ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF APPLIED & PURE SCIENCES

(RSAPS)

DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE & SYLLABUS

(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.Sc. IN CHEMISTRY

(4 YEARS SINGLE MAJOR)

W.E.F

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TABLE OF CONTENTS

Preamble

The National Education Policy (NEP) 2020 conceives a new vision for India's higher education system. It recognizes that higher education plays an extremely important role in promoting equity, human as well as societal well-being and in developing India as envisioned in its Constitution. It is desired that higher education will significantly contribute towards sustainable livelihoods and economic development of the nation as India moves towards becoming a knowledge economy and society.

If we focus on the 21st century requirements, the higher education framework of the nation must aim to develop good, thoughtful, well-rounded, and creative individuals and must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first-century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education should be capable enough to enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. Overall, it should focus on preparing students for more meaningful and satisfying lives and work roles and enable economic independence.

Towards the attainment of holistic and multidisciplinary education, the flexible curricula of the University will include credit-based courses, projects in the areas of community engagement and service, environmental education, and value-based education. As part of holistic education, students will also be provided with opportunities for internships with local industries, businesses, artists, crafts persons, and so on, as well as research internships with faculty and researchers at the University, so that students may actively engage with the practical aspects of their learning and thereby improve their employability.

The curriculum of B.Sc. (Hons.) Chemistry is adopted to make the course more flexible and to provide more options for the students to broaden their skills in the field of chemistry and interdisciplinary areas. The curriculum is designed not only to provide the personal and social skills to students but also to make them fit for academics and industry with sound theoretical

and experimental knowledge.

The undergraduate curriculums are diverse and have varied subjects to be covered to meet the needs of the programs. As per the recommendations from the UGC, introduction of courses related to Indian Knowledge System (IKS) is being incorporated in the curriculum structure which encompasses all of the systematized disciplines of Knowledge which were developed to a high degree of sophistication in India from ancient times and all of the traditions and practises that the various communities of India—including the tribal communities—have evolved, refined and preserved over generations, like for example Vedic Mathematics, Vedangas, Indian Astronomy, Fine Arts, Metallurgy, etc.

At RGU, we are committed that at the societal level, higher education will enable each student to develop themselves to be an enlightened, socially conscious, knowledgeable, and skilled citizen who can find and implement robust solutions to its own problems. For the students at the University, Higher education is expected to form the basis for knowledge creation and innovation thereby contributing to a more vibrant, socially engaged, cooperative community leading towards a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation."

Abbreviations

1. Cr. - Credit
2. Major - Core Courses of a Discipline
3. Minor - May/may not be related to Major.
4. SEC - Skill Enhancement Course
5. VAC - Value Addition Course
6. AEC - Ability Enhancement Course
7. GEC - Generic Elective Course
8. IKS - Indian Knowledge System
9. AICTE - All India Institute of Technical Education
10. CBCS - Choice Based Credit System
11. HEIs - Higher Education Institutes
12. MSDE - Ministry of Skill Development and Entrepreneurship
13. NAC - National Apprenticeship Certificate
14. NCrF - National Credit Framework
15. NCVET - National Council for Vocational Education and Training
16. NEP - National Education Policy
17. NHEQF - National Higher Education Qualification Framework
18. NSQF - National Skill Qualifications Framework
19. NTA - National Testing Agency
20. SDG - Sustainable Development Goals
21. UGC - University Grants Commission
22. VET - Vocational Education and Training
23. ME-ME - Multiple Entry Multiple Exit
24. OJT - On Job Training
25. NCH - Notional Credit Hours

Section 1:

Overview

1. 1. Introduction:

The National Education Policy (NEP) 2020 clearly indicates that higher education plays an extremely important role in promoting human as well as societal well-being in India. As envisioned in the 21st-century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. According to the new education policy, assessments of educational approaches in undergraduate education will integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) that will lead to positive learning outcomes. This will lead to develop creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning, and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. and more in-depth learning.

The NEP highlights that the following fundamental principles that have a direct bearing on the curricula would guide the education system at large, viz.

i. Recognizing, identifying, and fostering the unique capabilities of each student to promote her/his holistic development.

ii. Flexibility, so that learners can select their learning trajectories and programmes, and thereby choose their own paths in life according to their talents and interests.

iii. Multidisciplinary and holistic education across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world.

iv. Emphasis on conceptual understanding rather than rote learning, critical thinking to encourage logical decision-making and innovation; ethics and human & constitutional values, and life skills such as communication, teamwork, leadership, and resilience.

v. Extensive use of technology in teaching and learning, removing language barriers, increasing access for Divyang students, and educational planning and management.

vi. Respect for diversity and respect for the local context in all curricula, pedagogy, and policy.

vii. Equity and inclusion as the cornerstone of all educational decisions to ensure that all students can thrive in the education system and the institutional environment are responsive to differences to ensure that high-quality education is available for all.

viii. Rootedness and pride in India, and its rich, diverse, ancient, and modern culture, languages, knowledge systems, and traditions.

1.2. Credits in Indian Context:

1.2.1. Choice Based Credit System (CBCS) By UGC

Under the CBCS system, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be earned by the students. This framework is being implemented in several universities across States in India. The main highlights of CBCS are as below [2]:

- The CBCS provides flexibility in designing curriculum and assigning credits based on the course content and learning hours.
- The CBCS provides for a system wherein students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.
- CBCS also provides opportunity for vertical mobility to students from a bachelor's degree programme to masters and research degree programmes.

1.3. Definitions

1.3.1. Academic Credit:

An academic credit is a unit by which a course is weighted.

1 Credit = 30 NOTIONAL CREDIT HOURS (NCH)

Yearly Learning Hours = 1200 Notional Hours (@40 Credits x 30 NCH)

30 Notional Credit Hours

Lecture/Tutorial	Practicum	Experiential Learning
1 Credit = 15 -22 Lecture	10-15 Practicum	0-8 Experiential Learning
Hours	Hours	Hours

1.3.2. ~~Course of Study:~~

Course of study indicate pursuance of study in a particular discipline/programme. Discipline/Programmes shall offer Major Courses (Core), Minor Courses, Skill Enhancement Courses (SEC), Value Added Courses (VAC), Ability Enhancement Courses (AECs) and Interdisciplinary courses.

1.3.3. Disciplinary Major:

The major would provide the opportunity for a student to pursue in-depth study of a particular subject or discipline. Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year. Advanced-level disciplinary/interdisciplinary courses, a course in research methodology, and a project/dissertation will be conducted in the seventh semester. The final semester will be devoted to seminar presentation, preparation, and submission of project report/dissertation. The project work/dissertation will be on a topic in the disciplinary programme of study or an interdisciplinary topic.

1.3.4. Disciplinary/interdisciplinary minors:

Students will have the option to choose courses from disciplinary/interdisciplinary minors and skill-based courses. Students who take a sufficient number of courses in a discipline or an interdisciplinary area of study other than the chosen major will qualify for a minor in that

discipline or in the chosen interdisciplinary area of study. A student may declare the choice of the minor at the end of the second semester, after exploring various courses.

1.3.5. Courses from Other Disciplines (Interdisciplinary):

All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below. These courses are intended to broaden the intellectual experience and form part of liberal arts and science education. Students are not allowed to choose or repeat courses already undergone at the higher secondary level (12_{th} class) in the proposed major and minor stream under this category.

i. Natural and Physical Sciences: Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc.

ii. Mathematics, Statistics, and Computer Applications: Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools.

iii. Library, Information, and Media Sciences: Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)

iv. Commerce and Management: Courses include business management, accountancy, finance, financial institutions, fintech, etc.,

v. Humanities and Social Sciences: The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behaviour, society, and nation. Students be introduced to survey

methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political

Economy and Development, Sustainable Development, Women's, and Gender Studies, etc. will be useful to understand society.

1.3.6. Ability Enhancement Courses (AEC): Modern Indian Language (MIL) & English language focused on language and communication skills. Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills. The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity. They would also enable students to acquaint themselves with the cultural and intellectual heritage of the chosen MIL and English language, as well as to provide a reflective understanding of the structure and complexity of the language/literature related to both the MIL and English language. The courses will also emphasize the development and enhancement of skills such as communication, and the ability to participate/conduct discussion and debate.

1.3.7. Skill Enhancement Course (SEC): These courses are aimed at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students and should be related to Major Discipline. They will aim at providing hands-on training, competencies, proficiency, and skill to students. SEC course will be a basket course to provide skill-based instruction. For example, SEC of English Discipline may include Public Speaking, Translation & Editing and Content writing.

A student shall have the choice to choose from a list, a defined track of courses offered from 1st to 3rd semester.

1.3.8. Value-Added Courses (VAC):

Understanding India: The course aims at enabling the students to acquire and demonstrate the knowledge and understanding of contemporary India with its historical perspective, the basic framework of the goals and policies of national development, and the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties. The course would also focus on developing an understanding among student-teachers of the Indian knowledge systems, the Indian education system, and the roles and obligations of teachers to the nation in general and to the school/community/society. The course will attempt to deepen knowledge about and understanding of India's freedom struggle and of the values and ideals that it represented to develop an appreciation of the contributions made by people of all sections and regions of the country, and help learners understand and cherish the values enshrined in the Indian Constitution and to prepare them for their roles and responsibilities as effective citizens of a democratic society.

ii. Environmental science/education: The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes, and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living. The course will also deepen the knowledge and understanding of India's environment in its totality, its interactive processes, and its effects on the future quality of people's lives.

iii. Digital and technological solutions: Courses in cutting-edge areas that are fast gaining prominences, such as Artificial Intelligence (AI), 3-D machining, big data analysis, machine learning, drone technologies, and Deep learning with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth.

iv. Health & Wellness, Yoga education, sports, and fitness: Course components relating to health and wellness seek to promote an optimal state of physical, emotional, intellectual, social, spiritual, and environmental well-being of a person. Sports and fitness activities will

be organized outside the regular institutional working hours. Yoga education would focus on preparing the students physically and mentally for the integration of their physical, mental, and spiritual faculties, and equipping them with basic knowledge about one's personality, maintaining self-discipline and self-control, to learn to handle oneself well in all life situations. The focus of sports and fitness components of the courses will be on the improvement of physical fitness including the improvement of various components of physical and skills-related fitness like strength, speed, coordination, endurance, and flexibility; acquisition of sports skills including motor skills as well as basic movement skills relevant to a particular sport; improvement of tactical abilities; and improvement of mental abilities.

These are a common pool of courses offered by different disciplines and aimed towards embedding ethical, cultural and constitutional values; promote critical thinking. Indian knowledge systems; scientific temperament of students.

1.3.9. Summer Internship /Apprenticeship:

The intention is induction into actual work situations**.** All students must undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the ***summer term***. Students should take up opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability. Students who wish to exit after the first two semesters will undergo a 4-credit work-based learning/internship during the summer term to get a UG Certificate.

1.3.9.1. Community engagement and service: The curricular component of 'community engagement and service' seeks to expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life

experiences to generate solutions to real-life problems. This can be part of summer term activity or part of a major or minor course depending upon the major discipline.

1.3.9.2. Field-based learning/minor project: The field-based learning/minor project will attempt to provide opportunities for students to understand the different socio-economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, and to observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would have the opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate solutions to the identified problems. This may be a summer term project or part of a major or minor course depending on the subject of study.

1.3.10. Indian Knowledge System:

In view of the importance accorded in the NEP 2020 to rooting our curricula and pedagogy in the Indian context all the students who are enrolled in the four-year UG programmes should be encouraged to take an adequate number of courses in IKS so that the ***total credits of the courses taken in IKS amount to at least five per cent of the total mandated credits*** *(i.e. min. 8 credits for a 4 yr. UGP & 6 credits for a 3 yr. UGP)***.** The students may be encouraged to take these courses, preferably *during the first four semesters of the UG programme*. At least half of these mandated credits should be in courses in disciplines which are part of IKS and are related to the major field of specialization that the student is pursuing in the UG programme. They will be included as a part of the total mandated credits that the student is expected to take in the major field of specialization. The rest of the mandated credits in IKS can be included as a part of the mandated Multidisciplinary courses that are to be taken by every student. All the students should take a Foundational Course in Indian Knowledge System, which is designed to present an overall introduction to all the streams of IKS relevant to the UG programme. The foundational IKS course should be broad-based and cover introductory material on all aspects.

1.3.11. Experiential Learning:

One of the most unique, practical & beneficial features of the National Credit Framework is assignment of credits/credit points/ weightage to the experiential learning including relevant experience and professional levels acquired/ proficiency/ professional levels of a learner/student. Experiential learning is of two types:

a. Experiential learning as part of the curricular structure of academic or vocational program. E.g., projects/OJT/internship/industrial attachments etc. This could be either within the Program-internship/ summer project undertaken relevant to the program being studied or as a part time employment (not relevant to the program being studied- up to certain NSQF level only). In case where experiential learning is a part of the curricular structure the credits would be calculated and assigned as per basic principles of NCrF i.e., 40 credits for 1200 hours of notional learning.

b. Experiential learning as active employment (both wage and self) post completion of an academic or vocational program. This means that the experience attained by a person after undergoing a particular educational program shall be considered for assignment of credits. This could be either Full or Part time employment after undertaking an academic/ Vocation program.

In case where experiential learning is as a part of employment the learner would earn credits as weightage. The maximum credit points earned in this case shall be double of the credit points earned with respect to the qualification/ course completed. The credit earned and assigned by virtue of relevant experience would enable learners to progress in their career through the work hours put in during a job/employment.

Section 2

Award of Degree

The structure and duration of undergraduate programmes of study offered by the University as per NEP 2020 include:

2.1. Undergraduate programmes of either 3 or 4-year duration with Single Major, with multiple entry and exit options, with appropriate certifications:

2.1.1. UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

2.1.2. UG Diploma: Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

2.1.3. 3-year UG Degree: Students who will undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits and satisfying the minimum credit requirement.

2.1.4. 4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 160 credits and have satisfied the credit requirements as given in Table 6 in Section 5.

2.1.5. 4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or

dissertation under the guidance of a Faculty Member of the University. The research project/dissertation will be in the major discipline. The students who secure 160 credits, including 12 credits from a research project/dissertation, will be awarded UG Degree (Honours with Research).

2.2. The Post Graduate Programme structure and duration of study offered by the University will include

2.2.1. 2-year PG programme (with the option of having the second year devoted entirely to research) for those who have completed a 3-year Bachelor's programme.

2.2.2. 1-year PG programme for students who have completed a 4-year Bachelor's degree; and

2.2.3. Integrated 5-year Bachelor's/Master's programme.

2.2.3. 2-year PG programme (with the option of having the second year devoted entirely to research) for those who have completed a 4-year Bachelor's programme may also opt for a 2 years PG.

2.3. The Ph.D. programme shall require a PG degree or a 4-year Bachelor's degree.

Table: 1: Award of Degree and Credit Structure with ME-ME

Award	**Year**	**Credits to earn**	**Additional Credits**	**Re-entry allowed within (yrs)**	**Years to Complete**
UG Certificate	1	40	4	3	7
UG Diploma	2	80	4	3	7
3-year UG Degree (Major)	3	120	x	x	x
4-year UG Degree (Honours)	4	160	x	x	x
4-year UG Degree (Honors with Research):	4	160	Students who secure cumulative 75% marks and above in the first six semesters		

Section 3

Credit, Credit Points & Credit hours for different types of courses

3.1. Introduction:

'Credit' is recognition that a learner has completed a prior course of learning, corresponding to a qualification at a given level. For each such prior qualification, the student would have put in a certain volume of institutional or workplace learning, and the more complex a qualification, the greater the volume of learning that would have gone into it. Credits quantify learning outcomes that are subject achieving the prescribed learning outcomes to valid, reliable methods of assessment.

The ***credit points*** will give the learners, employers, and institutions a mechanism for describing and comparing the learning outcomes achieved. The credit points can be calculated as credits attained multiplied with the credit level.

The workload relating to a course is measured in terms of credit hours. A credit is a unit by which the coursework is measured. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

Each course may have only a lecture component or a lecture and tutorial component or a lecture and practicum component or a lecture, tutorial, and practicum component, or only practicum component. Refer to the Section 1.3.1

A course can have a combination of ***lecture credits, tutorial credits, practicum credits and experiential learning credits.***

The following types of courses/activities constitute the programmes of study. Each of them will require a specific number of hours of teaching/guidance and laboratory/studio/workshop activities, field-based learning/projects, internships, and community engagement and service.

- **Lecture courses:** Courses involving lectures relating to a field or discipline by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.

- **Tutorial courses:** Courses involving problem-solving and discussions relating to a field or discipline under the guidance of qualified personnel in a field of learning, work/vocation, or professional practice. Should also refer to the Remedial Classes, flip classrooms and focus on both Slow and Fast Learners of the class according to their merit.

  Practicum or Laboratory work: A course requiring students to participate in a project or practical or lab activity that applies previously learned/studied principles/theory related to the chosen field of learning, work/vocation, or professional practice under the supervision of an expert or qualified individual in the field of learning, work/vocation or professional practice.

  Seminar: A course requiring students to participate in structured discussion/conversation or debate focused on assigned tasks/readings, current or historical events, or shared experiences guided or led by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.

- **Internship:** A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations. Internships involve working with local industry, government or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

- **Studio activities:** Studio activities involve the engagement of students in creative or artistic activities. Every student is engaged in performing a creative activity to obtain a specific outcome. Studio-based activities involve visual- or aesthetic-focused experiential work.

- **Field practice/projects:** Courses requiring students to participate in field-based learning/projects generally under the supervision of an expert of the given external entity.

Community engagement and service: Courses requiring students to participate in field-based learning/projects generally under the supervision of an expert of the given external entity. The curricular component of ‘community engagement and service’ will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

Table:2: Course wise Distribution of Credits

Broad Category of Course	**Minimum Credit Requirement**	
	3-year UG	**4-Year UG**
Major (Core)	60	80
Minor Stream	24	32
Interdisciplinary	9	9
Ability Enhancement Courses (AEC)	8	8
Skill Enhancement Courses (SEC)	9	9
Value Added Courses common for all UG	6	6
Summer Internship	4	4
Research Project / Dissertation	NA	12
Total	**120**	**160**

Table 3: Credit Distribution for 3-year Course

Semester	Course Credits							
	Major	**Minor**	**ID**	**AEC**	**SEC**	**VAC**	**SI**	**Total**
I	6	3	3	2	3	3	0	**20**
II	6	3	3	2	3	3	0	**20**
III	8	4	3	2	3	0	0	**20**
IV	12	6	0	2	0	0	0	**20**
V	12	4	0	0	0	0	4	**20**
VI	16	4	0	0	0	0	0	**20**
	60	**24**	**9**	**8**	**9**	**6**	**4**	**120**

Table 4: Credit Distribution for 4-year Course

Semester	Course Credits								Total
	Major	**Minor**	**ID**	**AEC**	**SEC**	**VAC**	**SI**	**RP**	
I	6	3	3	2	3	3	0	0	**20**
II	6	3	3	2	3	3	0	0	**20**
III	8	4	3	2	3	0	0	0	**20**
IV	12	6	0	2	0	0	0	0	**20**
V	12	4	0	0	0	0	4	0	**20**
VI	16	4	0	0	0	0	0	0	**20**
VII	16	4	0	0	0	0	0	0	**20**
VIII	4	4	0	0	0	0	0	12	**20**
	80	**32**	**9**	**8**	**9**	**6**	**4**	**12**	**160**

Section 4

Level of Courses

4.1 NHEQF levels:

The NHEQF levels represent a series of sequential stages expressed in terms of a range of learning outcomes against which typical qualifications are positioned/located. NHEQF level 4.5 represents learning outcomes appropriate to the first year (first two semesters) of the undergraduate programme of study, while Level 8 represents learning outcomes appropriate to the doctoral-level programme of study.

Table: 5: NHEQF Levels

NHEQF level	**Examples of higher education qualifications located within each level**	**Credit Requirements**
Level 4.5	Undergraduate Certificate. Programme duration: First year (first two semesters) of the undergraduate programme, followed by an exit 4-credit skills-enhancement course(s).	40
Level 5	Undergraduate Diploma. Programme duration: First two years (first four semesters) of the undergraduate programme, followed by an exit 4-credit skills-enhancement course(s) lasting two months.	80
Level 5.5	Bachelor's Degree. Programme duration: First three years (Six semesters) of the four-year undergraduate programme.	120
Level 6	Bachelor's Degree (Honours/ Honours with Research). Programme duration: Four years (eight semesters).	160

Level 6	Post-Graduate Diploma. Programme duration: One year (two semesters) for those who exit after successful completion of the first year (two semesters) of the 2-year master's programme	160
Level 6.5	Master's degree. Programme duration: Two years (four semesters) after obtaining a 3- year Bachelor's degree (e.g. B.A., B.Sc., B.Com. etc.).	80
Level 6.5	Master's degree. Programme duration: One year (two semesters) after obtaining a 4 -year Bachelor's degree (Honours/ Honours with Research) (e.g. B.A., B.Sc., B.Com. etc.).	40
Level 7	Master's degree. (e.g., M.E./M.Tech. etc.) Programme duration: Two years (four semesters) after obtaining a 4-year Bachelor's degree. (e.g., B.E./B.Tech. etc.)	80
Level 8	Doctoral Degree	Credits for course work, Thesis, and Published work

4.2. Course Code based on Learning Outcomes:

Courses are coded based on the learning outcomes, level of difficulty, and academic rigor. The coding structure is as follows:

i. 0-99: ***Pre-requisite courses*** required to undertake an introductory course which will be a pass or fail course with no credits. It will replace the existing informal way of offering bridge courses that are conducted in some of the colleges/ universities.

ii. 100-199: ***Foundation or introductory courses*** that are intended for students to gain an understanding and basic knowledge about the subjects and help decide the subject or discipline of interest. These courses may also be prerequisites for courses in the major subject. These courses generally would focus on foundational theories, concepts, perspectives, principles, methods, and procedures of critical thinking in order to provide a broad basis for taking up more advanced courses.

iii. 200-299: ***Intermediate-level courses*** including subject-specific courses intended to meet the credit requirements for minor or major areas of learning. These courses can be part of a major and can be pre-requisite courses for advanced-level major courses.

iv. 300-399: ***Higher-level courses*** which are required for majoring in a disciplinary/interdisciplinary area of study for the award of a degree.

v. ***400-499: Advanced courses*** which would include lecture courses with practicum, seminar-based course, term papers, research methodology, advanced laboratory experiments/software training, research projects, hands-on-training, internship/apprenticeship projects at the undergraduate level or First year post-graduate theoretical and practical courses.

vi. 500-599: ***Courses at first-year PG degree level*** for a 2-year post-graduate degree programme

vii. 600-699: ***Courses for second year of 2-year PG*** or 1-year post-graduate degree programme

viii. 700 -799 & above: Courses limited to doctoral students.

Course Structure & Framework

Table 6. Semester wise and component wise distribution of credit (Four Year UGP - Single Major) [6]

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M101	General Chemistry-I	100	3	3-0-0
	CHY012M112	Chemistry Lab-I	100	3	0-0-3
Minor	CHY012N101	Fundamentals of Chemistry	100	3	3-0-0
Interdisciplinary (IDC)	IKS992K101	Introduction to Indian Knowledge System - I	100	3	3-0-0
Ability Enhancement course (AEC)	CEN982A101	Communicative English - I	100	2	2-0-0
	BSH982A102	Behavioural Science-I			
Skill Enhancement Course (SEC)	CHY012S111	Preparation and Estimation Techniques	100	3	3-0-0
Value Added Course (VAC)	VAC-1	Basket Course	100	3	3-0-0
		Swayam/MOOCS		4/5/6	
TOTAL CREDIT FOR 1st SEMESTER				20 + 4/5/6	

2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M201	General Chemistry-II	100	3	3-0-0
	CHY012M212	Chemistry Lab-II	100	3	0-0-3
Minor	CHY012N201	General Chemistry Lab-I	100	3	0-0-3
IDC	IDC-2	Introduction to Indian Knowledge System - II	100	3	3-0-0
AEC	AEC982A201	Communicative English and Behavioural Science- II	100	2	2-0-0
SEC	CHY012S211	Basic Preparative Techniques in Chemistry and Food Analysis	100	3	3-0-0
VAC	VAC-2	Basket Course	100	3	3-0-0
		Swayam/MOOCS		4/5/6	
TOTAL CREDIT FOR 2nd SEMESTER				20 + 4/5/6	
3rd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M301	Organic Chemistry-I	200	4	4-0-0

	CHY012M311	Chemistry Lab - III	200	4	0-0-4
Minor	CHY012N301	Physical & Organic Chemistry	200	4	4-0-0
IDC	IDC-3	Basket Course	200	3	3-0-0
AEC	AEC982A301	Communicative English and Behavioural Science- III	200	2	2-0-0
SEC	CHY012S311	Analytical Laboratory Methods	200	3	3-0-0
		Swayam/MOOCS	200	4/5/6	
TOTAL CREDIT FOR 3rd SEMESTER				20 + 4/5/6	
4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M401	Inorganic Chemistry-I	200	4	4-0-0
	CHY012M402	Physical Chemistry-I	200	4	4-0-0
	CHY012M113	Chemistry Lab-IV	200	4	0-0-4
Minor	CHY012N401	Organic & Inorganic Chemistry	200	3	3-0-0
	CHY012N412	General Chemistry Lab-II	200	3	0-0-3

AEC	AEC982A401	Communicative English and Behavioral Science- IV	200	2	2-0-0
		Swayam/MOOCS	200	4/5/6	
			TOTAL CREDIT FOR 4th SEMESTER	20 + 4/5/6	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M501	Organic Chemistry-II	300	4	4-0-0
	CHY012M502	Inorganic chemistry II	300	4	4-0-0
	CHY012M523	Physical chemistry II	300	4	4-0-0
Minor	CHY012N501	Inorganic & Physical Chemistry	300	4	4-0-0
Internship			300	4	0-0-0
			TOTAL CREDIT FOR 5th SEMESTER	20	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M601	Spectroscopy	300	4	4-0-0

	CHY012M602	Quantum Chemistry	300	4	4-0-0
	CHY012M603	Introduction to environmental and Green Chemistry	300	4	4-0-0
	CHY012M624	Analytical Chemistry	300	4	4-0-0
Minor	CHY012N601	Concepts of Analytical Chemistry	300	4	4-0-0
TOTAL CREDIT FOR 6th SEMESTER				20	
7th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M701	Organic Chemistry III	400	4	4-0-0
	CHY012M702	Physical Chemistry III	400	4	4-0-0
	CHY012M703	Inorganic Chemistry-III	400	4	4-0-0
	CHY012M704	Name reactions & Reagents in Organic Chemistry	400	4	4-0-0
Minor	CHY012N701	Chemistry in Everyday Life	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				20	

8th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	CHY012M801	Advanced Instrumental Techniques	400	4	4-0-0
Research Methodology	CHY012M802	Research Methodology	400	4	4-0-0
Dissertation /Research Project	CHY012M823	Research Project	400	12	0-0-0
Or 400 level advanced course Core (in lieu of Dissertation/Research project)	CHY012M804	Industrial and Polymer Chemistry	400	4	4-0-0
	CHY012M805	Material Chemistry	400	4	4-0-0
	CHY012M806	Biochemistry and Natural Products	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				20	

Section 6

Graduate Attributes & Learning Outcomes

6.1. Introduction:

As per the NHEQF, each student on completion of a programme of study must possess and demonstrate the expected ***Graduate Attributes*** acquired through one or more modes of learning, including direct in-person or face-to-face instruction, online learning, and hybrid/blended modes. The graduate attributes indicate the quality and features or characteristics of the graduate of a programme of study, including learning outcomes relating to the disciplinary area(s) relating to the chosen field(s) of learning and generic learning outcomes that are expected to be acquired by a graduate on completion of the programme(s) of study.

The graduate profile/attributes must include,

- capabilities that help widen the current knowledge base and skills,
- gain and apply new knowledge and skills,
- undertake future studies independently, perform well in a chosen career, and
- play a constructive role as a responsible citizen in society.

The graduate profile/attributes are acquired incrementally through development of cognitive levels and describe a set of competencies that are transferable beyond the study of a particular subject/disciplinary area and programme contexts in which they have been developed.

Graduate attributes include,

- ***learning outcomes that are specific to disciplinary areas*** relating to the chosen field(s) of learning within broad multidisciplinary/interdisciplinary/ transdisciplinary contexts.
- ***generic learning outcomes*** that graduate of all programmes of study should acquire and demonstrate.

6.2. Graduate Attributes:

Table: 7: The Learning Outcomes Descriptors and Graduate Attributes

Sl.no.	Graduate Attribute	The Learning Outcomes Descriptors
GA1	**Disciplinary knowledge**	Acquire knowledge and coherent understanding of the chosen disciplinary/interdisciplinary areas of study.
GA2	**Complex Problem solving**	Solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.
GA3	**Analytical & Critical thinking**	Apply analytical thought including the analysis and evaluation of policies, and practices. Able to identify relevant assumptions or implications. Identify logical flaws and holes in the arguments of others. Analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.
GA4	**Creativity**	create, perform, or think in different and diverse ways about the same objects or scenarios and deal with problems and situations that do not have simple solutions. Think 'out of the box' and generate solutions to complex problems in unfamiliar contexts by adopting innovative imaginative, lateral thinking, interpersonal skills, and emotional intelligence.
GA5	**Communication Skills**	Listen carefully, read texts and research papers analytically, and present complex information in a clear and concise manner to different groups/audiences. Express thoughts and ideas

		effectively in writing and orally and communicate with others using appropriate media.
GA6	**Research-related skills**	Develop a keen sense of observation, inquiry, capability for asking relevant/ appropriate questions. Should acquire the ability to problematize, synthesize and articulate issues and design research proposals, define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships. Should develop the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work.
GA7	**Collaboration**	Work effectively and respectfully with diverse teams in the interests of a common cause and work efficiently as a member of a team.
GA8	**Leadership readiness/ qualities**	Plan the tasks of a team or an organization and setting direction by formulating an inspiring vision and building a team that can help achieve the vision.
GA9	**Digital and technological skills**	Use ICT in a variety of learning and work situations. Access, evaluate, and use a variety of relevant information sources and use appropriate software for analysis of data.
GA10	**Environmental awareness and action**	Mitigate the effects of environmental degradation, climate change, and pollution.

		Should develop the technique of effective waste management, conservation of biological diversity management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

6.3. Programme Learning Outcomes (PLO)

The outcomes described through learning outcome descriptors in Table 6 are attained by students through learning acquired on the completion of a programme of study relating to the chosen fields of learning, work/vocation, or an area of professional practice. The term 'programme' refers to the entire scheme of study followed by learners leading to a qualification. Individual programmes of study will have defined learning outcomes that must be attained for the award of a specific certificate/diploma/degree.

PLO1: **Knowledge of Chemistry**: The students shall gain the foundation and concepts in Chemistry in general. The students shall be able to relate the basic knowledge of Chemistry to the broad understanding of life and industrial processes.

PLO2: **Develop the ability to solve complex problems:** Identify, formulate, review literature, and analyze complex problems of chemistry and also think methodically, independently and draw a logical conclusion using the principles of chemical and basic sciences.

PLO3: Design/ Develop solutions: The student shall have the ability for appreciating, understanding and developing strategies to address problem requiring knowledge and skills of Chemistry and come forward with innovative solutions.

PLO4: Develop the ability to create: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PLO5: Develop effective communication skills: Enhancement in communication skill is important for overall growth of the student.

PLO6: Develop research related skills: One should grow the ability to manage and demonstrate the experiment within the set limit. One should be capable to identify and organize proper resources required for a project for completion with ethical scientific

conduct, safety and chemical hygiene is practiced.

PLO7: Develop the skills for collaborative work and team building: Though students may come from diverse fields but they must work in team when needed. The student should behave with fellow classmates in an accommodative as well as meaningful way. There should be some positive outcome from the team against the concerned issues

PLO8: Develop leadership quality: Leadership quality is a very coveted characteristic for students which will lead to a very effective class of environment.

PLO9: Imbibe emerging technological skills: One should be capable to identify digital problem and organize proper resources required for a project for completion with ethical scientific conduct, safety is practiced.

PLO10: Develop environment awareness and sustainability awareness: Understand the impact of chemical synthesis and find out the green route for chemical reaction for sustainable development solutions in environmental context, and demonstrate the knowledge and need of sustainable development

Section 7
Program Evaluation

7.1 The Programme structures and examinations shall normally be based on Semester System. However, the Academic Council may approve Trimester/Annual System for specified programmes.

7.2 In addition to end term examinations, student shall be evaluated for his/her academic performance in a Programme through, presentations, analysis, homework assignments, term papers, projects, field work, seminars, quizzes, class tests or any other mode as may be prescribed in the syllabi. The basic structure of each Programme shall be prescribed by the Board of Studies and approved by the Academic Council.

7.3 Each Programme shall have a number of credits assigned to it depending upon the academic load of the Programme which shall be assessed on the basis of weekly contact hours of lecture, tutorial and laboratory classes, self-study. The credits for the project and the dissertation shall be based on the quantum of work expected.

7.4 Depending upon the nature of the programme, the components of internal assessment may vary. However, the following suggestive table indicates the distribution of marks for various components in a semester: -

	Component of Evaluation	Marks	Frequency	Code	Weightage (%)
A	**Continuous Evaluation**				
	Analysis/Class test	Combination of any three from (i) to (v) with 5 marks each	1-3	C	25%
	Home Assignment		1-3	H	
	Project		1	P	
	Seminar		1-2	S	
	Viva-Voce/Presentation		1-2	V	
	MSE	MSE shall be of 10 marks	1-3	Q/CT	
	Attendance	Attendance shall be of 5 marks	100%	A	5%
	Semester End Examination		1	SEE	70%
					100%

Section 8
Detailed Syllabus

SYLLABUS (1st Semester)		
Subject Name: General Chemistry-I	**Level: 100**	**Subject Code: CHY012M101**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Chemistry-I** is to provide basic understanding and application of structure of atom and periodicity of atoms along with their bonding prospective to form compounds, also a brief idea of their acid and base properties. In this paper students will also be provided with basic idea of organic chemistry.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and get the detailed idea of atomic structure, their periodicity and chemical bonding along with acid base properties	BT1
CO2	**Explain** the principle and apply the knowledge for solving the problems related to their structure and bonding.	BT2
CO3	**Apply** the idea to interpret changes of properties along the periods and group	BT3
CO4	**To get** information about basic organic chemistry	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Fundamentals of Atomic Structure** Basic quantum mechanical ideas and principles leading to atomic structure, black body radiation, Planck's hypothesis, wave character of particles- electron diffraction, discrete nature of energy levels of atomic and molecular systems, line spectra of atoms and molecules, de Broglie hypothesis, uncertainty principle. Schrödinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular distribution curves, shapes of *s, p, d* and *f* orbitals, probability diagrams, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, variation of orbital energy with atomic number.	**15**

II	**Periodicity of Elements** s, p, d, f block elements, the long form of periodic table, detailed discussion of the following properties: effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, atomic radii (van der Waals), ionic and crystal radii, covalent radii, ionization enthalpy, electron gain enthalpy, electronegativity: Pauling's, Mulliken's, Allred Rachow's and Mulliken-Jaffe's electronegativity scales, variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.	**15**
III	**Chemical Bonding I** Ionic bonding: size effects, packing of ions in crystals, lattice energy, Born-Lande equation and its applications, Born-Haber cycle and its applications. Solvation energy, polarizing power and polarizability, ionic potential, Fazan's rule. Covalent bonding: Lewis structures, formal charge. Valence bond theory, directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs, bond moment and dipole moment, concept of resonance, resonance energy, resonancestructures.	**15**
IV	**Introduction to organic compounds** Unique properties of organic compounds, sources of organic compounds, classification of organic compounds on the basis of their functional groups, homologous series, IUPAC nomenclature for organic compounds with single and multiple functional groups, chain, position and functional group isomerism, special types of organic compounds. Covalent bond, hybridization of carbon in organic compounds, orbital representation of methane, ethane, ethyne and benzene.	**15**
TOTAL		**60**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60 hrs	--	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. ; 4th edition; 2007; PearsonEducation.
3. Organic Chemistry, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition,

2017, published by Prentice Hall.

Reference Books:

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indianedition.

2. Cotton F.A., Wilkinson, G., Murillo A., BochmannM.;*Advanced Inorganic Chemistry;*6th edition; 2007; Wiley Interscience; NewYork

3. Sykes, P. *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, Pearson India.

SYLLABUS (1st Semester)

Subject Name: Chemistry Lab-I	**Level: 100**	**Subject Code: CHY012M112**
L-T-P-C–0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

***Objective*: The objective of Chemistry Lab I** is to provide the knowledge of estimation of chemical species with titrimetric, viscometric and kinetic analysis as well as practical experience of inorganic compound synthesis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Show** the preparation of inorganic compounds and salt.	BT1
CO2	**Demonstrate** the estimation the impurities in water and inorganic compounds in solutions.	BT2
CO3	**Experiment** with various techniques to determine the chemical elements present in sample.	BT3
CO4	**Compare** the viscosity, surface tension of unknown solutions and to inspect the rate of reaction.	BT4

Detailed Syllabus:

1. Preparation of following Inorganic compounds:
   a) Chrome alum, $K_2SO_4.Cr_2(SO_4)_3.24H_2O$
   b) Ferrous ammonium sulfate or Mohr salt, $FeSO_4.(NH_4)_2SO_4.6H_2O$

2. To determine the total hardness of water by titration with EDTA
3. Estimation of Ferrous ion Fe(II) using $KMnO_4$ solution
4. Estimation of copper by using standard solution of sodium thiosulphate
5. To determine the water of crystallization of green vitriol by titration of its prepared solution with $KMnO_4$ solution
6. To determine the coefficient of viscosity of a given liquid by Ostwald viscometer.
7. To determine the composition of a given mixture by viscosity method.
8. To determine the surface tension of a liquid by stalagmometer.
9. To determine the composition of a given mixture by surface tension method.
10. To determine the specific reaction rate of hydrolysis of methyl acetate catalysed by hydrogen ions at room temperature.
11. To study the rate of acid catalysed iodination of acetone.

Text Books:

1. *A text Book of Practical Chemistry*, Barua, S, 2th edition; 2016; KalyaniPublishers.
2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7thedition; Pearson.

Reference Books:

1. Mendham J., Denney R.C., Barnes J.D. and. ThomasM.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., NewDelhi
2. Halpern,M.;*Experimental Physical Chemistry*, 6th edition, 2008; Prentice Hall, Upper Saddle River, NJ07458.

SYLLABUS (1stSemester) (Minor)

Subject Name: Fundamentals of Chemistry	**Level: 100**	**Subject Code: CHY012N101**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: (T)**

Objective: The objective of **Fundamentals of Chemistry** is to make students familiar with origin of quantum theory and atomic structure. It will help students to understand the bonding and structure of molecules, and also evaluate acidic-basic character of compounds.

Course Outcomes:

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

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Recall** the concepts of quantum theory.	BT1
CO2	**Explain** the theories of chemical bonding.	BT2
CO3	**Apply** the concept of hybridization to geometry.	BT3
CO4	**Examine** the compounds to determine the chemical components present in sample.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Fundamentals of atomic structure** Origin of Quantum theory (black body radiation, heat theory, H-atom spectra, photo-electric effect), calculations based on Bohr's theory of H-atom – atomic spectra of hydrogen atom, wave-particle duality, de Broglie hypothesis, Heisenberg's uncertainty principle. Schrödinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular distribution curves, shapes of *s*, *p*, *d* and *f* orbitals, probability diagrams, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, variation of orbital energy with atomic number.	**15**
II.	**Chemical Bonding** Ionic bonding: Size effects, radius ratio rules and their limitations, lattice energy, Born-lande equation and its applications, Born-Haber cycle. Covalent bonding: Valence bond theory, hybridizations, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs, dipole moment, electronegativity.	**15**
III.	**Structure and bonding of Organic compound** Hybridization, localized and delocalized chemical bond, resonance, conditions of resonance, Electronic displacements: inductive effect, electrometric effect, mesomeric effect &hyperconjugation, nature of fission of covalent bond, type of reagents: nucleophiles and electrophiles, Reaction intermediates: carbocations, carbanions, free radicals, carbenes, nitrenes, and benzynes.	**15**

IV.	**Acid-Base concept** Arrhenius concept, Bronsted-Lowry's concept, relative strength of acids, Pauling rules, amphoterism, Lewis concept, superacids, HSAB principle, acid base equilibria in aqueous solution and pH, acid-base neutralisation curves.	**15**
Total		**60**

List of Experiments:

1) To determine the strength of the given glucose solution by titrating with Fehling's solution.
2) Estimation of Ferrous Iron, Fe (II) using potassium permanganate solution.
3) Estimation of copper by using standard solution of sodium thiosulphate ($Na_2S_2O_3$)
4) To determine the coefficient of viscosity of the given liquid at a given concentration by using Ostwald's viscometer.

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60 hrs	--	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Organic Chemistry*, MorrisonR. T. and BoydR.N., Bhattacharjee S.K.B.,6th edition, 2011, published by Prentice Hall.
2. *A text Book of Practical Chemistry*, Barua, S, 2th edition; 2016; Kalyani Publishers.

Reference Books:

1. Huheey, J.E. Keiter, E.A. Keiter, R.L Medhi, O.K.; *Inorganic Chemistry Principles of Structure and Reactivity*; 4th edition, 2006; Pearson Education.
2. Sen, B.K.; Quantum Chemistry Including Spectroscopy; 4th edition; 2018; KakyaniPublisheres, New Delhi.
3. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7thedition Pearson.

SYLLABUS (1stSemester)

Subject Name: Preparation and Estimation techniques **Subject Code: CHYO12S111**

LTPC: 0-0-6-3 **Credit: 3** **Level: 100** **Scheme of Evaluation: T**

Objective:

The objectives of **Preparation and Estimation techniques** are to make students familiar with organic and inorganic preparation methods with hands on practical. It will also improve the understanding of the concepts of estimation and separation processes.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and gain the preparation knowledge of inorganic compounds.	BT1
CO2	**Explain** the concept of organic synthesis methods	BT2
CO3	**Apply** the knowledge of chromatography in separation of compounds.	BT3
CO4	**Analyse** and **Estimate** the species present by gravimetry.	BT4

1. **Preparation of following Inorganic compounds**:
   I. Potash alum
   II. Sodiumtrioxalatoferrate(III)
2. **Preparation of following Organic compounds**:
   I. Aspirin
   II. *p*-Bromoaniline
3. **Chromatography**:
   I. To separate and identify the amino acids by ascending paper chromatography.
   II. To separate and identify the sugars by ascending paper chromatography.
   III. Separation of a mixture of dyes by column chromatography.

4. **Gravimetry**
   I. Estimation of Silver
   II. Estimation of Barium
   III. Estimation of Sulphate
5. **Demonstration of UV-Vis Spectrophotometer**

Text Books:

1. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; Kalyani Publishers.

2. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

Reference Books:

1. Mendham J., Denney R.C., Barnes J.D. and. ThomasM.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., NewDelhi
2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005,Pearson

SYLLABUS (2nd Semester)

Subject Name: General Chemistry-II	Level: 100	Subject Code: CHY012M201
L-T-P-C : 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)

Course Objective: The objective of **Chemistry-II** is to understand and apply the concepts of classical thermodynamics. It will also provide in-depth knowledge related to the fundamental concepts on organic parameters which is required to rationalize and predict the chemical reactivity

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and gain the knowledge from laws of thermodynamics to solve the complex problems of physical chemistry	BT1
CO2	**Explain** the concept of thermodynamical parameters and their importance to interpret the spontaneity of reaction.	BT2
CO3	**Apply** the knowledge of chemical kinetics and analyze chemical reactions and reaction mechanism.	BT3
CO4	**Illustrate** different parameters like aromaticity, inductive effect, etc. which is vital to understand the chemical reaction	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Chemical Thermodynamics-I** Terminology used in thermodynamics (system, surroundings, extensive and intensive properties, state and path functions), concept of heat and work. *First law:* Internal energy, statement first law, Calculation of w, q, ΔU & ΔH for expansion of ideal gases under isothermal and adiabatic conditions for reversible and irreversible processes, heat capacity and relation between C_p&C_v, Joule-Thomson experiment, relation between P,V and T in adiabatic processes, limitations of first law. *Thermochemistry:* Heats of reactions: standard enthalpy changes, Hess's Law of heat summation and its applications, calculation of bond dissociation energy from thermochemical data, effect of temperature on enthalpy of reactions (Kirchhoff's equation).	**15**
II	**Chemical Thermodynamics-II** *Second Law*: Different statements of the law, Cornot's cycle and its efficiency, Carnot's theorem *Concept of entropy*: Entropy as a criterion of spontaneity and equilibrium, entropy change for an ideal gas, entropy of phase transitions, entropy of mixture of ideal gas, entropy of mixing. *Gibbs and Helmholtz functions:* Gibbs function (G) and Helmhotz (work) function (A) as thermodynamic quantities, criteria of spontaneity, variation of G with T and P, Maxwell relations, Gibbs-Helmholtz equation	**15**
III	***Third law*: Nernst heat theorem, statement of third law, residual entropy.** Equilibrium constant, thermodynamic derivation of law of mass action, equilibrium constant of a reaction in terms of standard Gibb's free energy, relation between K_p and K_c, Le Chatelier principle, van't Hoff isotherm and isochore, Clapeyron-Clausius equation and its applications. .	**15**
IV	**Chemical Bonding and structure of organic molecules** Bond angles, bond length and bond energies, resonances or mesomeric effect and aromaticity, tautomerism, hydrogen bonding and its effect on the properties, polarity of bonds. Structural effects like inductive, resonance, hyper conjugation, steric effect and their influence on acidity and basicity of organic compounds, pKa and pK values of common organic acids and bases.	**15**
	Total	**60**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
60 hrs	-	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Physical Chemistry*, Atkins P. W.and Paula J. de; 11th edition; 2018; Oxford UniversityPress.
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 48th edition; 2020; Vishal PublishingCompany.
3. *Organic Chemistry*, Stanley H. Pine, 5th edition,2014, McGraw-Hill Bool.
4. *Organic Chemistry*, Solomons T.J., 11th Revised edition,2013, John Wiley & Sons Inc.

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrandcompany.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;*7th edition; 2018; Oxford UniversityPress.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 8th edition,; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer AcademicPublishers
5. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2017, published by Prentice Hall.

SYLLABUS (2ndSEMESTER)

Subject Name: Chemistry Lab II **Level: 100** **Subject Code: CHY012M212**

L-T-P-C: 0-0-6-3 **Credit Units: 3** **Scheme of Evaluation: P**

Course Objective: The objective of **Chemistry Lab II** is to improve the understanding of the theoretical concepts and application of organic chemistry as well as to grow the practical knowledge.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in modern applied chemistry.	BT1
CO2	**Interpret** analytical abilities for independent thinking.	BT2

CO3	**Make use** of the functional group analysis of simple organic compounds tosynthesize different derivatives of simple organic molecules	BT3
CO4	**Distinguish** different methods for the preparation of complexes	BT4

Detailed Syllabus:

A. Qualitative analysis of organic sample should be done by eachstudent.

1. Detection of special elements (N, Cl, S) by Lassaigne'stest
2. Solubility and Classification (solvents: H_2O, 5% HCl, 5% $NaHCO_3$, 5%NaOH)
3. Detection of the following functional groups by systematic chemical tests: Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), Phenolic – OH, Carboxylic acid (-COOH), Carbonyl (>C=O); only one test foreach functional group is to be reported along with confirmatory test, if any existsthere.
4. Preparation of derivative and purification bycrystallization
5. Determination of M.P. of the given sample and itsderivative

   Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (at least 5)

B. The following preparations are to be done by each student in class. Any one of these will be required to be done in theexamination.

1. Acetylation: Preparation of acetanilide from aniline OR preparation of aspirin from salicylic acid (any oneonly).
2. Nitration: Preparation of m-dinitrobenzene from nitrobenzene OR preparation of p- nitro acetanilide from acetanilide (any oneonly).
3. Preparation of benzanilide fromaniline

C. Purification of mixture of amino acids by PaperChromatography

D. To determine the strength of a given glucose solution by Fehling'ssolution

Text Book:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005,Pearson.

Reference Books:

1. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

SYLLABUS (2ndSEMESTER)

Subject Name: General Chemistry Lab-I Level: 100 Subject Code: CHY012N201

L-T-P-C: 0-0-6-3 Credit Units: 3 Scheme of Evaluation: P

Course Objective: The objective of **General Chemistry Lab-I** is to provide the knowledge of volumetric estimation and qualitative analysis of organic compounds as well as practical experience of organic compound analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in analytical chemistry	BT1
CO2	**Demonstrate** the estimation of Ferrous Iron, Fe (II) and copper	BT2
CO3	**Apply** the knowledge oforganic chemistry to analyse the functional group analysis of simple organic compounds to synthesize different derivatives of simple organic molecules.	BT3
CO4	**Inspect** and determine the strength of glucose solution	BT4

Detailed Syllabus:

1) To determine the strength of the given glucose solution by titrating with Fehling's solution.
2) Estimation of Ferrous Iron, Fe (II) using potassium permanganate solution.
3) Estimation of copper by using standard solution of sodium thiosulphate ($Na_2S_2O_3$)
4) Qualitative organic analysis:
   a) Detection of N, S, and halogens in organic compounds
   b) Detection of functional groups
5) To determine the coefficient of viscosity of the given liquid at a given concentration by using Ostwald's viscometer.
6) To determine the surface tension by stalagmometer.

Text Book:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
2. *A text book of Practical Chemistry*, Barua, S, 2th edition; 2016; Kalyani Publishers.

Reference Books:

2. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

SYLLABUS (2nd Semester)(SEC)

Subject Name: Basic Preparative Techniques in Chemistry--And Food Analysis			**Subject Code: CHY012S211**
L-T-P-C: 0-0-6-3	**Credit Units: 3**	**Level: 100**	**Scheme of Evaluation: P**

Objective: The **Basic preparative techniques in chemistry and food analysis** is to provide the practical knowledge of synthesis of inorganic and organic compounds as well as some basic techniques for determination the adulterants in food stuffs

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in preparation of inorganic and organic compounds.	BT1
CO2	**Demonstrate** the synthetic methods for preparation of inorganic and organic compounds of practical importance.	BT2
CO3	**Make use** of the synthetic techniques to prepare different derivatives of simple organic molecules as well as coordination compounds.	BT3
CO4	**Demonstrate** different methods for finding the adulterants in food stuffs.	BT4

Detailed Syllabus:

12. Preparation of following inorganic compounds:
    c) Potassiumtrisoxalatoferrate(III) $K_3[Fe(C_2O4)_3].3H_2O$
    d) Potassiumtrisoxalatoaluminate(III) $K_3[Al(C_2O4)_3].3H_2O$
    e) Hexamminenickel(II) chloride, $[Ni(NH_3)_6]Cl_2$
    f) Hexammincobalt(II) chloride, $[Co(NH_3)_6]Cl_2$

2. Preparation of following organic compounds:

a) Osazone from glucose.

b) Aspirin from salicylic acid and acetic anhydride.

c) Two step preparation:

i) Aniline to acetanilide to p-nitroacetanilide

ii) Benzoin to benzil to benzilic acid.

3. To determine the adulterants in food stuffs:

a) To detect adulterants in milk

b) To detect adulterants in turmeric powder

c) To detect vanaspati in pure ghee.

Text Books:

1. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th edition; Pearson.

Reference Books:

1. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

2. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; Kalyani Publisher

SYLLABUS (3rd SEMESTER)

Subject Name: Organic Chemistry I		**Subject Code:** CHY012M301
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation:**

Objective: The objective of **Organic Chemistry I** are to provide a thorough knowledge of stereochemistry and conformational analysis of organic molecules, classifications of reaction with mechanism, stability and reactivity of reaction intermediates.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the stereo chemical and conformational aspect of molecules.	BT1

CO2	**Explain** the background of organic reaction mechanisms like formation of carbocation, carbenes etc and to know about the types of reactions and mechanisms by realizing the various factors which are affecting on the reactions.	BT2
CO3	**Apply** the concept of organic chemistry to understand the methods of preparation and chemical reactions of alkanes and cycloalkanes.	BT3
CO4	**Analyze** the reaction mechanism to develop strategy of a new reactions.	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Stereochemistry-I** Types of isomerism, types of stereoisomerism– conformational and configurational isomers, enantiomers & diastereomers. Geometrical isomerism– determination of configuration of geometrical isomers. Syn/anti, cis/trans & E/Z system ofnomenclature. Introduction to molecular symmetry and chirality, Axis, plane, centre, alternating axis of symmetry. Optical isomerism – optical activity, Criteria for showing optical activity, Enantiomers, stereogenic centre, asymmetry, molecular chirality, racemic modification, methods of resolution of racemic modification, Relative and absolute configuration; D, L and R, S configuration for asymmetric and dissymmetric molecules, Cahn-Ingold-Prelog rules. Conformational isomerism, conformation of acyclic systems with examples of ethane and butane, nomenclature for the conformers, projection formula-Newman projections and Sawhorse formulae, Fischer and flying wedge formulae, axial and equatorial bonds.	
II	**Organic reaction mechanism I** Idea of driving force, activation energy, transition state, energy profile diagrams, concept of kinetic and thermodynamic control of reactions, notations used in reaction mechanisms, types of bond fission, types of reagents – electrophiles and nucleophiles, types of reaction intermediates - carbocations, carbanions, free radicals, carbenes, arynes and nitrenes, methods of determination of reaction mechanism. Addition reactions: electrophilic, nucleophilic and free radical mechanism. Elimination reaction: ß-elimination reaction - base catalysed and pyrolytic elimination.	**12**

III	**Reaction mechanism II** Substitution reactions: Electrophilic, nucleophilic and free radical mechanism. Nucleophilic aliphatic substitution – SN1, SN2 reactions and free radical mechanism, energy profile diagram of SN1 and SN2 reactions and their stereochemistry, ambident nucleophiles and substrates. Mechanism of electrophilic aromatic substitution, directive influence of groups, activation and deactivation of aromatic rings, o/p ratio, mechanism to begiven with examples. Mechanism of nucleophilic aromatic substitution, intermediate complex mechanism, benzyne mechanism. Directive influences in benzyne mechanism, cine substitution, methods of trapping benzyne intermediates.	**12**
IV	**Chemistry of organic compounds – I** Alkanes –IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, methods of preparation of alkanes with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties and chemical reaction of alkanes. Cycloalkanes – Baeyer's strain theory and its limitations, ring strain in small rings (cyclopropane and cyclobutane), theory of stainless rings, shapes of cyclopentane and cyclohexane rings,the case of cyclopropane ring: banana bonds.	**12**
	Total	**48**

Text books:

1. *Advanced organic chemistry: Reactions, mechanism and structure*; March Jerry; 7th edition; John Wiley; 2015; United States of America.
2. *Advanced organic chemistry*; Carey F. A. and Sundberg R. J.; 5th edition; 2007; Plenum.
3. *A guide book to mechanism in organic chemistry*; Sykes Peter; 6th edition; Longman.

Reference books:

1. Ingold C.K.; *Structure and mechanism in organic chemistry*; 2nd edition; Cornell University press.
2. Norman R.O.C.and Coxon J. M.; *Principle of Organic Synthesis*; 3rd edition; 1993; Blackie academic professional.
3. Warren S.; *Designing organic synthesis*; 2nd edition; 2008; Wiley; UK.
4. Nasipuri D.; *Stereochemistry of organic compounds*; 5th edition; 2014; New age international
5. Kalsi P.S.; *Stereochemistry of organic compounds*; 2007; New age international.

SYLLABUS (3rd Semester)

Subject Name: Chemistry Lab III	**Level: 200**	**Subject Code:** CHY012M311**L-**
T-P-C: 0-0-8-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Chemistry Lab-III** is to provide the knowledge of conductometric, pH metric and photophysical principles as well as practical experience of inorganic compound synthesis

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Show** the preparation of inorganic compounds	BT1
CO2	**Demonstrate** proficiency in the preparation of various inorganic compounds, understanding the principles of stoichiometry and chemical synthesis.	BT2
CO3	**Experiment** with titration techniques, encompassing conductometric titration and pH metric titrations	BT3
CO4	**To** apply fundamental principles of physical chemistry through experiments such as verifying Debye-Huckel, Onsagar equation,	BT4

	testing the validity of Beer-Lambert's law using a spectrophotometer, and determining the dissociation constant of acetic acid/oxalic acid using Henderson's equation	

Detailed Syllabus:

1. Preparation of following Inorganic compounds:

a) Tetraamminecopper(II)sulfate, $[Cu(NH_3)_4]SO_4.H2O$

b) Potassiumtrioxalatochromate(III), $K_3[Cr(C_2O_4)_3].3H_2O$

c) Sodium trioxalatochromate (III), $Na_3[Fe(C_2O_4)_3].9H_2O$

2. Determination of acetic acid in commercial vinegar using NaOH.

3. To determine the percentage of calcium carbonate in precipitated chalk by using HCl and NaOH solution.

4. Conductometric titration
   i. HCl vs NaOH
   ii. Oxalic acid vs NaOH
   iii. Acetic acid vs NaOH.
5. To verify Debye, Huckel, Onsagar equation for sodium chloride.
6. To test the validity of Beer-Lambert's law using spectrophotometer.
7. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.
8. Determine the dissociation constant of acetic acid/ oxalic acid using Hendersen's equation.

Text Books:

1. Barua, S. (2016). *A Textbook of Practical Chemistry (2nd ed.).* Kalyani Publishers.

2. G. Svehla and B. Sivasankar. *Vogel's Qualitative Inorganic Analysis*,7thedition; Pearson.

Reference Books:

1. Charles C. Garland, Joseph W. Nibler, and David P. Shoemaker. *Physical Chemistry: A Laboratory Manual.* 3rd edition (1996). McGraw-Hill Education.

2. John David Moynes and Robert J. Gordon. *Experimental Physical Chemistry: A Laboratory Textbook.* 2nd edition (1999), W. H. Freeman.

3. J Mendham, R.C. Denney, J.D. Barnes. and M.J.K. Thomas, *Vogel's Textbook of*

Quantitative Chemical Analysis, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.

4. M Halpern, *Experimental Physical Chemistry*, 6th edition, 2014; Prentice Hall, Upper Saddle River, NJ 07458
5. Geoffrey Pass and Haydn Sutcliffe. *Practical Inorganic Chemistry.* 2nd edition, Blackie Academic & Professional
6. Judith K. Bassett. *Experimental Inorganic/Physical Chemistry: An Investigative, Integrated Approach To Practical Project Work*. 2nd edition, Oxford University Press.

SYLLABUS (3rd Semester)(Minor)		
Subject Name: Physical and Organic chemistry;	**Level: 200**	**Subject Code:** CHY012N301
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Physical and Organic chemistry** is to provide the basic concepts of physical and organic chemistry. Nomenclature, methods of preparation and reactions of simple hydrocarbons will be taught in this paper along with basic concepts of stereochemistry. In physical chemistry, basic concepts of electrochemistry and chemical thermodynamics will be discussed.

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** concept of isomerism, types of isomers and representation of organic molecules, Concept of geometrical isomerism with E/Z nomenclature.	BT1
CO2	**Demonstrate** concept of isomerism, types of isomers and representation of organic molecules. Concept of geometrical isomerism with E/Z nomenclature will also be discussed.	BT2
CO3	**Make use** of the basic concepts of electrochemistry.	BT3
CO4	**Learn** various basic concepts of thermodynamics.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Hours	Marks
I.	**Stereochemistry** Concept of isomerism, types of isomerism,classification – geometrical (simple examples involving alkenes, *cis-trans* and *E-Z* nomenclature) optical and conformational isomers, asymmetry, enantiomerism, diastereomerism, dissymmetry,meso structures, chirality, racemization, racemic mixtures, D-L and R-S notation.	**10**	**25**
II.	**Hydrocarbons I** Alkanes: preparation, properties and reactions. Cycloalkanes: preparation of cyclopropane, cyclobutane, cyclopentane, cyclohexane. Strain theory and stability. Alkenes: preparation (elimination of alkyl halides, alcohols, Wittig reaction, pyrolysis of esters), reactions of alkenes, Markownikoff's and anti- Markownikoff's addition rules, Saytzeff rule, Mechanism of electrophilic addition reaction. Alkynes: preparation, properties, reactions of alkynes, addition reactions of alkynes with polar reagents, ozonolysis, catalytic hydrogenation.	**10**	**25**
III.	**Electrochemistry** Electrochemical cells, electrode potential and cell potential (EMF), representation of a cell, electrochemical series and its application. Nernst's equation, numericals on electrode and cell potentials, reference electrodes (H_2 electrode, calomel electrode), glass electrode, concentration cell. Batteries: its classification, Lead – acid battery, Ni – Cd battery, alkaline battery, wind energy, fuel cell, solar cell.	**10**	**25**
IV.	**Chemical Thermodynamics** Terminology used in thermodynamics (system, surrounding, extensive and intensive properties),work, heat, energy and enthalpy, first law of thermodynamics and its limitations, reversible, adiabatic and isothermal expansion of an ideal gas, heat capacity and relation between C_p& C_v.	**10**	**25**

	Carnot theorem, entropy, entropy change for an ideal gas, reversible and irreversible processes, entropy of phase transitions,free energy and work function: Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equation, Clausius-Clapeyron equation, Gibbs-Duhem equation,chemical potential.		
Total		**40**	**100**

Text Books:

3. *Organic Chemistry*, Morrison R. T. and BoydR.N., Bhattacharjee S.K.B.,6th edition, 2011, published by Prentice Hall.
4. *Organic Chemistry*, Solomons T.J.,11th Revised edition,2013, John Wiley & Sons Inc.
5. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.;Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books

1. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition,; 2011; Macmillan, India

2. Kalsi P.S.;*Stereochemistry of organic compounds*;2007; New age international Ltd.

SYLLABUS (3rd Semester)

Subject Name: Analytical Laboratory Methods **Level: 200** **Subject Code:** CHY012S311

L-T-P-C: 3-0-0-3 **Credit Units: 3** **Scheme of Evaluation: T**

Objective:

The objectives of **Preparation and Estimation techniques** are to make students familiar with various methods of estimation, separation and preparation of derivatives.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**State** the importance of precipitation technique and its gravimetric analysis	BT1

CO2	**Explain** the concept of chromatography in separation of compounds.	BT2
CO3	**Prepare** important organic compounds and their derivatives.	BT3
CO4	**Analyse** and **Estimate** the organic components after separation.	BT4

1. **Gravimetric Analysis of two constituents**:

   I. To estimate copper and zinc in a given solution.
   II. To estimate iron and nickel in a given solution.

2. **Chromatographic separation of organic mixtures.**

   I. Separation of α –napthol and β-napthol by plate chromatography.
   II. Separation of anilines and phenols by plate chromatography.

3. **Separation of binary mixtures**

   I. Separation of a mixture of naphthalene and *p*-bromo benzoic acid (by $NaHCO_3$ solution)
   II. Separation of a mixture of anthracene and *p*-anisidine (by dil. HCl solution)

4. **Derivatives and their preparations**

   I. Derivatives of aldehydes and ketones.
   II. Derivatives phenolic hydroxyl group.
   III. Derivatives of carbohydrates.

5. **Demonstration of UV-Vis Spectrophotometer**

Text Books:

1. *Advanced Practical organic Chemistry*, Agarwal, O. P.; 20th edition; 2014; Kalyani Publishers.

2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.

3. *Advanced Practical Inorganic Chemistry*, Raj, G.; 22nd edition, 2019; Kalyani Publishers

Reference Books:

3. Mendham J., Denney R.C., Barnes J.D. and. Thomas M.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi

4. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson.

SYLLABUS (4th SEMESTER)

Paper III/Subject Name: Inorganic Chemistry-I	**Subject Code:** CHY012M401
L-T-P-C – 4-0-0-4 **Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Inorganic Chemistry-II** is to make students familiar with advanced concept of chemical bonding as well as acid-base properties of inorganic compounds. It will also help students to understand the structures of common binary ionic crystals.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the concepts of chemical bonding.	BT1
CO2	**Explain** the theories of transition elements.	BT2
CO3	**Apply** the concept of acid and base of inorganic compounds.	BT3
CO4	**Examine** the common binary ionic crystals to determine their structure	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I.	**Chemical Bonding II** Molecular orbitals of diatomic molecules: LCAO approximation, bonding, antibonding and nonbonding orbitals, MO configurations of simple homonuclear diatomic and hetero nuclear diatomic molecules, bond properties, bond order and bond strength. Weak chemical forces: van der Waals forces, ion- dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions. repulsive forces, hydrogen bonding, melting and boiling points, solubility energetics of dissolution process.	**13**

II.	**Chemistry of Non Transition Elements I** Polarizing power of cations, polarisability of anions, Fajan's rule, non-aqueous solvents: liquid ammonia, liquid sulphur dioxide, liquid HF, liquid N_2O_4 and supercritical CO_2. Preparation, properties, bonding and structure of the following: ortho and para hydrogen, hydrates, clathrates and inclusion compounds, binary metallic hydrides, allotropes of carbon (including fullerenes), graphite, intercalation compounds, carbides, cyanogens, oxides and oxy-acids of carbon.	**13**
III.	**Acid-Base Concept** Arrhenius concept, theory of solvent system (H_2O, NH_3, SO_2 and HF), Bronsted- Lowry's concept, relative strength of acids, Pauling rules, amphoterism, Lux- Flood concept, Lewis concept. superacid, HSAB principle. acid base equilibria in aqueous solution and pH, acid-base neutralisation curves, indicator, choice of indicators.	**13**
IV.	**Solids** Types of solids, unit cells; crystal lattices and Miller indices, crystal system and Bravais lattices for elemental crystals, close- packed structures of elemental solids, ionic solids: ionic radii; radius ratio and its effect on structures of binary ionic crystals. Structures of common binary ionic crystals: CsCl structure, NaCl structure, ZnS structure, fluorite structure, common ionic crystals: spinel and perovskite structures, lattice energy of ionic solids, Born-Haber cycle.	**13**
	Total	**52**

Text Books

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.

2. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. ; 4th edition; 2007; Pearson Education.

Reference Books

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.

2. Cotton F.A.,Wilkinson, G.,Murillo A., Bochmann M.;*Advanced Inorganic Chemistry;*6th edition; 1999; Wiley Interscience; New York.

SYLLABUS (4th Semester)

Subject Name: Physical Chemistry-I	**Level: 200**	**Subject**	**Code:** CHY012M402

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of **Physical Chemistry-I** is to learn the concepts of different states of matter, colligative properties of solutions and principles of electrochemistry and to apply it in different chemical reactions.

Course Outcomes:

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

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Introduction** to gaseous state, thermodynamics involved and isotherms	BT1
CO2	**Acquire** knowledge about the structure of the liquid state and understand the physical properties of liquids, solutions, and their colligative properties.	BT2
CO3	**Demonstrate** knowledge about conductivity, equivalent and molar conductivity, Ostwald's dilution law and the dependence of molar conductivity on concentration and temperature.	BT3
CO4	**Explore** the effect of temperature on the rate of reaction, Arrhenius equation, and the concept of activation energy. Gain knowledge about consecutive, concurrent, and opposing reactions, as well as differential rate equations and steady-state approximation in reaction mechanisms	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Gaseous State** Postulates of kinetic theory of gases, derivation of the kinetic gas equation, Maxwell's distribution of molecular velocities, root mean square, average and most probable velocities, collision number, collision frequency, mean free path and collision diameter. *Behaviour of real gases:* Deviations from ideal gas behaviour, compressibility factor (Z),causes of deviation from ideal behaviour der Waals equation of state.	**15**

	Critical phenomena: P-V isotherm of real gases, principle of continuity of states, critical constants, relationship between critical constants and van der Waals constants, law of corresponding states.	
II	**Liquid State, Solutions and Colligative Properties** Qualitative treatment of the structure of liquid state, physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination, effect of temperature on surface tension and viscosity. Dilute solutions, Raoult's law and Henry's law, definition of colligative properties: lowering of vapour pressure, elevation of boiling point, freezing point depression and osmotic pressure, thermodynamic treatment of colligative properties, abnormal colligative properties due to dissociation and association, van't Hoff factor, applications in calculating molar masses of normal, dissociated and associated solutes in solution.	**15**
III	**Electrolytic Conduction** Conductivity, equivalent and molar conductivity, dependence of molar conductivity on concentration and temperature, Kohlrausch's law of independent migration of ions, Debye-Hückel-Onsager equation, activity of ions, Debye Huckel theory (elementary ideas) of strong electrolytes Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, degree of dissociation of weak acids and bases, Ostwald's dilution law, ionic product of water, solubility product of sparingly soluble salts, conductometric titrations, concept of pKa and pKb, buffer solution, derivation of Henderson equation, buffer action	**15**

IV	**Chemical Kinetics** Reaction rate, factors influencing the rate of a reaction, rate law, order and molecularity of a reaction, differential and integrated form of rate expressions for zero, first and second order reactions, half-life period, determination of the order of reaction by various methods, effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Consecutive, concurrent and opposing reactions, differential rate equations and steady-state approximation in reaction mechanisms, problems on steady-state approximation. Kinetics of chain reaction (Rice-Herzfeld mechanism), H_2-Br_2 reaction	**15**
	TOTAL	**60**

Text Books:

1. Peter Atkins and Julio de Paula, *Physical Chemistry*, 11th edition (2017), Oxford University Press.
2. Puri, Sharma, and Pathania, *Principles of Physical Chemistry,* 47th edition, Vishal Publishing Co.
3. Donald A. McQuarrie and John D. Simon, *Physical Chemistry: A Molecular Approach*, 1st edition (1997), University Science Books.

Reference Books:

6. S Glasstone, *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
7. Gilbert W. Castellan. *Physical Chemistry*, (2004) Narosa.
8. Kapoor, K. L.; *A textbook of Physical chemistry*; 2018; Macmillan, India Ltd.
9. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers
10. Keith J. Laidler, *Chemical Kinetics,*3e, (2003) Pearson Education India.

SYLLABUS (4th SEMESTER)		
Paper III/Subject Name: Chemistry Laboratory-IV		**Subject Code:** CHY012M113
L-T-P-C – 0-0-8-4	**Credit Units: 4**	**Scheme of Evaluation: P**

1. Qualitative inorganic analysis (at least 4 sample containing mixtures of both acid and basic radicals): Identification of the following in an inorganic salt:

   Cations: Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{3+}, As^{3+}, Sb^{3+}, Sn^{2+}/Sn^{4+}, Fe^{2+}/Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}

   Anions: Cl^{-}, Br^{-}, I^{-}, NO^{2-}, NO^{3-}, S^{2-}, $SO3^{2-}$

2. Determine the equivalent conductivity of acetic acid at infinite dilution by Kohlrausch's method and hence find out the degree of dissociation of the acid.
3. To determine the specific rotation of an optically active substance by polarometric method.
4. Qualitative analysis of organic liquid sample (Purification by fractional distillation, determination of boiling point, functional group analysis).

   At least three samples should be done.

Text Book:

1. *Advanced Practical Physical Chemistry*; Yadav, J.B.; 28th edition; 2009; Goel Publishing House
2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7thedition; Pearson.
3. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson.

Reference Books:

1. Gurtu, J.N., Gurtu, A.; *Advanced Physical Chemistry Experiments*, 6th edition, 2014, Pragati Prakashan
2. Halpern, M.; *Experimental Physical Chemistry*, 2nd edition, 1988; Prentice Hall, Upper Saddle River, NJ 07458
3. Agarwal O. P., *Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

Course Outcomes:

The student will

1. be able to understand and analyse advanced experimental techniques in separation and determination of inorganic ions.
2. be able to perform purification and qualitative analysis of organic liquid samples.
3. be able to handle different instruments related to optical property in chemistry.
4. will get familiar with some modern instrumentation techniques.

Teaching Learning Process:

- Theoretical explanation in class rooms with concepts of reactions involved.
- Execution of experiments
- Recording of data and observation of result
- Regular evaluation of lab copy
- Group discussions

Assessment methods:

- Semester End Examination: 70 marks
- Internal Assessment: 30 marks (Copy: 10, Skill test: 05, Viva: 10, Attendance : 05)

SYLLABUS (4th SEMESTER)

Subject Name: Organic and Inorganic Chemistry:	**Level: 200**	**Subject Code:** CHY012N401
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Organic and Inorganic Chemistry** is to provide basic understanding of important aromatic and aliphatic organic compounds as well as detailed discussions and applications on transition and non-transition elements.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Learn** the basic concepts of aromaticity of important organic compounds	BT1

CO2	**Study** the importance of coordination compounds and its magnetic behaviour	BT2
CO3	**Understand** allotropes of non-transition elements	BT3
CO4	**Classify** alcohols and carboxylic acids and study their reactions**.**	BT4

Detailed Syllabus:

Modules	Topics / Course content	Marks
I.	**Aromatic Hydrocarbons and Aromaticity** Definition and structure of aromatic compounds, structure of benzene, Resonance of benzene, Aromatic character: The Huckel 4n+2 rule, electrophilic aromatic substitution, effect of substituent groups. Polynuclear aromatic hydrocarbons and its reactions.	**25**
II.	**Hydrocarbon-II** Aliphatic and aromatic hydroxyl compounds: Classification of alcohols, 1°, 2° and 3° alcohols. General methods of preparation, properties and reactions Synthesis and reactions of phenols. Acidity of phenols. Electrophilic aromatic substitution of phenols. Aliphatic and aromatic carboxylic acids. General methods of preparation, properties and reactions of aliphatic and aromatic carboxylic acid.	**25**
III.	**Chemistry of non-transition elements** Allotropes of phosphorous. Hydrides, oxides and oxy-acids of phosphorous. Allotropes of sulphur, oxides, hydrides, oxyacids and per-acids of sulphur. Interhalogen compounds, polyhalides, pseudohalogen, oxides and oxyacids of halogens. Noble gas compounds – xenon oxides and fluorides.	**25**

IV.	**Coordination compounds** Types of ligands: monodentate, bidentate, ambidentate, polydentate and macro cyclic ligand. Nomenclature of complex compounds, Isomerism in 4- and 6-coordinate compounds, effective atomic number rule, valence bond, crystal field and introduction to ligand field theories, colour and magnetism	**25**
Total		**100**

Text Books:

1. "*Organic Chemistry*", Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, Prentice Hall.
2. "*Modern methods of organic synthesis"* Carruthers, W. and Coldham, I. 4th edition, 2015, Cambridge University Press.
3. "*Concise Inorganic Chemistry*", Lee J. D., 5th edition, 2008, John Wiley and Sons Ltd., Indian Edition.
4. *"Principles of Inorganic Chemistry",* Puri B.R., Sharma L.R. and Kalia K.C.; 33rd edition, 2020, Vishal Publishing Co.

Reference Books:

1. Clayden, J., Greeves, N., and Warren, S. "*Organic chemistry*", 2nd edition, 2012, Oxford University Press, USA
2. Huheey J. E., Keiter E. A., Keiter R. L. and Medhi O. K., "*Inorganic Chemistry Principles of Structure and Reactivity*'',4th edition, 2006, Pearson Education.

SYLLABUS (4th Semester)(Minor)		
Subject Name: General chemistry lab-II	**Level: 200**	**ubject Code:** CHY012N412
L-T-P-C: 0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

Objective: The **General chemistry lab-II** is to provide the practical knowledge of basic practical chemistry like detection of hardness of water, preparation and use of TLC, synthesis of inorganic and organic compounds and some techniques for determination the adulterants in food items.

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in preparation of inorganic and organic compounds.	BT1
CO2	**Demonstrate** the synthetic methods for preparation of inorganic and organic compounds of practical importance.	BT2
CO3	**Make use** of the procedures required to estimate hardness of water.	BT3
CO4	**Demonstrate** different methods for finding the adulterants in stuffs and learn how to make TLC plates and use it for knowing fate of reaction.	BT4

Detailed Syllabus:

13. Preparation of following inorganic compounds:

    g) Ferrous ammonium sulfate or Mohr salt, $FeSO_4.(NH_4)_2SO_4.6H_2O$

    h) Chrome alum, $K_2SO_4.Cr_2(SO_4)_3.24H_2O$

2. Preparation of following organic compounds:

    a) Osazone from glucose.

    b) Benzil from benzoin.

3. To determine *any one* adulterants in food stuffs:

    a) To detect adulterants in milk

    b) To detect adulterants in turmeric powder

4. To determine the total hardness, calcium hardness and magnesium hardness of water.

5. To prepare TLC (Thin Layer chromatography) plates and gives spotting of reaction mixtures.

Text Books:

1. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th edition; Pearson.

Reference Books:

1. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

2. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; KalyaniPublisher

SYLLABUS (5th SEMESTER)

Major (Core)/Subject Name: Organic Chemistry-II			**Subject Code: CHY012M501**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Level 300**	**Scheme of Evaluation: T**

Objective: The objective of **Organic Chemistry II** is to provide concept related to synthetic organic reactions and their mechanism along with information related to reagents used for reaction.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept involved in the reaction via analysis of reaction mechanism related to nucleophilic addition and substitution reaction on aromatic compounds.	BT1
CO2	**Explain** the mechanisms of various chemical reactions of alkyl halides, alcohols, alkenes and alkynes, carbonyl compounds, carboxylic acids and their derivatives, ether, amines and nitroalkanes.	BT2
CO3	**Apply** the reagents for the conversion of one functional group into other functional group in one or more number of steps.	BT3
CO4	**Analyze** the structures knowledge of commercially important molecules.	BT4

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I.	**Chemistry of organic compounds – II** Alkyl halides–Methods of preparation and reactions, elimination vs. substitution reactions – controlling factors, mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides. Alcohols – Preparation with special reference to reduction of aldehyde and ketones, hydroboration and oxymercuration, conversions to and from alcohols, hydrogen bonding, acidic nature and reaction of alcohol. Glycols and their reactions with lead tetra-acetate and per-	**18**

	iodic acid.	
II.	**Chemistry of organic compounds – III** Alkenes – Methods of preparation of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, mechanism of elimination reactions: Saytzeff and Hoffmann elimination, properties of alkenes and relative stabilities of alkenes, mechanism involved in hydrogenation, electrophilic and free radical additions to alkenes , Markownikoff's rule, hydroboration-oxidation, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO4, reactivities at the allylic and vinylic positions of alkenes. Alkynes – Methods of preparation of alkynes, chemical reactions of alkynes, acidity of alkynes, mechanism of electrophilic and nucleophilic addition reactions.	**18**
III	**Chemistry of organic compounds – IV** Carbonyl compounds: Preparation of carbonyl compounds. Nucleophilic addition to carbonyl compounds – redox reactions and condensation reactions. Mechanisms ofaldol condensation, Cannizzaro reaction, Claisen condensation, Reformatsky reaction,Oppeneauer reaction, Wolff-Kishner reduction, Benzoin condensation. Carboxylic acids and their derivatives: Preparation of carboxylic acids, acidity and effect of substituents. Derivatives of carboxylic acids – acid chlorides, amides and esters. Acidic and alkaline hydrolysis of esters.	**18**
IV	**Chemistry of organic compounds – V** Ethers: preparation, cleavage and auto-oxidation reactions. Epoxides: preparation, acid and base catalysed ring opening. Amines (aliphatic and aromatic): Classification and preparation of amines, distinction between primary, secondary and tertiary amines. Hoffmann bromamide reaction, exhaustive methylation and Hoffmann elimination, Hinsberg test, carbylamine test, Mannich reaction. Formation of diazonium salts, Sandmeyerreaction. Synthesis, and reactivity of nitroalkanes, alkyl nitriles, isonitriles and aromatic nitro compounds.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, published by PrenticeHall.
2. *Organic Chemistry*,FinarI. L. 6th edition, (Low price), 2017, PearsonEducation.

Reference Books:

1. Peter Sykes, *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, published by PearsonIndia.
2. KalsiP.S.,*Organic Reactions and their Mechanisms*, 3nd edition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .
4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (5th SEMESTER)			
Major (Core)/Subject Name: Analytical Chemistry			**Subject Code: CHY012M502**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective: The objective of Analytical **Chemistry** is to learn the importance of analytical data and basic concepts of separation and analysis of organic and inorganic materials.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and represent analytical data obtained from analytical methods.	BT1
CO2	**Demonstrate** importance of purification and identification of analytes.	BT2
CO3	**Apply** the knowledge of analysis to understand the nature and properties of individual components.	BT3
CO4	**Categorize** and estimate and the chemical species present in the sample.	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Data analysis** Evaluation of analytical data: Accuracy and precision, deviation, relative mean deviation, standard deviation, variance, significant figures in reporting measurements and calculation. Types of errors: determinate and indeterminate errors, various types of determinate errors, absolute errors, relative errors.	18
II	**Conventional purification techniques and gravimetric analysis** Purification of solid organic compounds: extraction, use of immiscible solvents, solvent extraction, recrystallization. Purification of liquids: distillation, vacuum distillation, fractional distillation, azeotropic distillation – principles and techniques. Gravimetry: Introduction, precipitation, properties of precipitates, co-precipitation and post precipitation, drying and ignition, role of precipitating agents in gravimetric analysis.	18
III	**Chromatography** Introduction to chromatography, principle of chromatography, retention time, classification of chromatographic methods, paper chromatography, thin layer chromatography, R_f value, column chromatography, choice of solvent system in chromatography, ion-exchange chromatography, applications of chromatographic methods.	18
IV	**Titrimetric analysis** Redox titrations: theory and feasibility of redox titrations, redox indicators, their choice and application. Acid-Base Titrations: theory of neutralisation titrations, indicators-theory and choice of indicators for acid/base titrations, neutralization curves. Complexometric titration: theory, titrations involving monodentate and multidentate ligands (EDTA), metallochromic indicators and their choice.	18
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
2. *Fundamental of Analytical Chemistry*, Skoog D.M.*;* 8th Edition, 2013; Saunders College Publishing, New York.

Reference Books:

1. MendhamJ., Denney R.C.,Barnes J.D. and. ThomasM.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
2. Day R.A. and A.L., *Quantitative Analysis;* Underwood, 9th edition, 2015 Prentice Hall, Inc. New Delhi.

SYLLABUS (5th SEMESTER)			
Minor/Subject Name: Inorganic and physical chemistry			**Subject Code: CHY012N501**
L-T-P-C: 3-0-0-3	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective:

- To provide knowledge of organometallic chemistry and their use in catalytic processes.
- To provide the fundamental concepts of kinetic theory of gases, structure and some physical properties of liquids.
- To provide the concept of various types of catalysis, adsorption isotherms, and colloid stability.
- To provide the concept of crystal lattice, lattice defects and analyze the structure of some common ionic crystals.

Prerequisites:

- Concept of coordination chemistry, noble gas, ideal behavior of gases, catalysis, electromagnetic radiation, and idea of spectroscopy.
- Fundamentals of general chemistry from H.S. (10+1 and 10+2) level.

Course outcomes:

After successful completion of the course, student will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** 18 electron count, oxidative addition and reductive elimination reaction, adsorption isotherm, crystal defects.	BT 1
CO 2	**Demonstrate** kinetic theory of gases in predicting the behavior of gases, demonstrate the effect of temperature and pressure on enzyme catalysis.	BT 2
CO 3	**Apply** 18 electron in prediction coordinative unsaturation, **apply** adsorption isotherm to determine surface area of adsorbent.	BT 3
CO 4	**Categorize** types of carbonyl groups in metal carbonyls, **categories** various types of adsorption isotherm.	BT 4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Organometallic Compounds and Catalysis** Definition, electron count, 18 electron rule, isolobal analogy, structure and bonding in some organometallic compounds (Metal – Olefins compound, metal – ligand σ -bonded compounds, ferrocene, terminal and bridged carbonyls), oxidative addition and reductive elimination reaction. Uses of some organometallic compounds in catalysis (Wilkinson's catalyst, Vaska's compound and $HCo(CO)_4$).	**15**
II.	**Gaseous and Liquid State** Postulates of kinetic theory of gases – derivation of expression for pressure from kinetic theory, calculation of rms speed and average kinetic energy, deviation from ideal behavior, van der Waals equation of state. Structure of liquids, kinetic molecular model and properties of liquid, definition and experimental measurement of surface tension (drop number method) and viscosity (Ostwald method), variation of these properties with temperature.	**15**
III.	**Catalysis and surface chemistry** Homogeneous heterogeneous catalysis, acid-base catalysis catalytic promoter, poisoning, negative catalysis, enzyme catalysis, effect of temperature and pressure on enzyme catalysis, auto catalysis. Types of adsorptions. Differences between chemisorption and Physical adsorption; Freundlich adsorption isotherm and Langmuir adsorption isotherm, application of adsorption. Colloids-Classification, structure and stability.	**15**
IV.	**Solids** Crystal lattices, unit cells of the seven crystal systems. density of cubic unit cell, the fcc, bcc and simple cubic systems, closed packed structures, imperfections in solids, introduction to Schottky and Frenkel defects) Structures of common binary ionic crystals: CsCl structure, NaCl structure, ZnS structure.	**15**
Total		**60**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60	**-----**	**30**

Text Books:

1. "*Concise Inorganic Chemistry*", Lee J. D., 5th edition, 2008, John Wiley and Sons Ltd., Indian Edition.
2. "*Principles of Physical Chemistry*", Puri B. R., Sharma L. R., Pathania M. S., 47th edition, 2016; Vishal Publishing Company.

Reference Books:

1. Atkins, P. W.; and Paula, J. de., *"Physical Chemistry"*, 10th edition; 2011; Van Nostrand Company.
2. Huheey J. E., Keiter E. A., Keiter R. L. and Medhi O. K., "*Inorganic Chemistry Principles of Structure and Reactivity*'', 4th edition, 2006, Pearson Education.

Course Outcomes:

- The student is expected to gain the knowledge of organometallic chemistry and their applications.
- The students will understand the structure and properties of liquid.
- The student is expected to know the chemistry of catalytic processes.
- The student is expected to gain the concepts of crystal structure of solids.

SYLLABUS (6th SEMESTER)

Major (Core) / Subject Name: Spectroscopy			**Subject Code: CHY012M601**
L-T-P-C – 3-1-0-4	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective: The objective of the course is to instill knowledge about the light matter interactions, principles of spectroscopic techniques and to give preliminary ideas about the applications of various spectroscopic techniques.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** and learn the electromagnetic radiation and basics of spectra.	BT 1
CO 2	**Explain** basic principles of Rotational, Vibrational and Raman Spectroscopy, Electronic Spectroscopy, Spin Resonance Spectroscopy and Mass Spectrometry.	BT 2
CO 3	**Integrate, compare** and **apply** various techniques in Structure Elucidation of molecules.	BT 3 & BT 4

CO 4	**Evaluate** the importance of Selection rules, chemical shift, Chromophore and McLafferty Rearrangement in spectroscopy.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	**Basic theory of spectroscopy** Particle Nature of light, Electromagnetic Radiation, Spectral region, Interaction of electromagnetic radiation with matter, Energy Levels, Born Oppenheimer Approximation, Types of spectra- absorption and emission, Signal to Noise ratio, Spectral line width, Spectral Broadening-Collisional Broadening, Doppler Broadening, Intensity of Spectral Transitions- Factors affecting the intensity. Beer-Lambert Law, Molar Absorption coefficient, transmittance, absorbance	**18**
II	**Rotational, Vibrational and Raman Spectroscopy** Rotational Energy levels, Classification of molecules based on their moment of inertia, Rotational spectra of diatomic molecules - Rigid Rotator Concept, Selection rules, Intensities of Spectral Line, application of rotational spectra. Vibrational spectra of diatomic molecules – harmonic and anharmonic oscillators - Morse potential, Selection rules, calculation of force constants, dissociation energies, fundamental frequencies, overtones. Application IR spectra in structure elucidation- finger print region. Principle of Raman spectroscopy-Stokes and anti-Stokes lines, Classical Theory of Raman Spectra.	**18**
III	**Electronic Spectroscopy** Electronic transitions and selection rules, Electronic Transitions in diatomic molecule- selection rule - Vibrational fine structure, Types of electronic transitions, Franck-Condon principle, Nature of electronic states: singlet and triplet states, fluorescence and phosphorescence. Structure Elucidation- Chromophore, Auxochrome, absorption and intensity shifts, Woodward-Fieser rule for calculating absorption maxima (in conjugated diene system), Effect of solvents on electronic transition.	**18**
IV	**Nuclear Spin Resonance Spectroscopy and Mass Spectrometry** Principles of NMR spectroscopy, ^{1}H NMR Spectroscopy, presentation of the spectrum - chemical shift, chemical shift of simple organic molecules, spin-spin coupling and spectra of simple molecules. Mass Spectrometry: Principle, ionization techniques, fragmentation	**18**

	Pattern, nitrogen rule, McLafferty Rearrangement. Applications.	
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. Fundamentals of Molecular Spectroscopy; Banwell Colin N., McCashEllain M; 4th edition; 2017; Tata McGraw-Hill.
2. Introduction to Spectroscopy; Pavia, D.L; Lampman; Kriz, G.S.; 5th edition, 2015; Brooks/Cole Cengage Learning.

Reference Books:

1. Modern Spectroscopy; Hollas, J.M; 4th edition, 2013, John Wiley & Sons
2. Organic Spectroscopy; Kemp, W.; 3rd edition, 2011; Palgrave

SYLLABUS (6th SEMESTER)

Major (Core)/Subject Name: Quantum Chemistry **Subject Code: CHY012M602**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level: 300** **Scheme of Evaluation: T**

Objective: The basic objectives of this course are to impart quantum mechanical postulates in solving the Schrödinger equation and to apply LCAO-MO theory to real atoms/ions.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the postulates and interpret the basic principles of quantum mechanics	BT1 & BT2
CO2	**Apply** quantum mechanical treatment to various models	BT3
CO3	**Construct** atomic-orbital wave functions plot and **solve** spin-orbit interactions for Term symbols	BT3 & BT4
CO4	**Evaluate** the various orbital theoriesto **solve** for energy values of different molecules	BT 4 & BT5

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Quantum Mechanics-I** Transition from classical mechanics to quantum mechanics: Black body radiation – Planck's hypothesis, Photoelectric effect – Einstein's explanation, Compton effect, Bohr's theory of atom: derivation for energy of an electron in hydrogen like species, de Broglie hypothesis, Heisenberg's uncertainty principle. Postulates of Quantum mechanics, wave functions, operators, eigen functions and eigen values, Schrodinger postulatesof operator transforms and the wave equation boundary conditions, normalization of the wave functions, expectation values,interpretation of the wave function – orthogonal and orthonormal wave functions.	**18**
II	**Quantum Mechanics-II** Model systems – particle in 1D and 3D boxes – particle in a ring, harmonic oscillator and rigid rotator (detailed mathematical treatment not necessary): Outline of solution of their Schrodinger equations, energy expression, wave functions and quantum numbers. Qualitative discussions of special features like degeneracy, energy level diagrams, plot of wave functions and their squares vs displacement from origin, zero point energy, quantum mechanical tunneling, force constant and bond strength (for harmonic oscillator), moment of inertia in 3D,angular momentum, space quantization of angular momentum (for rigid rotator).	**18**
III	**Atomic Structure** The Hamiltonian and Schrodinger equation for hydrogen and helium atoms, energy levels and quantum numbers, the radial and angular part of the wave functions, concept of atomic orbitals, plots of atomic-orbital wave functions and their squares vs. displacement from origin, construction of two-dimensional plots of probability density and calculation of radial probability functions, The orbitals of hydrogen and hydrogen-like atmos, contour diagrams of electron density, Stern-Gerlach experiment, electron spin and spin quantum number – spin orbitals, electron configuration of many electron atoms, Pauli's exclusion principle –illustration by He atom using wave functions, Spin-orbit interactions, Russel-Saunder's coupling, Term symbols. Effect of magnetic field on energy levels. Hund's rule.	**18**
IV	**The Nature of Chemical Bond** Schrodinger equation for a molecule, Born-Oppenheimer approximation, LCAO-MO theory as applied to $H_2^+$and H_2, drawback of MO theory. MO energy level diagram of homonuclear (O_2, N_2) and heteronuclear (HF, LiF, CO) diatomic molecules,HeitlerLondontheory – wave function and potential energy curve of H_2, concept of resonance and hybridisation from VB theory, term symbols of diatomic molecules. Huckel theory for ethene and benzene.	**18**

Total	72

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Quantum Chemistry*; Levine, I.N.; 7th edition, 2016; Prentice Hall of India
2. *Quantum Chemistry;* Prasad, R.K.; 4threvised edition; 2010; New Age International Publishers Limited

Reference Books:

1. Chandra, A.K.; I*ntroductory Quantum Chemistry*; 4threvised edition; 2017; Tata McGraw Hill
2. Sen, B.K.; Quantum Chemistry Including Spectroscopy; 4th edition; 2011; KakyaniPublisheres, New Delhi
3. McQuarrie, D.A.; *Quantum Chemistry*; 2nd edition; 2011; Viva Books Pvt Ltd
4. Atkins, P.W and S.F. Ronald; *Molecular Quantum Mechanics;* 5thedition; Oxford University Press.

SYLLABUS (6th SEMESTER)

Major (Core)/Subject: Introduction to Environmental & Green Chemistry **Subject Code: CHY012M603**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level: 300** **Scheme of Evaluation: T**

Objective: The objective of **Introduction to Environmental and Green Chemistry is** to provide the knowledge of major pollutants and different ways of treatment of air, water and soil pollutions. The students will be able to understand the fundamental concepts of green chemistry and to know its utility in modern synthesis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard, and risk of chemical substances.	BT 1

CO 2	**Summarize** the innovative approaches to solve the problems related to environmental and societal challenges.	BT 2
CO 3	**Build** the knowledge of green chemistry in problem solving skills, critical thinking and valuable skills to innovative and find out solution to environmental problems.	BT 3
CO 4	**Analyse** various chemical products and processes that are less toxic, than current alternatives.	BT 4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Atmospheric Chemistry** Composition of atmosphere – major regions of atmosphere**,** major air pollutants and their harmful effects. Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog, air pollution controls.	**18**
II	**Hydrosphere and Soil Chemistry** Criteria and standards of water quality- safe drinking water, water pollutants, wastewater treatment processes, water purification for drinking and industrial purposes. Composition of soil, types of soil, waste matters and pollutants in soil, waste classification, treatment and disposal, control measures of soil pollution.	**18**
III	**Introduction and principles of Green Chemistry** Introduction and definition of green chemistry, need and goal of green chemistry, limitations and obstacles of green chemistry, twelve principles of green chemistry with examples, prevention and minimization of generation of hazardous byproducts in chemical processes.	**18**
IV	**Green Chemistry synthesis** Designing of green synthesis using principles of green chemistry, selection of green solvents, basic idea of microwave and ultrasound assisted reactions, preliminary idea of solvent free reactions (solid phase reactions), biocatalysis in organic synthesis.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Book:

1. *Environmental Chemistry* De A. K.; 6th edition, New Age International, New Delhi.
2. *Environmental Chemistry*, Sharma B. K.; and Kaur, H., 2nd edition, **2013**, Goel Publishing House, Meerut.

Reference Books:

1. *Environmental pollution Control Engineering*, Rao C. S., 2nd edition, **2016**, New Age International.
2. *Green Chemistry: Environment Friendly alternatives*, Sanghi R. and Srivastava M. M., 2nd edition, 2018, Narosa Publishing House, New Delhi, India.
3. *Green Chemistry*, Ahluwalia V. K., 2nd edition, 2018, Narosa Publishing House, New Delhi.

SYLLABUS (6th SEMESTER)

Minor/Subject Name: Concepts of Analytical Chemistry			**Subject Code: CHY012N601**
L-T-P-C – 3-0-0-3	**Credit Units: 3**	**Level: 300**	**Scheme of Evaluation:**

Objective: The objective of **Concepts of Analytical Chemistry** is to provide the basic concept of chemical analysis through separation Techniques and titrimetric analysis. The students will also be able analyse the experimental data using data analysis knowledge.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the importance of chemical analysis with instrumental techniques	BT1
CO2	**Explain** the concept of separation techniques and chromatographic techniques.	BT2
CO3	**Apply** titrimetric analysis in quantitative sample determination	BT3
CO4	**Analyze** the accuracy and types of errors in experimental data.	BT4

Detailed Syllabus:

Modules	Topics/ Course content	Periods
I	**Chemical analysis:** Introduction, stages of analysis, qualitative and quantitative analysis, importance of instrumental techniques, factors affecting the choice of analytical method.	**15**
II	**Separation Techniques:** Introduction, bulk separation, instrumental separation, filtration, solvent extraction, crystallisation and precipitation. Basic principles of chromatographic separation- Gas chromatography, liquid chromatography and thin layer chromatography.	**15**
III	**Titrimetric analysis:** Introduction, classification of reactions in titrimetric analysis, standard solution- primary and secondary standard. Principles of potentiometric titration, conductometric titration and complexometric titration.	**15**
IV	**Errors and accuracy**: Definition of Significant figures, accuracy and precision, mean, median, variance, deviation, relative mean deviation, standard deviation. Error-Determinate and indeterminate error, absolute errors, relative errors.	**15**
Total		**60**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60	**-----**	**30**

Text Books:

1. *Fundamentals of Analytical Chemistry*, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Cengage Learning, **2013**
2. *Vogel's Quantitative Chemical Analysis*, J Mendham, R C Denney, J D Barnes and M J K Thomas, 6th Edition, **2009**

Reference Books:

1. *Analytical Chemistry*, Gary D. Christian, 6ed Paperback – **2007**

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Organic Chemistry-III			Subject Code: CHY012M701
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Level: 400**	**Scheme of Evaluation: T**

Objective: The objective of **Organic Chemistry III** is to provide concept related to synthetic organic reactions, rearrangement, and their mechanism along with information related to pericyclic and photochemical reactions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept behind mechanism of molecular rearrangements, pericyclic reactions and photochemical reactions.	BT1
CO2	**Explain** with mechanisms, the chemical reactions of Phenols, haloarenes, polynuclear hydrocarbons, active methylene compounds and heterocyclic compounds	BT2
CO3	**Apply** basic concept of molecular rearrangements to synthesize important molecules from starting materials.	BT3
CO4	**Analyze** the structures of compounds formed by various rearrangements.	BT4

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I.	**Chemistry of organic compounds – VI** Phenols: Preparation and typical reactions, Kolbe's reaction, Reimer-Tiemann reaction. Haloarenes: Preparation, mechanism of nucleophilic aromatic substitution, benzyne mechanism, cine substitution, chichibabin reaction and methods of trapping benzyne intermediates. Polynuclear aromatic hydrocarbons: Structure, bonding, properties and reactivity of naphthalene, anthracene, phenanthrene and anthraquinone-important methods of synthesis.	**18**

II.	**Chemistry of organic compounds – VII** Active methylene compounds: The active methylene group, synthesis of compounds containing active methylene groups (ethyl acetoacetate, diethylmalonate and ethyl cyanoacetate) and their use in organic synthesis. Heterocyclic compounds: Synthesis, structure, bonding, properties (basicity, aromaticity) and reactions of the following heterocycles: Furan, pyrrole, indole, thiophene, pyridine, quinoline and isoquinoline.	**18**
III	**Molecular Rearrangements** (i) Nucleophilic or anionotropic: Wagner-Meerwein rearrangement, Whitmore 1, 2-shift, Wolff, Curtius, Hoffmann, Lossen, Schmidt, Favorskii, Beckmann, Benzil-benzilic acid, Baeyer–Villiger rearrangements. (ii) Electrophilic or cationotropic: pinacol rearrangement. (iii) Free radical: Wittig rearrangement. Special rearrangements: Fries rearrangement, Stevens rearrangement.	**18**
IV	**Pericyclic Reactions and Organic Photochemistry** Definition and examples of 2+2 and 2+4 cycloadditions. The conservation of orbital symmetry. Woodward Hoffman rules. Diels Alder reaction, 1, 3 Dipolar Cycloaddition. Sigmatropic rearrangements-Cope and Claisen rearrangements. Electrocyclic reactions. Basic principles, Jablonski diagram, Typical photochemical reactions: Photo-reduction of benzophenone, photolysis of ketones, Norrish type-I and Norrish type-II reactions, dimerization and cycloaddition of ethene.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

***Text Books*:**

1. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, published by PrenticeHall.

2. *Organic Chemistry*,FinarI. L. 6th edition, (Low price), 2017, PearsonEducation.

3. Advanced Organic Chemistry, by B S Bahl and Arun Bahl.

Reference Books:

1. Peter Sykes, *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, published by PearsonIndia.
2. Kalsi P.S.,*Organic Reactions and their Mechanisms*, 3nd

edition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .
4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Physical Chemistry III			**Subject Code: CHY012M702**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 400**	**Scheme of Evaluation: (T)**

Objective: The objective of **Physical Chemistry-II** is to learn the concepts of different states of matter, colligative properties of solutions, and principles of electrochemistry and to apply it in different chemical reactions.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Relate** the ideal and non- ideal behaviors of (real) gas, critical phenomena of gases, solutions properties and electrolytic conduction.	**BT 1**
CO 2	**Explain** the properties of liquid and conductivity of strong and weak electrolytes.	**BT 2**
CO 3	**Apply** the concept of colligative properties to determine the molar mass of solutes.	**BT 3**
CO 4	**Evaluate** the critical phenomena of gases, buffer action, pKa and pKb, buffer solution	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I	**Gaseous State** Postulates of kinetic theory of gases, derivation of the kinetic gas equation, Maxwell's distribution of molecular velocities, root mean square, average and most probable velocities, collision number, collision frequency, mean free path and collision diameter. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor (Z), causes of deviation from ideal behaviour der Waals equation of state.	**18**

	Critical phenomena: P-V isotherm of real gases, principle of continuity of states, critical constants, relationship between critical constants and van der Waals constants, law of corresponding states.	
II	**Liquid State** Qualitative treatment of the structure of liquid state, physical properties of liquids; vapor pressure, surface tension and coefficient of viscosity, and their determination, effect of temperature on surface tension and viscosity, explanation of cleansing action of detergents. Liquid crystals: An introduction to liquid crystals, classification and properties of liquid crystals.	**18**
III	**Solutions and Colligative Properties** Dilute solutions, Raoult's law and Henry's law, definition of colligative properties: lowering of vapor pressure, elevation of boiling point, freezing point depression and osmotic pressure, thermodynamic treatment of colligative properties, abnormal colligative properties due to dissociation and association, van't Hoff factor, applications in calculating molar masses of normal, dissociated and associated solutes in solution.	**18**
IV	**Electrolytic Conduction** Conductivity, equivalent and molar conductivity, dependence of molar conductivity on concentration and temperature, Kohlrausch's law of independent migration of ions, Debye-Hückel-Onsager equation, activity of ions, Debye-Hückel theory (elementary ideas) of strong electrolytes, transport number of ions and its determination. Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, degree of dissociation of weak acids and bases, Ostwald's dilution law, ionic product of water, solubility product of sparingly soluble salts, conductometric titrations, concept of pKa and pK_b, buffer solution, derivation of Henderson equation, buffer action.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72	-----	48

***Text Books*:**

1. *Physical Chemistry*, Atkins P. W. and Paula J. de; 10th edition; 2014; Oxford University Press
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

***Reference Books*:**

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;* 6th edition; 2018; Oxford University Press.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Inorganic Chemistry-III			**Subject Code: CHY012M703**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level 400**	**Scheme of Evaluation: T**

Objective: The objective of **Inorganic Chemistry-III** is to make students familiar with advanced concept of organometallic chemistry as well as inorganic reaction mechanism. It will also help students to understand the chemistry of d & f block elements and radioactive elements.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** organometallic compounds and apply the knowledge to know their bonding and applications.	BT1
CO2	**Explain** the theories of transition elements (d and f block)	BT2
CO3	**Apply** the concept of **inorganic reaction mechanism to understand inorganic reactions.**	BT3
CO4	**Illustrate** the concept of nuclear chemistry to understand various types of nuclear reactions as well as application of radioactive elements.	BT4

Detailed Syllabus:

Modules	**Topics & Course content**	**Periods**
	Organometallic Compounds 18-electron rule and its applications, carbonyls: preparation, structure and reactions, metal-olefin complexes: Zeises salt (preparation, structure and bonding), Ferrocene (preparation, structure and reactions), hapticity(η) of	

I.	organometallic ligands, Coordinative unsaturation: oxidative addition, reductive elimination and insertion reactions. Homogeneous catalysis by organometallic compounds: hydrogenation, hydroformylation and polymerization of alkenes (Ziegler-Natta catalysis).	**18**
II.	**Chemistry of d- and f- block elements** **d-block elements**: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. **f-block elements**: electronic configuration, ionization energies, oxidation states, variation in atomic and ionic (3+) radii, lanthanide contraction, magnetic properties of lanthanides comparison between lanthanide and actinides, separation of lanthanides.	**18**
III.	**Inorganic reaction mechanism & symmetry** Introduction to inorganic reaction mechanism, inert and labile complexes, association, dissociation and concerted paths, acid and base hydrolysis (with reference to cobalt complexes only), substitution reaction in octahedral and square planar complexes, trans effect, electron transfer reactions- outer and inner sphere mechanism Symmetry elements and symmetry operations, definition of point groups, point groups of simple molecules, symmetry of octahedron, tetrahedron and square planar complexes, structure and symmetry of simple inorganic compounds.	**18**
IV.	**Nuclear Chemistry** Physical properties of the proton and the neutron, structure of the nucleus, mass defect and binding energy. Radioactive decay and equilibrium. Nuclear reactions, Q value, nuclear cross sections. Theory of radioactive disintegration, rates of disintegration, the radiochemical series. Transmutation of elements and artificial radioactivity, fission and fusion. Nuclear reactions and their use, methods of measurement of radioactivity. Isotopes of elements, methods of separation of isotopes, application of isotopes (tracer technique, neutron activation analysis, radiocarbon dating).	**18**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *2. Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L and Medhi, O. K.; 4th edition; 2007; Pearson Education.

Reference Books

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
2. Cotton F.A.,Wilkinson, G.,Murillo A., Bochmann M.;*Advanced Inorganic Chemistry;*6th edition; 1999; Wiley Interscience; New York.

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Name reactions and reagents in organic chemistry **Subject Code: CHY012M704**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level: 400** **Scheme of Evaluation: T**

Objective: The objective of **Name reactions and reagents in organic chemistry** is to provide concept related to reagents and reactions involved in synthetic organic reactions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept involved in various name reactions.	BT1
CO2	**Explain** the mechanisms involved in various name reactions.	BT2
CO3	**Apply** the reagents for the conversion of one functional group into other functional group in one or more number of steps.	BT3
CO4	**Analyze** the role of organic reagents in various organic transformations.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Selective Name Reactions-I** Aldol condensation, Perkin reaction, Stobbe reaction, Dieckmann condensation, Diels-Ader reactions, Robinson annulation, Michael reaction, Mannich, Stork enamine, Sharpless asymmetric epoxidation, Barton, Ene, Suzuki reaction, Heck reaction, Buckwald reaction.	**18**
II.	**Selective Name Reactions-II** Hoffman-Loffler- Freytag, Shapiro reaction, Chichibabin, Cannizaro, Bayer-Hilman, Darens, Benzoin condensation, Knoevenegel, Reimer-Tieman reaction, Wolf- Kishner reduction, Clemmenson reduction, Moningo reduction, Meerwein-Pondorf-Verley reduction, Oppenauer oxidation, Dess-Martin oxidation, Swern oxidation, Reformatsky reaction.	**18**
III	**Reagents in organic synthesis-I** Complex metal hydrides, DIBAL-H, Gilman's reagent, LDA, DCC, 1,3-propane dithiane, Trimethyl-silyl-tin hydride, Tri-n-butyl-tin hydride, Woodwords and Prevost hydroxylation, DDQ, SeO_2, Methods of generation, properties and reactions of organo magnesium, lithium, cadmium, copper, Grignard reagent and its application,	**18**
IV	**Reagents in organic synthesis-II** PPC, PDC, Merifield resins, Peterson's synthesis, Baker's yeast, Chromic acid, Potassium dichromate, Jones reagent, Collins reagent, Birch reduction, Periodic acid, Lead tetra acetate, Osmium tetra oxide, Ozonolysis, m-CPBA, Wittig reagent, Phosphorous and sulfur ylides: methods of generation, properties and reactions.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. Advanced organic chemistry: Reactions, mechanism and structure; March Jerry; 7th edition; John Wiley.
2. *Organic Chemistry*, Finar I. L. 6th edition, (Low price), 2017, Pearson Education.

Reference Books:

1. Peter Sykes, *A guidebook to mechanisms in Organic Chemistry*, 6th edition, 2003, published by Pearson India.
2. Kalsi P.S.,*Organic Reactions and their Mechanisms*, 3nd edition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool.
4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (7th SEMESTER)

Minor/Subject Name: Chemistry in Everyday Life			**Subject: CHY012N701**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 400**	**Scheme of Evaluation: T**

Objective:

The objective of **Chemistry in everyday life** is to enhance understanding of materials and their effects on the environment.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Find** the concepts of chemistry related to drugs, colloids and corrosion.	BT1
CO2	**Summarize** the knowledge on awareness on handling chemicals.	BT2
CO3	**Apply** the concepts of chemistry to solve the problems in day to day life.	BT3
CO4	**Analyze** the influence of chemistry in day to day life.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Colloids and Cleansing Agents**: Classification, preparation methods – Dispersion and Condensation, application of colloids. Detergents and its classification, Advantage and disadvantage of soap.	**18**
II.	**Corrosion:** Introduction, corrosion types – dry and wet corrosion, mechanism of corrosion, pitting, stress, intergranular and waterline corrosion, factors influencing corrosion, corrosion failure, corrosion control.	**18**
	Toxic chemicals in the environment: Detergents - pollution aspects, eutrophication. Impact of pesticides and insecticides. Heavy metal	**18**

III.	pollution. Solid pollutants - treatment and disposal. Treatment of industrial liquid wastes. Sewage and industrial effluent treatment.	
IV.	**Chemistry of Drugs:** Introduction of Drugs, antacid, Tranquilizers (Psychotherapeutic Drugs), neurotransmitter, analgesics- narcotics and non-narcotics, antipyretics, anti-microbial	**18**
Total		

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Textbooks

1. Drugs and Pharmaceutical Sciences Series, Marcel Dekker, Vol.II, INC, New York.

2. Analysis of Foods – H.E. Cox; 13. Chemical Analysis of Foods- H.E. Cox and Pearson.

Reference Books*:*

1. B.K. Sharma: introduction to Industrial Chemistry, Goel Publishing, Meerut(2018)

2. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6 th ed. 2016, FAI.

3. Foods – Facts and Principles. N. Shakuntala Many and S. Swamy, 4th ed. New Age Internatl (2018).

SYLLABUS (8th SEMESTER)

Major (Core)/Subject Name: Advanced Instrumental Techniques			**Subject Code: CHY012M801**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level 400**	**Scheme of Evaluation: (T)**

Objective: The objective of **Advanced Instrumental Techniques** is to introduce fundamental concepts of advanced instruments commonly used in chemical analysis. Students will gain an understanding of instrument calibration and learn to analyze experimental data using data analysis techniques, with applications in molecular analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the importance of several instrumental techniques	BT1
CO2	**Explain** the working principles of different instruments	BT2
CO3	**Apply** the knowledge of the instrumental techniques to analyse unknown samples	BT3
CO4	**Analyze** the experimental data obtained from the instruments for structure elucidation.	BT4

Detailed Syllabus:

Modules	Topics/ Course content	Period
I	**Nuclear Magnetic Resonance spectroscopy:** Principles of H-NMR and C-NMR, chemical shift, factors affecting chemical shift, coupling constant, Spin – spin coupling, relaxation, instrumentation and applications **Mass Spectrometry:** Principles, Fragmentation, Ionization techniques, chemical ionization, MALDI, FAB, Analyzers-Time of flight and Quadrupole, instrumentation, applications **Hyphenated techniques:** LC-MS/MS, GC-MS/MS, HPTLC-MS.	**18**
II	**Thermal Methods of Analysis:** Principles, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC)	**18**

	X-Ray Diffraction Methods: Origin of X-rays, basic aspects of crystals, X-ray Crystallography, rotating crystal technique, single crystal diffraction, powder diffraction, structural elucidation and applications.	
III	**Calibration and validation**-as per ICH and USFDA guidelines. **Calibration of following Instruments:** Electronic balance, UV-Visible spectrophotometer, IR spectrophotometer, Fluorimeter, Flame Photometer, HPLC and GC.	**18**
IV	**Infra-Red Spectroscopy:** Principles of FT-IR, IR Spectrophotometer, different IR regions- Near IR, far IR and fingerprint region, Common IR peaks for Functional group determination, Limitation and Applications of FT-IR. **FT-IR sample preparation:** Different methods – Liquids, solids (in solution), solids (as Nujol mulls), KBr pellets/disks, thin film.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Instrumental Methods of Chemical Analysis*, B.K Sharma, 24th Edition, **2005.**
2. *Organic spectroscopy*, Y.R Sharma, **2007**.
3. *Organic spectroscopy*, William Kemp, 1st Edition.
4. *Spectroscopy of organic compounds*, P.S. Kalsi, 9th Edition, **2022**.

Reference Books:

1. *Spectrophotometric identification of Organic Compounds*, Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th Edition, **2014.**

SYLLABUS (8th SEMESTER)

Advanced Course/Subject Name: Industrial and polymer Chemistry	**Subject Code: CHY012M804**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level 400**	**Scheme of Evaluation: (T)**

Objective: The objective of **Industrial and polymer Chemistry** is to make students familiar with chemistry of industrial products. It will also help students to the understand the chemistry of polymers.

Course Outcomes:

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

Sl. No	Course Outcome	Bloom's Taxonomy Level
CO1	**Define** and get the detailed idea of petroleum products and petrochemical Industry.	BT1
CO2	**Explain** the concept of surface Coatings, fats, oils and detergents to understand their chemistry along with applications.	BT2
CO3	**Apply** the knowledge of chemistry to understand fertilizers, glass, ceramics and cement as well as their industrial application.	BT3
CO4	**Examine** the chemistry of polymers.	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I.	**Petroleum and Petrochemical Industry** Composition of crude petroleum, refining and different types of petroleum products and their applications, fractional Distillation (principle and process), cracking (thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.	**18**

II.	**Surface Coatings and Fats-Oils-Detergents** **Surface Coatings**: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings, paints and pigments-formulation, composition and related properties, oil paint, vehicle, modified oils, pigments, toners and lakes pigments, fillers, thinners, emulsifying agents. **Fats-Oils-Detergents**: Fats and oils, natural fat, edible and inedible oil of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oil, production of vanaspati and margarine, enzyme-based detergents, detergent powder, liquid soaps.	**18**
III.	**Fertilizers, Glass, Ceramics and Cement** **Fertilizers**: Different types of fertilizers, manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. **Glass and Ceramics**: Definition and manufacture of glasses, optical glass and colored glass, clay and feldspar, glazing, glazed porcelain, enamel. **Portland cement**: Composition and setting of cement, white cement.	**18**
IV.	**Chemistry of polymers** Definition, classification of polymers on the basis of composition, degree of polymerization, addition and chain growth polymerization, vinyl polymerization, ionic vinyl polymerization, Ziegler –Natta polymerization, vinyl polymers, homopolymers, co-polymers, graft copolymers, crystalline polymers, amorphous polymers, classification of polymers on the basis of structure of polymer, i.e., linear, branched, and cross linked; molecular weight of polymers, number average and weight average molecular weights.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Industrial Chemistry*, Stocchi E.; 1st edition; 2012(reprint); Ellis Horwood Ltd. UK.

2. *Riegel's Handbook of Industrial Chemistry*, Kent J.A.; 10th edition; 2013; CBS Publishers, New Delhi.

Reference Books:

1. Felder, R.M. and R. W. Rousseau, R.W: *Elementary Principles of Chemical Processes*, 4th edition;2004, Wiley Publishers, New Delhi.

2. Gowariker, V.R.; *Polymer science*; 4th edition; 2015; New Age International Pvt. Ltd.

SYLLABUS (8TH SEMESTER)

Advanced Course/Subject Name: Material Chemistry			**Subject Code: CHY012M805**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level 400**	**Scheme of Evaluation: (T)**

Objective: The objective of **Material Chemistry** is to make students familiar with the properties of Liquid Crystals and nano materials. It will also help students to understand synthesis and applications of silicate and alloy in industries.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Identify** the compounds or materials having distinctive electrical and optical properties.	BT1
CO2	**Explain** the applications of silicates in glass and ceramic industries.	BT2
CO3	**Apply** the properties of materials in various forms, including liquid crystals and nanomaterials, to gain a deeper understanding of their characteristics.	BT3
CO4	**Analyze** the chemical composition and reactions involved in batteries and alloys.	BT4

Detailed Syllabus:

Modules	**Topics & Course Content**	**Periods**
I	**Electrical and optical properties** Band theory, conductors, insulators and semi-conductors. Intrinsic and extrinsic semiconductors, Superconductivity and examples of superconducting materials, Ferroelectric and Piezoelectric materials, Conductors; variation of conductivity with temperature, semiconductors; p and n types, pn- junction, Photoconduction, photo voltaic cell and photo galvanic cell – solar energy conversion, organic semiconductors. Piezoelectric, pyro-electric and ferroelectrics (introduction and application). photoluminescence.	**18**
	Silicate Industries **Glass*:*** Glassy state and its properties, classification, manufacture and processing of glass, composition and properties of the following types of glasses:	**18**

	soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. **Ceramics*:*** Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides.	
III	**Liquid Crystals and nano materials** **Liquid Crystals**: Mesomorphic behavior, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, smectic A and smectic C phases, optical properties of liquid crystals. Lyotropic phases. **Nanomaterials**: Fundamentals, novel optical properties of nano materials, characterization and fabrication, self-assembled nanostructures. Control of nano-architectures: 1-D, 2-D and 3-D control. Carbon nanotubes.	**18**
IV	**Batteries and Alloys** **Batteries:** Primary and secondary batteries, battery components and their role, characteristics of battery, working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. fuel cells, solar cell and polymer cell. **Alloys:** Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.	**18**
TOTAL		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Material Science and Engineering*, *An Introduction*; Callister, W.D., 8th edition, 2017,Wiley and sons.

2. *Handbook of Liquid Crystals*, Kelker and Hatz, Chemie Verlag.; 2nd edition, 2014

Reference Books:

1. Keer, H.V.; *Principles of the Solid State*, 4th edition, 2017; Wiley Eastern.

2 Anderson, J.M. Leaver, K.D., Rawlings, R.D.; *Materials Science*, 4th edition, 2003; ELBS.

SYLLABUS (8th SEMESTER)

Subject Name: Biochemistry and Natural products			**Subject Code: CHY012M806**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Level: 400**	**Scheme of Evaluation:**

Objective: The objective of **Biochemistry and Natural products** is to provide concept related to biomolecules and natural products.

Course Outcomes:

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

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Understand** the concept of various biomolecules and natural products.	BT1
CO2	**Explain** the structure and reactions of biomolecules and natural products.	BT2
CO3	**Apply** basic concepts of biochemistry to understand roles of biomolecules as well as metabolism process in biological systems.	BT3
CO4	**Analyze** the structures of various biomolecules and natural products.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Vitamins, minerals and enzyme** Classification and nomenclature of vitamins. Need for vitamin in body, Types of vitamins, water soluble and fat-soluble vitamins, Sources, deficiency diseases and structures of vitamin A1, vitamin B12, Vitamin C (Cyanocobalamine), vitamin D vitamin E and vitamin K. Role of minerals in body, iodine deficiency and remedy. Classification and nomenclature, prosthetic groups, cofactors of enzyme, properties of enzymes as catalysts, specific activity, turn over number and catalytic center activity. Isolation of enzymes from different sources.	**18**
II.	**Amino acids, peptides and proteins** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Study of peptides: Determination of their primary structures, end group analysis, methods of peptide synthesis. Proteins: Overview of primary, secondary, tertiary and quaternary structure of proteins. Protein denaturation/ renaturation.	**18**
III	**Carbohydrate Chemistry** Carbohydrates: Definition, classification of carbohydrates, general idea of monosaccharides, configuration of the hydroxyl groups in the monosaccharides, open chain and ring structure of glucose, reactions of glucose: osazone formation, bromine – water oxidation etc., concept of mutarotation, anomers, epimers, oligosaccharides and polysaccharides.	**18**
IV	**Alkaloids and Terpeneoids** Natural occurrence, General structural features, Isolation and their physiological action. Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Quinine, Morphine, Cocaine, and Reserpine. Terpenes: Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.	**18**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Organic Chemistry*, Finar I. L. 6th edition, (Low price), 2017, Pearson Education.
2. Advanced Organic Chemistry, by B S Bahl and Arun Bahl, S. Chand Publications.

Reference Books:

1. *Organic Chemistry* by Mukherji, Singh, Kapoor and Dass, New Age International Publishers.
2. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .
3. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.