV	**KINETICS AND NON-KINETIC METHODS TO STUDY MECHANISM** Kinetic methods: primary and secondary kinetic isotopic effects, isotopic labeling; non-kinetic methods: detection and interception of intermediates, systematic structural variation, stereochemical studies and cross-over experiments.	8

Suggested Readings:

1. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry, Part A, 5thEdition, Springer, 2012.
2. E. V. Anslyn and D. A. Dougherty, Modern Physical Organic Chemistry, University Science Books, 2005.
3. Warren, S.; Greeves, N.; J. Clayden and P. Wothers, Organic Chemistry, 2ndEdition, Oxford University Press, 2001.
4. J. March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure, 4thEdition, John-wiley, 1999.
5. N. S. Isaacs, Physical Organic Chemistry, 2ndEdition, Longman Scientific & Technical, 1995.
6. P. Sykes, A guidebook to Mechanism in Organic Chemistry, 5thEdition, Longman Scientific Technical, 1985.
7. P. Deslongchamps, Stereoelectronic Effects in Organic Chemistry, Pergamon, 1983.

DISCIPLINE CENTRIC ELECTIVE COURSES (DCEC)
NUCLEAR CHEMISTRY

Course No: CH-44	**Course Name:** Nuclear Chemistry				**Course Code:081401005**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **I**	**L** 2	**T** 0	**P** 0	**Credit** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks:50		**Examination Duration:** 2 Hrs.					
		Pre-requisite of *course:* To provide the basic knowledge of nuclear structures, radioactivity and applications.					
Course Objectives	*To provide the basics of nuclear structures, radiations, artificial radioactivity and applications of nuclear chemistry, radiopharmacy and chelation therapy.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of nuclear structure **CO2**: To identify and understand various nuclear reactions **CO3**: Measurement of radioactivity **CO4**: Artificial radioactivity **CO5**: To understand chelation therapy **CO6**: Applications of nuclear chemistry						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one part. Question 1 will be of 8 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

i) 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 2 hours.

Unit No.	Contents	Contact Hrs.
I	**NUCLEAR STRUCTURE** Composition of the nucleus, nuclear size, shape and density, theories of nuclear composition, magnetic and electric properties of nucleus, nuclear spin and parity, nuclear binding forces.	7
II	**NUCLEAR REACTIONS** Penetration potential, nuclear binding energy, nuclear emissions, nuclear transformations, bombardment of nuclei, nuclear fission, nuclear fusion, nuclear explosives, nuclear reactors in India, Szilard–Chalmer's effect, fuel cycle and waste management, reactor power control.	8

III	**RADIOACTIVITY** Radioactive decay and growth, naturally occurring and artificially produced radioactive substances, Measurement of radioactivity, group displacement law, radioactive disintegration series, rate of disintegration, half-life, average life of radioactive elements, unit of radioactivity, nuclear decay, determination of decay constants, decay rates, types of nuclear decay.	7
IV	**ARTIFICIAL RADIOACTIVITY AND APPLICATIONS OF NUCLEAR CHEMISTRY** Discovery of artificial radioactivity, isotopes used in medicines, radiocarbon dating, age determination, effects of radiation on life, applications of tracer element in medical, agriculture and analytical fields, biological effects of radiation, radiation protections, chelation therapy.	8

Suggested Readings:

1. G. Friedlander, J. W. Kennedy, E. S. Macias; Nuclear and Radiochemistry, 3rdEdition.*Willey*, 2013.
2. W. D. Loveland, D. Morrissey and G. T. Seaborg, Modern Nuclear Chemistry, *John Wiley & Sons*, 2006.
3. C. E. Housecroft and A. G. Sharpe; *Inorganic Chemistry*, 2ndEdition.*Pearson*, 2005.
4. H. J. Arnikar, Essentials of Nuclear Chemistry, *Wiley Eastern*, 1988.

GE- CHEMISTRY FOR BIOLOGIST

Course No: CH-58	**Course Name:** Chemistry for Biologists						**Course Code: 081401006**
Batch: 2024 onwards	**Programme:** P.G. (Generic Elective Course)	**Semester:** **I**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks:100		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: None					
Course Objectives	*To provide an opportunity to learn some basic concepts of chemistry important for biologists.* *To provide the knowledge of UV-vis., IR and ^{1}H-NMR spectroscopy*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of some important concepts of chemistry **CO2**: Understanding of formulae writing and stereochemistry of organic compounds **CO3:** Important aspects associated with other branches of science **CO4**: Skills to interpret data of organic compounds using advanced spectral techniques **CO5**: Ability to communicate about chemical sciences across the fields **CO6**: Ability to analyse, design and solve problems						
COURSE SYLLABUS							

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**SOME BASIC TERMS AND CONCEPTS** Mole concept and Stoichiometry. Solution and different methods of expressing the concentration of a solution. Chemical bonds: Ionic, covalent, coordinate and metallic bonds. Shapes of the molecules, Polarized chemical bonds and polarity in the molecules. Intermolecular forces: Dispersion, dipole-dipole, hydrogen bonds, ion-dipole forces and their effect on the properties of the compounds. Biological implications of hydrogen bonding. Problems based on given topics.	15
II	**STEREOCHEMISTRY** Isomerism: Introduction, Formula writing, Structural and stereo isomerism, Conformations: analysis of ethane, *n*-butane, cyclohexane and its derivatives, Configurational isomerism, Geometrical and optical isomerism. Symmetry and chirality in the molecules having one or more than one chiral center, R & S, D & L, threo and erythro nomenclature, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective reactions. Problems based on given topics.	15

III	**CONCEPTS OF PHYSICAL CHEMISTRY** Thermodynamics: Change in Internal energy, enthalpy, free energy and entropy; Endothermic and exothermic processes, Exergonic and endergonic processes, Coupled biological processes, Chemical Kinetics: Reaction rate and rate constant, Catalysts and catalysis, Enzymes as catalysts, Enzyme inhibition. Chemical equilibrium: Equilibrium, equilibrium constant, Le Châtelier's principle and factors affecting the principle, Aqueous Equilibria: Introduction, importance in biology, pH and pH control, Buffers and their importance.	15
IV	**SPECTROSCOPIC TECHNIQUES** Ultraviolet and visible (UV-vis) spectroscopy: Introduction, Principle and selection rules of UV phenomenon, Various electronic transitions, Beer-Lambert law, presentation of spectrum, effect of solvents on electronic transitions, ultraviolet bands for carbonyl compounds and unsaturated carbonyl compounds. Fieser-Woodward rules for conjugated dienes. Infrared Spectroscopy: Introduction, Principle and selection rules of IR spectroscopy, Hookes law, Characteristic vibrational frequencies of organic compounds. Overtones, combination bands and Fermi resonance. Factors affecting the vibrational frequencies. ^{1}H NMR: Principle, nuclear spin states, nuclear magnetic moments, mechanism of resonance, chemical shifts, diamagnetic shielding, magnetic anisotropy, spin-spin splitting, coupling constant, ^{1}H NMR spectra of various simple organic compounds.	15

Suggested Readings:

1. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry,47th Edition. *Vishal Publishing Co.,* 2017.
2. B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, 33rd Edition. *Vishal Publishing Co.,* 2017.
3. D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan, Spectroscopy, 5th Edition. *Cengage Learning India Private Limited,* 2015.
4. P. S. Kalsi, Stereochemistry: Conformation and Mechanism, *New Age International Private Limited*, 2015.
5. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition. (Revised by S. P. Singh and Om Prakash). *TRINITY Press, An Imprint of Laxmi Publications Pvt. Ltd*., 2015.
6. P. Atkins and J. Paula, Atkins' Physical Chemistry, 10th Edition. *Oxford University Press*, 2014.
7. J. Clayden, N. Geeves and S. Warren, Organic Chemistry, *Oxford University Press*, 2012.
8. Morrison, Boyd and Bhattcharjee, Organic Chemistry, 7th Edition, *Pearson*, 2010.
9. F. A. Carey and R. J. Sundburg, Advanced Organic Chemistry PART A., *Springer*, 2007.
10. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition, *New Age International*, 2005.
11. K. J. Laidler, Chemical Kinetics, 3rd Edition. *Pearson Education*, 1997.

GE- CHEMISTRY OF MATERIALS

Course No: CH-59	Course Name: Chemistry of Materials						Course Code:081401007	
Batch: 2024 onwards	**Programme:** P.G. (Generic Elective Course)	**Semester:** I	**L** 3	**T** 1	**P** 0	**Credit** 4	**Contact Hrs. per Week:** 04	**Total Hrs.:** 60
Total Evaluation Marks:100		**Examination Duration:** 3 Hrs.						
		Pre-requisite of course: To provide basic nanomaterials and photophysical phenomena						
Course Objectives	*To give a very basic understanding of Chemistry of nanomaterials, porous materials and some photophysical phenomena with focus on energy and environment.*							
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of nanomaterials **CO2**: To understand the dramatic changes in properties that occurs by reducing the size **CO3**: Characterization of nanomaterials **CO4**: To impart knowledge on how to perform the synthesis of such small sizes and shapes of materials **CO5**: Knowledge of fundamental of photophysical phenomena **CO6**: Application of nanomaterials and photophysical phenomenon							

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**NANOMATERIALS** An Introduction, Elementary Consequences of Small Particle Size - Surface of Nanoparticles. Classification of nanomaterials-zero dimensional (0D)-one dimensional (1D)-two dimensional (2D) nanomaterials. Gas-Phase Synthesis of Nanoparticles - Physical and Chemical Vapor Synthesis Processes. Radio- and Microwave Plasma Processes. Flame Aerosol Process. Synthesis of Coated Particles.	15
II	**CHARACTERIZATION OF NANOMATERIALS** Global Methods for Characterization, X-Ray and Electron Diffraction, Electron Microscopy, Scanning Transmission Electron Microscopy. Nanotubes, Nanorods, and Nanoplates, One-Dimensional Crystals, Graphene and Carbon Nanotubes. Nanotubes and Nanorods from Materials other than Carbon, Synthesis of Nanotubes and Nanorods.	15

III	**HYBRID MATERIALS** Coordination Polymers, Introduction, Classification of Coordination Polymers, Design Strategies of Coordination Polymers-Metal Nodes and Linkers, Secondary Building Unit Concept, Topology and Interpenetration, Synthesis of Coordination Polymers-Solvothermal/Hydrothermal, Sonochemical, Microwave, Mechanochemical. Charaterization: X-ray diffraction and Spectroscopic Methods. Applications of Coordination Polymers in Gas Storage, Gas Separation, Catalysis and Drug Delivery.	15
IV	**PHOTOPHYSICAL PHENOMENA** Interaction of electromagnetic radiation with matter, Grotthus-Draper law, Stark-Einstein law of photochemical equivalence, quantum yield, electronically excited singlet states, life time of electronically excited state, construction of Jablonski diagram, electronic transitions and intensity of absorption bands, types of photophysical pathways, radiationless transitions, fluorescence emission, phosphorescence emission, Fluorescence quenching, chemiluminescence, photochemical reactions.	15

Suggested Readings:

1. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Edition. *Wiley-VCH*, 2013.
2. D. C. Agarwal, Introduction to Nanoscience and Nanomaterials. *World Scientific*, 2013.
3. S. R. Batten, S. M. Neville and D. R. Turner, Coordination Polymers: Design, Analysis and Application. *RSC Publishing*, 2009.
4. M.-C. Hong and L. Chen, design and Construction of Coordination Polymers. *Wiley*, 2009.
5. S. Kaskel, The Chemistry of Metal-Organic Frameworks, Vol. 1, *Wiley-VCH*, 2016.
6. L. R. Macgillivray, Metal-Organic Frameworks: Design and Applications, *Wiley*, 2010.
7. W. D. Jr. Callister and D. G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, *John Wiley and Sons*, 2012.
8. K. K. Rohatgi and K. K. Mukherjee; Fundamentals of Photochemistry, 3rdEdition. *New Age International (P) Ltd.*, 2014.

SWACH BHARAT INTERNSHIP PROGRAMME

Course No: CH-56	**Course Name:** Activities at Department and University Level*				**Course Code:**	
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I to IV	**L** 0	**T** 0	**A** 7	**Credit** 2	**Contact Hrs. per Week: 7** **Total Hrs.: 100**
Total Evaluation Marks: Evaluation will be done at departmental level by giving the remarks as Excellent/Good/Satisfactory/Poor		**Examination Duration:** NA					
		Pre-requisite of course: None					

Course Objectives	*The main objective of this course is to make the students aware about the importance of cleanliness for social development.*
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Learn about the importance of cleanliness **CO2**: Develop skills in finding and solving sanitation related problems **CO3:** Motivating others not to litter **CO4**: Motivating others not to use plastic bags **CO5**: To manage and implement campaigns and demonstrate sanitation advice in nearby villages. **CO6**: Skill to train others

COURSE SYLLABUS

Unit No.	**Contents**	**Contact Hrs.**
I-IV	This course is applicable to all students to carry out various activities associated with cleanliness and recycling of the waste materials at departmental and university level in line with Swachh Bharat Abhiyan that may include: ● To conduct outreach programs for creating awareness on Swachh Bharat in association with NCC or NSS or women cell etc. ● To produce energy and manure using bio-wastes. ● Plantation drives to increase the green cover and conservation of old trees. ● Self-sustainable units through energy production using solar panels. ● Plastic free environment. ● Development of Green Buildings concept in the society. ● Effective Waste management and recycling. ● Rain water harvesting. ● Proper disposal of chemical waste. ● Creating awareness in the community through short films. ● Use of social media for broader community outreach. **Note**: Students will submit a brief report on the activities carried out to the department for the record purpose.	100

A = Activity

*https://www.ugc.ac.in/pdfnews/8118809_UGC-Letter-reg-Swachcha-Bharat-Abhiyan-.pdf

INORGANIC CHEMISTRY II

Course No: CH-07	Course Name: Inorganic Chemistry-II				Course Code: 081402001		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** II	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** 3 Hrs.					
		Pre-requisite of course: Basic understanding of electronic spectroscopy, magnetic properties and reaction mechanisms in coordination compounds.					

Course Objectives	*To provide an understanding of the fundamentals of electronic spectroscopy of coordination compounds and advanced topics such as, reaction mechanism in complexes. Introductory nuclear chemistry and its theory will be discussed as well.*
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of electronic properties of coordination compounds **CO2:** Knowledge of term symbols and Orgel diagrams **CO3:** Able to predict the allowed transitions between various molecular energy levels **CO4:** Understanding of anomalous magnetic behaviour **CO5:** Understanding of reaction mechanisms in coordination compounds **CO6:** Understanding of metal-ligand equilibria in solution in coordination compounds

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**ELECTRONIC SPECTROSCOPY AND MAGNETIC PROPERTIES-I** Spectroscopic ground states and the evaluation of energies of various *J* states of free ions, Term symbols, splitting of *S*, *P*, *D* and *F* terms under octahedral and tetrahedral electrostatic potential, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of *Dq*, *B* and β parameters, charge transfer spectra of complexes (both metal to ligand and ligand to metal). Spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information.	15
II	**ELECTRONIC SPECTROSCOPY AND MAGNETIC PROPERTIES-II** Brief review of different types of magnetic behaviors, spin-orbit coupling, quenching of orbital angular moments, temperature independent paramagnetism, anomalous magnetic moments. Crystal field theory and its application to explain magnetic properties of coordination compounds. Magnetic interactions in polynuclear systems, canting, spin frustration.	15

III	**REACTION MECHANISMS OF TRANSITION METAL COMPLEXES** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism,	15
	direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reaction in square planar complexes, *trans* effect, mechanism of the substitution reactions. Redox reactions, mechanism of inner-outer sphere type reactions, cross reactions and Marcus-Hush theory.	
IV	**METAL-LIGAND EQUILIBRIA IN SOLUTION** Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors influencing stability of metal complexes dependent on size and charge, metal class, ligand preference, nature of transition metal ions, basic strength, chelate effect, ring size, steric strain, macrocyclic effect, thermodynamic and kinetic stability, determination of formation constants by pH-metry and spectrophotometry.	15

Suggested Readings:

1. G. L. Miessler, P. J. Fischer and D. A. Tarr, Inorganic Chemistry, 5th Edition. *Pearson*, 2014.
2. B. N. Figgis and M. A. Hitchman, Ligand Field Theory and Its Applications, *Wiley-India*, 2010.
3. J. E. House, Inorganic Chemistry, *Academic Press*, 2008.
4.
5. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Inorganic Chemistry: Principles of Structure and Reactivity, 4thEdition. *Pearson Education*, 2006.
6. F. A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 6thEdition. *John Wiley*, 2006.
7. D. F. Shriver, P.W. Atkins and C.H. Landgord, Inorganic Chemistry, 3rd Edition. *Oxford University Press*, 1998.
8. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, 2ndEdition. *Butterworth- Heinemann*, 1997.
9. J. D. Lee, Concise Inorganic Chemistry, *Chapman & Hall Ltd*., 1991.

INORGANIC CHEMISTRY PRACTICAL-II

Course No: CH-10	**Course Name:** Inorganic Chemistry Practical-II				**Course Code:081402001 P**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **II**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 50		**Examination Duration:** 6 Hrs.					
		Pre-requisite of course: Basic knowledge of quantitative estimation and radical analysis gained during undergraduate courses.					
Course Objectives	*To impart knowledge of volumetric-redox and complexometric estimations and analysis of mixture of radicals, both acidic and basic.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Detailed understanding of quantitative estimations **CO2:** Knowledge of volumetric-redox titrations **CO3:** Knowledge of complexometric titrations **CO4:** Advanced knowledge of qualitative analysis **CO5:** Analysis of acidic and basic radicals from mixture of radicals **CO6:** Analysis of interfering radicals present in a mixture of ions						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	**Contents**	**Contact Hrs.**
I	**QUANTITATIVE ESTIMATION** Quantitative estimation (involving volumetric-redox and complexometry) of constituents in two and three component mixtures.	30
II	**SEMIMICRO QUALITATIVE ANALYSIS** Complete systematic analysis of Inorganic mixtures containing six ions including the interfering radicals.	30

Suggested Readings:

1. J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, Vogel's Textbook of Quantitative Analysis, revised, 5thEdition. *ELBS*, 1989.
2. G. Svehla, Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, 5thEdition. *Longman*, 1979.
3. Marr and Rocket, Practical Inorganic Chemistry. *Van Nostrand Reinhold*, 1972.

ORGANIC CHEMISTRY-II

Course No: CH-08	**Course Name:** Organic Chemistry-II				**Course Code: 081402002**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** **3 Hrs.**					
		Pre-requisite of course: Basic knowledge about the structure and reactions of various alkenes and carbonyl compounds; formation, stability and reactions of free radicals; fundamentals of interaction of light with matter; basic knowledge of conjugation and molecular orbital diagrams.					
Course Objective	*To provide advance knowledge of organic chemistry reactions such as addition reactions, free radical, photochemistry and pericyclic reactions. At the end of this course, students will be trained in solving the problems related to addition reactions, free radical reactions, photochemistry and pericyclic reactions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: In-depth understanding of electrophilic addition reaction of alkenes, alkynes and allenes **CO2**: Thorough knowledge of the addition, substitution and condensation reactions of carbonyl compounds **CO3**: Advanced knowledge of formation, stability and reactions of free radicals **CO4**: In-depth knowledge of various photochemical reactions in organic chemistry **CO5**: Ability to understand, explain and predict various aspects of pericyclic reactions such as electrocyclic reactions and cycloadditions. **CO6**: Theoretical treatments and applications of sigmatropic rearrangements and chelotropic reactions						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one part. Question 1 will be of 8 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 2 hours.

Unit No.	**Contents**	**Contact Hrs.**
	imine and enamine formation, Grignard, organozinc and organolithium reagents, Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions, Addition of ylides (Wittig, Julia and Peterson reactions), hydride reductions of various carbonyl compounds. Hydrolysis of acetals, esters, amides and nitriles.	

I	**ADDITION REACTIONS OF CARBON-CARBON AND CARBON-HETEROATOM MULTIPLE BONDS** ***a) Polar addition to Carbon-Carbon Multiple Bonds:*** Mechanistic and stereochemical aspects of following **electrophilic addition reactions**: hydrohalogenation, hydration, epoxidation, Woodward and Prevost dihydroxylations, halogenation, halocyclizations, oxymercuration, hydrogenation, hydroboration and carbene cyclopropanation. General aspects of addition reactions of alkynes and allenes. Addition of **nucleophiles** to alkenes, Michael reaction, nucleophilic epoxidation and cyclopropanation. ***b) Addition to Carbon-Heteroatom Multiple Bonds:*** Reactivity of various carbonyl compounds, Mechanistic and stereochemical aspects of following nucleophilic addition reactions to carbonyl compounds**:** hydration, acetalization,	15
II	**FREE RADICAL REACTIONS AND ORGANIC PHOTOCHEMISTRY** ***a) Free radicals:*** Generation of free radicals, structure and stability, persistent radicals, common initiators and uses (peroxides, UV light, AIBN-tin hydride), radical anions and cations (One electron redox reactions), radical chain reactions, radical scavengers, Types of free radical reactions: substitution (halogenation, Sandmeyer reaction), addition (to unsaturated systems, radical cyclization), fragmentation (Hunsdiecker reaction), intramolecular H-abstraction (Hofmann-Loeffler and Barton reactions), oxidation (auto-oxidation of aldehydes) and dimerization (Pinacol, McMurry, acyloin and Glaser reactions) ***b) Organic Photochemistry*****:** Fundamentals of organic photochemistry, Photochemical reactions of alkenes: photo-cycloaddition, Paterno-Buchi reaction, di-pi-methane rearrangement) Photochemical reactions of carbonyl compounds: Norrish type I and II reactions, di-pi methane and oxa-di-pi methane rearrangements. Basics of visible light photocatalysis.	15
III	**PERICYCLIC REACTIONS I- ELECTROCYCLIC AND CYCLOADDITION REACTIONS** Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allyl and pentadienyl systems. Classification of pericyclic reactions. FMO approach. **Electrocyclic reactions**: conrotatory and disrotatory modes and effect on stereochemistry, 4n, 4n+2, allyl and pentadienyl systems, Nazarov cyclization. **Cycloaddition reactions:** antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, Detailed treatment of Diels-Alder reactions (types of Diels-Alder reactions, common dienes and dienophiles, endo/exo selectivity, catalysis, synthetic applications, intramolecular and hetero Diels-Alder reactions), **1,3-dipolar cycloadditions**: structure, methods of preparation andsynthetic applications of nitrones, nitrile oxides and azides.	15
IV	**PERICYCLIC REACTIONS II- SIGMATROPIC, ENE AND CHELOTROPIC REACTIONS** **Sigmatropic rearrangements**: General considerations, suprafacial and antarafacial shifts of H and alkyl groups, 1,3, 1,5, 3,3 and 2,3-sigmatropic rearrangements. Valence tautomerism (divinylcyclopropane and bullvalene), Detailed treatment of Claisen (Eschenmoser, Johnson, Ireland and aromatic variants), Cope (oxy-Cope and anionic oxy-Cope) rearrangements. Wittig, aza-Wittig and Sommelet-Hauser rearrangements, concerted syn-eliminations. **Ene reactions**: General features, carbonyl and oxy-ene reactions, intramolecular ene reactions. **Chelotropic eliminations**: Definition, examples involving nitrogen, sulfur dioxide and carbon monoxide extrusions.	15

Suggested Readings:

1. S. Kumar, V. Kumar and S. P. Singh, Pericyclic Reactions, A Mechanistic and Problem-Solving Approach, Ist Edition. *Elsevier*, 2015.
2. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition. (Revised by S. P. Singh and Om Prakash). *TRINITY Press*, An Imprint of Laxmi Publications Pvt. Ltd., 2015.
3. Michael B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th Edition. *Wiley*, 2013.
4. J. Clayden, N. Geeves and S. Warren, Organic Chemistry, *Oxford University Press*, 2012.
5. Morrison, Boyd and Bhattacharjee, Organic Chemistry, 7thEdition. *Pearson*, 2010.
6. F. A. Carey and R. J. Sundburg, Advanced Organic Chemistry PART A and PART B, *Springer* 2007.
7. S. Sankararaman, Pericyclic reactions-A Textbook, 1st Edition. *Wiley-VCH, Weinheim*, 2005.
8. R. Bruckner, Advanced Organic Chemistry: Reaction Mechanism, *Harcourt (India) Pvt. Ltd*., 2001.
9. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, *Longman*, 1985.

ORGANIC CHEMISTRY PRACTICAL – II

Course No: CH-11	**Course Name:** Organic Chemistry Practical-II				**Course Code: 081402002 P**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **II**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 50		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Skills to handle solvent extractions, distillations, crystallizations simple chromatographic experiments independently. Ability to set up reaction assemblies which may require heating/cooling, set-up and execute filtration and drying processes.					
Course Objective	*To acquire the skills to plan and carry out separation of mixtures of organic compounds by means of solvent-solvent extraction, further purification and identification of isolated components and derivative preparation. To learn how to plan a synthetic operation from simple starting materials, set-up the reaction assembly, work-up, isolate and purify the product. Develop knowledge of proper and safe waste disposal in these operations.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** To analyze and separate binary mixtures of solids using solvent extraction, to purify and identify the isolated components via derivative preparation **CO2**: To analyze and separate binary mixtures of solid and liquid using solvent extraction, to purify and identify the isolated components via derivative preparation **CO3:** To analyze and separate binary mixtures of liquids using solvent extraction, to purify and identify the isolated components via derivative preparation **CO4:** To plan and carry out single-step preparation of organic compounds **CO5:** To work-up, isolate and purify, determine the purity of the prepared compound and safe treatment and disposal of chemical waste **CO6:** To develop an exposure to industrial chemical operations via a visit						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	**Contents**	**Contact Hrs.**
I	**QUALITATIVE ANALYSIS OF BINARY ORGANIC MIXTURES BY A SYSTEMATIC APPROACH** Chemical separation using H_2O, $NaHCO_3$, NaOH, HCl, Ether or any other reagent as per required conditions of solid-solid, solid-liquid and liquid-liquid mixtures Systematic identification of the components and preparation of at least one derivative of each.	30
	In order to get an exposure on how chemical industries function, department will arrange an industrial visit. Students to prepare a report on the industrial visit.	

II	**A. ORGANIC SYNTHESIS** Preparation of organic compound involving one-step reaction. (Prepare at least three compounds) [**Important *Note:*** *Greener protocols to be used wherever possible. Submit the recrystallised sample of the synthesized compound after checking its purity by TLC and melting points.*] **B. INDUSTRIAL VISIT**	30

Suggested Readings:

1. K. L. Williamson and K. M., Masters Macroscale and Microscale Organic Experiments, 7th Edition. *Cengage learning*, 2017.
2. H.A. Shally, Green Chemistry Laboratory Manual for General Chemistry, 1stEdition *CRC Press*, 2015.
3. R. K. Bansal, Laboratory Manual in Organic Chemistry, Wiley, 2006.
4. B. S. Furniss and others, Vogel's Text Book of Practical Organic Chemistry, 5th Edition Paperback, *Pearson*, 2003.
5. D. Pasto, C. Johnson and M. Miller, Experiments and Techniques in Organic Chemistry, *Prentice Hall, Instructor's Edition,* 1992.
6. H. T. Clarke revised by B. Haynee, A Hand book of Organic Analysis-Qualitative and Quantitative, *Edward Arnold, London*, 1975.
7. H. Middleton, Systematic Qualitative Organic Analysis, *Edward Arnold, London*, 1959.

PHYSICAL CHEMISTRY-II

Course No: CH-09	**Course Name:** Physical Chemistry-II (Quantum Chemistry & Group Theory)				**Course Code: 081402003**		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100		**Examination Duration:** **3** Hrs.					
		Pre-requisite of course: Knowledge of basic physical chemistry up to UG level.					
Course Objectives	*To provide students with an understanding of physical chemistry like quantum approach, enzyme kinetics, unimolecular reactions, principles of symmetry and group theory and non-equilibrium thermodynamics. This course will strengthen the essentials of Physical Chemistry, especially group theory and quantum chemistry.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of physical chemistry. **CO2**: Use of symmetry and enzyme kinetics in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important methods. **CO5**: Development of alternate and new theoretical methods. **CO6**: Use of advanced and recent technologies in Physical Chemistry.						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

i) 2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**QUANTUM APPROACH AND APPROXIMATION METHODS** ***Harmonic oscillator*:** Application to diatomic molecules and Energy levels. Properties of Legendre polynomials, Rodrigues formula, Recursion formulae, Associated Legendre polynomials, Laguerre and associated Laguerre polynomials. ***Rigid rotator*:** Model for a rotating diatomic molecule and Energy level. Solution of spherical eigen-functions, Recursion formulae, Derivation of Legendre polynomial equation. ***The Hydrogen atom*:** Schrödinger equation for hydrogen atom. Solution of radial wave function. Radial distribution curves and shapes of atomic orbitals. ***Approximate Methods*:** The linear variation principle, First order time-independent Perturbation theory for non-degenerate states. Variation theorem and variation methods. Use of these methods illustrated with some examples like particle in a box with finite barrier, anharmonic oscillator, approximation functions for particle in a box and hydrogen atom.	15

II	**ENZYME KINETICS AND THEORY OF UNIMOLECULAR REACTIONS** ***Enzyme Kinetics*:** Kinetics of (one intermediate) enzymatic reaction: Michaelis-Menton treatment, Evaluation of Michaelis's constant for enzyme-substrate binding by line weaver-Burk plot by Dixon and by Eadie-Hofstee methods. Competitive and non-competitive inhibition. ***Unimolecular reactions*:** Dynamics of unimolecular reactions (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theories of unimolecular reactions.	15
III	**PRINCIPLES OF SYMMETRY AND GROUP THEORY** Symmetry elements and Symmetry operations; Definitions of groups, subgroups, and classes; Symmetry elements in Allene, H_2O_2, Benzene and Ferrocene; Determination of point groups of small molecules and Schönfliesand Hermann-Mauguin Notations; The Great Orthogonality theorem. Character table for point group C_n (C_2v and C_3v), D_n, (n=2 and 3), T_d and O_h.	15
IV	**NON EQUILIBRIUM THERMODYNAMICS** General theory of non-equilibrium processes, Entropy production and entropy flow; Thermodynamic criteria for non-equilibrium states, Entropy production in heat flow, Mass flow, Electric current, Chemical reactions, Saxen's relation, Onsager's reciprocity relation, Thermomolecular pressure difference, Electro kinetic phenomenon, Coupled reactions.	15

Suggested Readings:

1. F. A. Cotton, Chemical Application of Group Theory, 3rd Edition. *John Willey & Sons*, 2018.
2. H. K. Moudgil, Textbook of Physical Chemistry, *PHI Publication House*, New Delhi, 2015.
3. P. Atkins and J. Paula, Atkins' Physical Chemistry, 10th Edition. *Oxford University Press*, 2014.
4. I. N. Levine, Quantum Chemistry, 7th Edition. *Pearson Education*, 2013.
5. C. Kalidas and M. V. Sangaranarayanan, Non-Equilibrium Thermodynamics: Principles & Applications, *Macmillan India Ltd*., 2012.
6. R. K. Prasad, Quantum Chemistry, *New Age International*, 2011.
7. A. K. Chandra, Introductory Quantum Chemistry, *Tata McGraw-Hill*, 2008.
8. K. J. Laidler, Chemical Kinetics, 3rd Edition. *Pearson Education*, 2007.
9. A. Katchalsky and P. F. Curren, Non-Equilibrium Thermodynamics in Biophysics*, Harvard University Press*, Cambridge, 1995.
10. G. Davidson, Group theory for Chemist, *Macmillan Physical Science*, 1991.

PHYSICAL CHEMISTRY PRACTICAL-II

Course No: CH-12	**Course Name:** Physical Chemistry Practical-II					**Course Code: 081402003 P**	
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** **II**	**L**	**T**	**P**	**Credit**	**Contact Hrs.per Week:** **04**
			0	0	4	2	**Total Hrs.:** **60**
Total Evaluation Marks: 50		**Examination Duration:** 6 Hrs.					
		Pre-requisite of course: Knowledge of solution preparation, safety measure in chemistry practical laboratory and basic practical knowledge up to UG level.					
Course Objectives	*To provide students exposure of refractometry, chemical kinetics, solution chemistry, turbidity metry, and pH, potentio and conductometry experiments. Advanced experiments such as pH metry, potentiometry and conductometry will be carried out. First-hand experience of turbidity meter studies will be provided. At the end of this course students will be equipped to carry out instrumental analysis at the research level.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of practical physical chemistry. **CO2**: Use of pH meter, potentiometer, conductivity meter in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important practical methods. **CO5**: Development of alternate analytical methods. **CO6**: Use of advanced and recent techniques in experimental chemistry.						

COURSE SYLLABUS

NOTE:
Depending on availability of time and instruments in laboratory, few experiments may be added/deleted.

Unit No.	**Contents**	**Contact Hrs.**
	• To determine the concentration of a reductant or an oxidant i.e. Ferrous ammonium sulphate, $K_2Cr_2O_7$and $KMnO_4$ by a pH metric titration method.	

I	**CHEMICAL KINETICS AND pH METRY EXPERIMENTS** *Chemical Kinetics* ● Determination of the effect of (a) change in temperature, (b) change in concentration of reactants and catalysts (c) ionic strength of the media on velocity constant of hydrolysis of an ester. ● Determine the velocity constant of hydrolysis of ethyl acetate catalyzed by an acid and NaOH solution. *Solution Chemistry* ● To determine the solubility of an inorganic salt like KCl, NaCl, KNO_3, $NaNO_3$, K_2SO_4 in water at different temperature and hence to obtain the solubility curve. ● To determine the heat of solution of given substance like oxalic acid and benzoic acid by solubility method. *pH metric* ● To determine the strength of strong acid versus strong base, weak acid versus strong base, mixture of strong and weak acids versus strong base, weak acid versus weak base, strong acid versus weak base using a pH meter.	30
II	**POTENTIOMETRY AND CONDUCTOMETRY EXPERIMENTS** *Potentiometry* ● To determine the strength of strong acid versus strong base, weak acid versus strong base, mixture of strong and weak acids versus strong base, weak acid versus weak base, strong acid versus weak base using a potentiometer. ● To prepare and test the standard reference electrode i.e., calomel electrode orsilver- silver chloride electrode. ● Titrate Mohr's salt against $KMnO_4$potentiometrically and carry out the titration inreverse order. *Turbidimetry* ● To find the turbidity of given solution by using Nephthalo turbidity meter. *Conductometry* ● Study of conductometric titration of NH_4Cl versus NaOH solution, CH_3COONa versusHCl, $MgSO_4$ versus $Ba(OH)_2$, $BaCl_2$ and $K_2SO_4$and comment on the nature of graph. ● To study stepwise neutralization of polybasic acid like oxalic acid, citric acid, phosphoric acid by conductometric titration and explain the variation in the graph.	30

Suggested Readings:

1. B. Viswanathan and P. S. Raghavan, Practical Physical Chemistry, *M V Learning*, 2017.
2. Shoemaker and Garland, Experiments in Physical Chemistry, *McGraw Hill*, 2015.
3. B. D. Khosla, V. C. Garg and Adarsh Gulati, Senior Practical Physical Chemistry, *R. Chand & Co.*, New Delhi, 2014.
4. S. K. Maity and N. K. Ghosh, Physical Chemistry Practical, *New Central book Agency*, 2012.
5. G. P. Mathews, Experimental Physical Chemistry, 1st Edition. *Oxford University Press*, 1995.
6. A. M. James and F. E. Prichard, Practical Physical Chemistry, *Lomgman*, 1994.
7. B. P. Levitt, Findley's Practical Physical Chemistry, 9th Edition. *Longman Group Ltd.*, 1993.
8. J. B. Yadav, Advanced Practical Physical Chemistry, *Goel Publishing House*, 1991.
9. R. C. Das and B. Behara, Experimental Physical Chemistry, *Tata McGraw Hill*, 1984.

DCSC- COMPUTATIONAL CHEMISTRY

Course No.:	Course Name: Computational Chemistry						Course Code: 081402004
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credit** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50		**Examination Duration:** 2 Hrs.					
		Pre-requisite of course: To provide the basic knowledge of computational Chemistry. Basic understanding of ab-initio methods, DFT, basis sets and potential energy map.					
Course Objectives	*To provide the basic knowledge of various parameters and software involved in computational Chemistry and its application towards understanding the stability of molecules and proposing its reaction mechanism.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of computational chemistry **CO2**: Scope of computational chemistry **CO3**: Computational methods **CO4**: Use of computational software and of polyatomic molecules **CO5**: Skills for analyzing stability of molecules and visualization of transition states **CO6**: Skills for proposing new molecules						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one part. Question 1 will be of 8 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 2 hours.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION TO COMPUTATIONAL CHEMISTRY** Scope of computational chemistry, Born-Oppenheimer approximation, Hartree-Fock theory, restricted HF calculations; open shell systems, ROHF and UHF calculations, HF limit and electron correlation, semi empirical methods.	7
II	**DENSITY FUNCTIONAL THEORY** Electron density, exchange-correlation functional, local Density approximation, generalized gradient approximation, hybrid density functional methods, self-Interaction corrections.	8
III	**BASIS SETS** Definition of basis sets, Slater and Gaussian type orbitals, minimal, double-zeta, split-valence, core-valence, Pople style basis Sets, polarization and diffuse functions, determination of basis functions, pseudopotentials or effective core potentials, choice of basis bets.	7

IV	**BASIC CONCEPTS OF POTENTIAL ENERGY SURFACES** Z-matrix construction, Stationary Points, geometry optimization, local and global minima, and transition state theory. Computations of single point energy, optimizations and transition states of polyatomic molecules, intrinsic reaction coordinate analysis.	8

Suggested Readings:

1. J. B. Foresman and A. Frisch, Exploring Chemistry with Electronic Structure Methods, 2nd Edition.*Gaussian Inc.*, 2015.
2. F. Jensen, Introduction to Computational Chemistry, *John Wiley & Sons*, 2007
3. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edition.*John Wiley & Sons Ltd*, 2004.
4. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2nd Edition.*John Wiley & Sons Ltd*, 2002.
5. D. A. McQuarrie, Physical Chemistry: A molecular Approach, 1st Edition.*University Science Books*, 1997.

DCSC- ANALYTICAL TECHNIQUES IN CHEMISTRY

Course No: CH-52	Course Name: Analytical Techniques in Chemistry				Course Code:081402005		
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** II	**L** 2	**T** 0	**P** 0	**Credit** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50		**Examination Duration:** 2 Hrs.					
		Pre-requisite of course: Knowledge of solution preparation, safety measure in chemistry practical laboratory and basic practical knowledge up to UG level.					
Course Objectives	*To provide students with a basic understanding of analytical chemistry, classical and modern analytical techniques. This course will strengthen the fundamentals of analytical chemistry, especially thermogravimetric, imaging and impedance spectroscopy techniques.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of analytical chemistry. **CO2**: Use of thermogravimetric, imaging and polarization techniques in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important analytical methods. **CO5**: Development of alternate analytical methods. **CO6**: Use of advanced and recent techniques in analytical chemistry.						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 8 marks each and may contain more than one part. Question 1 will be of 8 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 2 hours.

Unit No.	Contents	Contact Hrs.
I	**THERMOGRAVIMETRIC ANALYSIS (TGA/DTA/DSC)** Principle, instrumentation of TGA, DTA, and DSC. Effect of heat on Materials, Chemical decomposition and T. G. Curves, Analysis of T.G. curve to show nature decomposition reactions, the product and qualities of compounds expelled, T.G. in controlled atmosphere, applications.	8
II	**ELECTROCHEMICAL ANALYSIS** Analysis of Metal, Alloys, Soil and Fertilizers by using electrochemical techniques like cyclic voltammetry, chronoamperometry, Pulse voltammetry. Theory, principle, working and application of cyclic voltammetry, chronoamperometry, Pulse voltammetry. Use of chemical and biosensors in environmental pollutant detection.	7

III	**IMAGING TECHNIQUES** An introduction to microscopy, the transmission and scanning electron microscope, electron optics, TEM specimen preparation and imaging system, dynamics of scattering, operating principle of SEM, penetration of electron in solids, SEM operating conditions and specimen preparation, electron beam lithography.	8
IV	**ELECTROCHEMICAL POLARIZATION AND IMPEDANCE SPECTROSCOPY**	7
	Anodic and cathodic polarization, Tafel plots, anodic and cathodic Tafel slopes, Corrosion rate from corrosion current density, Open circuit potential, Impedance spectroscopy, Nyquesi plots, Bode plots.	

Suggested Readings:

1. S. L. Chopra and J. S. Kanwar, Analytical Agriculture Chemistry, *Kalyani publishers,* 2008.
2. S. M. Khopkar, Concepts in Analytical Chemistry, 2nd Edition. New Age International Pub.2004.
3. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental methods of analysis, 7th Edition. *United States*, 1988.
4. D. A. Skoog and D. M. West, Principles of instrumental analysis, 2nd Edition. *Saunders College*, Philadelphia, 1980.
5. F. D. Snell and F. M. Biffen, Commercial Methods of Analysis, Tata McGraw Hill Book Company, New York, 1944.

GE- MEDICINAL CHEMISTRY

Course No: CH-60	**Course Name:** Medicinal Chemistry				**Course Code: 081402006**		
Batch: 2024 onwards	**Programme:** P.G. (Generic Elective Course)	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks:100		**Examination Duration:** 3Hrs.					
		Pre-requisite of course: To provide basics of medicinal chemistry					
Course Objective	*This course will provide a basic understanding and fundamentals of Medicinal Chemistry, drug-target actions, process of development of new drugs and regulatory processes of drug approval, intellectual property and drug abuse and misuse.*						
Course Outcomes:	After completing this course, student is expected to learn the following. **CO1**: General overview about drugs and their function **CO2**: Idea of the various steps in drug discovery and development **CO3**: Fundamental understanding of how drug-target interactions happen **CO4**: Basic understanding of chemical principles involved in pharmacodynamics **CO5**: Classification and uses of various drugs **CO6**: A broad idea of drug manufacture, administration and drug abuse						

COURSE SYLLABUS

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit No.	Contents	Contact Hrs.
I	**FUNDAMENTALS** Historical development of systems of medicine, Basic chemical and biochemical principles, Key definitions, drug, target, receptors, enzymes, common drugs and their classification, anti-inflammatory drugs, antihistamines, antacids, antibiotics, narcotics, antivirals, and antineoplastics.	15
II	**DRUG ACTION** Chemistry of drug-target interactions, bioavailability, drug absorption, distribution, metabolism, excretion (ADME), pharmacokinetics and pharmacodynamics, toxicity, side effects, lipophilicity and hydrophilicity, blood-brain barrier and its significance, routes of drug administration	15

III	**DRUG DESIGN AND SYNTHESIS** Development of new drugs, concept of lead compounds and lead modifications, structure-activity relationship (SAR), isosterism, bio-isosterism, important chemical principles behind design of drugs, natural products and their uses, chemical synthesis of drugs, drug formulation, drug delivery, photodynamic therapy.	15
IV	**DRUGS AND SOCIETY** Regulatory processes for drug approval, regulatory agencies, intellectual property, patents, drug misuse, drug abuse, abuse of antibiotics, fraud practices in treatment, historically important drugs and vaccines.	15

Suggested Readings:

1. R. B. Silverman, The Organic Chemistry of Drug Design and Drug Action, 3rdEdition. *Academic Press*, 2014.
2. G. L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition. *Oxford University Press*, 2013.
3. D. Sriram and P. Yogeshwari, Medicinal Chemistry, 2ndEdition. *Pearson*, 2012.
4. Ed. Robert F. Dorge, Wilson and Gisvold'sTextBook of Organic Medicinal and Pharmaceutical Chemistry, 12thEdition, 2010.
5. Ed. M. E. Wolff, Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, 7th Edition. *John Wiley*, 2010.
6. S. S. Pandeya and J. R. Dmmock, An Introduction to Drug Design, 1st Edition. *New Age International*, 1999.

SWACH BHARAT INTERNSHIP PROGRAMME

Course No: CH-56	**Course Name:** Activities at Department and University Level*					**Course Code:**	
Batch: 2024 onwards	**Programme:** M.Sc. Chemistry	**Semester:** I to IV	**L** 0	**T** 0	**A** 7	**Credit** 2	**Contact Hrs. per Week: 7** **Total Hrs.: 100**
Total Evaluation Marks: Evaluation will be done at departmental level by giving the remarks as Excellent/Good/Satisfactory/Poor		**Examination Duration:** NA					
		Pre-requisite of course: None					

Course Objectives	*The main objective of this course is to make the students aware about the importance of cleanliness for social development.*
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Learn about the importance of cleanliness **CO2**: Develop skills in finding and solving sanitation related problems **CO3:** Motivating others not to litter **CO4**: Motivating others not to use plastic bags **CO5**: To manage and implement campaigns and demonstrate sanitation advice in nearby villages. **CO6**: Skill to train others

COURSE SYLLABUS

Unit No.	Contents	Contact Hrs.
I-IV	This course is applicable to all students to carry out various activities associated with cleanliness and recycling of the waste materials at departmental and university level in line with Swachh Bharat Abhiyan that may include: ● To conduct outreach programs for creating awareness on Swachh Bharat in association with NCC or NSS or women cell etc. ● To produce energy and manure using bio-wastes. ● Plantation drives to increase the green cover and conservation of old trees. ● Self-sustainable units through energy production using solar panels. ● Plastic free environment. ● Development of Green Buildings concept in the society. ● Effective Waste management and recycling. ● Rain water harvesting. ● Proper disposal of chemical waste. ● Creating awareness in the community through short films. ● Use of social media for broader community outreach. **Note**: Students will submit a brief report on the activities carried out to the department for the record purpose.	100

A = Activity

*https://www.ugc.ac.in/pdfnews/8118809_UGC-Letter-reg-Swachcha-Bharat-Abhiyan-.pdf

8. TEACHING-LEARNING PROCESS

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation or Project Work
- Technology-embedded Learning
- Hands on training
- Self study analysis
- Report writing

9. IMPLEMENTATION OF BLENDED LEARNING

Blended Learning is a pedagogical approach that combines face to-face classroom methods with computer- mediated activities in the process of teaching and learning. It implies nice blend of face-to-face and online activitiesto make the learning processes more interesting and engaging. It focuses on integration of traditional classroom activities and innovative ICT-enabled strategies. It emphasizes student-centric learning environment where the teacher is the facilitator for productive and measurable learning outcomes. It optimizes and compliments the face to face learning, giving ample freedom and flexibility to the students and teachers to access and explore the wide range of open-access sources such as video lectures, podcasts, recordings and articles through digital platforms. It gives freedom and autonomy to the teachers in selection of appropriate digital platforms, resources and time-slotsto complement and supplement face to face learning. The Blended Learning doesn't undermine the role of the teacher, rather it gives him/her an opportunity to explore the unexplored in accordance with the requirements of the curriculum.

Key features of Blended Learning

- **Student-Centric Pedagogical Approach** focusing on flexibility in timing, quality content, needs and interests of students and freedom to study through the mode of his/her choice;
- Freedom to Select variety of mediums and techniques;
- Increased student engagement in learning;
- Enhanced teacher and student interaction;

- Improved student learning outcomes;
- More flexible teaching and learning environment;
- More responsive for self and continuous learning;
- Better opportunities for experiential learning;
- Increased learning skills;
- Greater access to information, improved satisfaction and learning outcomes.

Note: It was resolved that Blended Learning with 40% component of online teaching and 60% face to face classes for each programme, may be adopted

10. ASSESSMENT AND EVALUATION

Overall assessment will be made as per CUH PG ordinances

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired if required
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments

11. KEYWORDS

- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes

- Postgraduate Attributes
- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation

12. REFERENCES

- National Education Policy-2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- The draft subject specific LOCF templates available on UGC website. https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==
- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website. https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf

13. APPENDICES

Curricular Reforms — Extracts from National Education Policy-2020

8118809_UGC-Letter-reg-Swachcha-Bharat-Abhiyan-.pdf (https://www.ugc.ac.in/pdfnews/8118809_UGC-Letter-reg-Swachcha-Bharat-Abhiyan-.pdf)

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