MAR IVANIOS COLLEGE (AUTONOMOUS)

Affiliated to the

University of Kerala, Thiruvananthapuram

Kerala

SCHEME AND SYLLABUS FOR THE

FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

MAJOR DISCIPLINE
CHEMISTRY

(With effect from 2024 Admissions)

Approved by the Board of Studies in

CHEMISTRY

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PREAMBLE

National Education Policy (NEP 2020) envisions ‘higher education as playing an extremely important role in promoting human as well as societal wellbeing and in developing India as envisioned in its Constitution - a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all’ (Section 9.1). NEP also expects higher education ‘to develop good, thoughtful, well-rounded, and creative individuals, enabling 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 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects’ (Section 9.1.1). Hence, more than the creation of greater opportunities for individual employment, higher education represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation. (Section 9.1.3). NEP also identifies some of the major problems currently faced by the higher education system in India (Section 9.2) and envisions a complete overhaul and re-energizing of the higher education system to overcome these challenges and thereby deliver high-quality higher education, with equity and inclusion (Section 9.3). One of the major changes which the policy proposes is moving towards a more multidisciplinary undergraduate education (Section 9.3(b)) which develops all capacities of human beings - intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner (Section 11.3). In order to achieve this in its full potential, NEP visions the adjusting of the structure and lengths of degree programmes accordingly. “The undergraduate degree will be of either 3 or 4-year duration, with multiple exit options within this period, with appropriate certifications, e.g., a certificate after completing 1 year in a discipline or field including vocational and professional areas, or a diploma after 2 years of study, or a Bachelor ’s degree after a 3-year programme. The 4-year multidisciplinary Bachelor's programme, however, shall be the preferred option since it allows the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.” (Section 11.9)

In accordance with the NEP 2020, the UGC formulated a new student-centric “Curriculum and Credit Framework for Undergraduate Programmes (CCFUP)” incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options and establishing three Broad Pathways,

(a) 3-year UG Degree,

(b) 4-year UG Degree (Honours), and

(c) 4-year UG Degree (Honours) with Research)

Accordingly, the Kerala Higher Education Reforms Commission 2022, headed by Prof Shyam B. Menon, has recommended a comprehensive reform in the undergraduate curriculum with the adoption of the 4-year undergraduate Programmes, which will bring undergraduate education in Kerala at par with the universities abroad. Consequently, Kerala State Curriculum Committee for Higher Education 2023 has been constituted, with Dr Suresh Das as Chairman, and they have proposed a model Kerala State Higher Education Curriculum framework for undergraduate education.

The University of Kerala has decided to introduce the Four Year Under Graduate Programmes (FYUGP) from the academic year 2024-2025 onwards in its teaching departments and all affiliated colleges, and has issued many draft documents and conducted college level awareness programmes about the same.

Mar Ivanios College, by virtue of its autonomy status, conferred in 2014 and extended in 2022, vide University Grants Commission (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023, has the power to review existing courses/programmes and, restructure, redesign and prescribe its own courses/programmes of study and syllabi and to formulate new courses/programmes within the nomenclature specified by UGC as per the Specification of Degrees 2014 as amended from time to time. Accordingly, the Board of Studies in Chemistry of Mar Ivanios College (Autonomous) proposed the implementation of the FYUGP scheme with effect from 2024 admission onwards and prepared the scheme and syllabi through many of the meetings and discussions. The Academic Council of the college which met on 30th April gave discussed the proposal and syllabi in detail and approved the same to be implemented from 2024 admission onwards, subject to the final directions of the University of Kerala.

The salient features of the syllabus prepared and presented by the Board of Studies include the following:

- The curriculum is designed based on Outcome Based Education (OBE) approach.
- The curriculum follows Choice-Based Credit System (CBCS): This system allows students to select courses from a prescribed list. A specified number of credits must be earned to award the degree.
- The curriculum follows the basic framework, course wise/programme-wise minimum/maximum credits set by the University of Kerala for FYUGP and abides by the basic mandatory principles of **Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024.**
- The curriculum adopts skill enrichment courses ensuring ample employment opportunities.
- Practicals are included in the courses which are in alignment to the theory modules offered in the respective courses.
- Industrial visit has been incorporated in courses wherever it is inevitable.

- Collaborations with research institutions of National importance have been incorporated in the courses to gets a hands on training and experience of the sophisticated analytical instruments and interpretation of the analytical data.

Graduate Attributes and Programme Outcomes (POs):

The National Higher Education Qualification Framework (NHEQF) envisages that students on completion of a programme of study must possess and demonstrate the expected graduate profile/attributes acquired through one or more modes of learning. The graduate profile/attributes indicate the quality and feature 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 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 the society. The graduate profile/attributes are acquired incrementally 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 profile/attributes are fostered through meaningful learning experiences made available through the curriculum and learning experience, the total college/university experience, and a process of critical and reflective thinking. Mar Ivanios College (Autonomous) is fully committed to ensuring the attainment of the necessary graduation attributes by the students. The college has clearly defined its raison de'tre, the philosophy of its existence, through the Motto "Truth Shall Liberate You" (Veritas Vos Liberabit) which refers to the ultimate enlightenment which can emerge only at the intersection of sharp intellect, sound physique, strong mind, staunch ethics, and profound spirituality. This is further made explicit through its Vision, Mission and Goals and the same expect all students who graduate from the college to:

- Have inculcated "the values of truth and charity for the protection and promotion of human dignity and of a cultural heritage, through teaching, research, and extension activities dedicated to society";
- Be co-creators of a vibrant academic community known for its innovation, intellectual rigour and social commitment;
- Be "intellectually trained, morally upright, socially committed, spiritually inspired and ecologically conscious young men and women who would be dedicated to working for the good of society, the nation and the world";
- Have acquired "global competencies and skills";
- Have inculcated a sense of harmony, equality and fraternity among youth, transcending religious, linguistic, regional or sectional diversities; and
- Have developed "scientific temper, humanism and the spirit of inquiry and reform".

Programme Outcomes are the expected student attributes achieved by a student after the student completes the FYUGP from any of the streams/pathways.

The Programme Outcomes (POs) for the FYUGP programmes across all streams and pathways, based on the above core philosophy, and in consonance with the National Higher Education Qualifications Framework (NHEQF) are given below:

By the end of the Four-Year Under-Graduate Programme, students will:

PO 1	**Demonstrate the acquisition of all necessary knowledge and skills within their disciplinary/ multi-disciplinary areas of learning. These include the acquisition of:** • **comprehensive knowledge and coherent understanding of their chosen disciplinary/ interdisciplinary areas of study, their linkages with related fields, and the awareness of current trends in their chosen area of study;** • **essential knowledge for skilled work in chosen field(s), including self-employment and entrepreneurship skills;** • **proficiency in specialized areas within chosen fields of study, encompassing diverse practical skills applicable to different situations within those fields;** • **the ability to apply learned knowledge to novel situations, solve problems, and relate concepts to real-world scenarios rather than just memorizing curriculum content.**
PO 2	**Acquire problem-solving, critical thinking, analytical reasoning skills and demonstrate creativity in their thought processes** by demonstrating the ability to: • solve different kinds of problems in familiar and non-familiar contexts both within and outside their disciplinary/ multidisciplinary areas of learning; • apply analytic thought to a body of knowledge, including the analysis and evaluation of policies, and practices, as well as evidence, arguments, claims, and beliefs; • analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples. • the ability to plan, execute and report the results of an experiment or investigation; • adhere to scientific temper and ethics in their thought process; • adopt innovative, imaginative, lateral thinking, interpersonal skills and emotional intelligence; and • incubate entrepreneurial and start-up ideas.
PO 3	**Develop a profound environmental dedication by fostering ecological awareness and engaging in actions that promote sustainable development** by achieving the ability to • recognize environmental and sustainability issues, and participate in actions to promote sustainable development as well as mitigate the effects of environmental degradation, climate change, and pollution; • contribute to effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, sustainable development and living, and the preservation of life in all forms. • participate in community-engaged services/ developmental activities and

	thus exemplify the ideals of community engagement and service learning and deep social commitment.
PO 4	**Accomplish perfect communication, teamwork, and leadership skills, particularly in academic and professional settings, while demonstrating nuance and attention to etiquette in all communicative contexts.** This will enable them to: • listen carefully, and read texts and research documents, and present complex information with clarity and precision to different audiences; • express thoughts and ideas and communicate effectively through speech and writing using appropriate media; • communicate using language which is respectful of gender and minority orientations; • act together as a group or a team in the interests of a common cause and working efficiently as a member of a team; • inspire the team with a vision to achieve a stated goal, and use management skills to guide the team in the right direction.
PO5	**Acquire the necessary skills, including 'learning to learn' skills, and foster innovative ideas to improve competence and employability, keeping pace with the evolving global landscape and technological advancements** by demonstrating the ability to: • pursue learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing trades and demands of the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling; • work independently, identify appropriate resources required for further learning; • acquire organizational and time management skills to set self-defined goals and targets with timelines; • be a proactive life-long learner. • 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; • navigate cyberspaces by following appropriate ethical principles and cyber etiquette. • use cutting edge AI tools with equal commitment to efficiency and ethics. • think 'out of the box' and generate solutions to complex problems in unfamiliar contexts;
PO6	**Develop research-related skills including the ability to conceptualize research hypotheses/projects and adopt suitable tools and methodologies for analysis** with: • a keen sense of observation, inquiry, and capability for asking relevant/ appropriate research questions;

	• the ability to problematize, synthesize, and articulate issues and design research proposals; • the ability to 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; • the capacity to develop appropriate methodology and tools for data collection; • the appropriate use of statistical and other analytical tools and techniques; • the ability to plan, execute and report the results of an experiment or investigation; • the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or the field of study
PO7	**Assimilate a sound value system, a sense of autonomy, multicultural competence, social commitment, and the spirit of inclusivity and empathy by imbibing the spirit and the holistic ethos of the 'Multi-Dimensional Ivanian' (MDI) approach.** This will enable them to: • embrace and practice constitutional, humanistic, ethical, and moral values in life, including universal human values of integrity, truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values; • identify ethical issues related to work, follow ethical practices and be objective, unbiased, and truthful actions in all aspects of work, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights; • exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces; • practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issues and to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies; • effectively engage in a multicultural group/society and interact respectfully with diverse groups; • identify with or understand the perspective, experiences, or points of view and emotions of another individual or group. • demonstrate gender sensitivity and adopt a gender-neutral approach, as also empathy for the less advantaged and the differently-abled including those with learning disabilities; • demonstrate proficiency in arts/ sports/ games, physical, mental and emotional fitness, entrepreneurial /organizational /pubic speaking/environmental/ community-oriented areas by actively participating in the wide range of co-curricular activities that are available to the students of Mar Ivanios College.

Programme Specific Outcomes (PSOs)

In conformity with the POs, the Programme Specific Outcomes (PSOs) of the Major in CHEMISTRY are drafted as given below:

Upon completion of BSc Degree programme in Chemistry, students

PSO no	Details	Key concept
PSO-1	Acquire expertise across chemistry domains: physical, organic, inorganic, and analytical. Proficiently predict reaction pathways, analyze outcomes, and interpret data using advanced analytical methods. Employ instruments for modeling chemical processes and evaluate theories and methods. Improve communication skills with chemistry software for creating molecular structures and visuals.	Mastery of Chemical reactions
PSO-2	Analyze chemical processes, apply findings to problem-solving, and utilize advanced analytical techniques. Embrace sustainability by using chemical software and tools responsibly, and cultivate an eco-friendly mindset by understanding pollution impacts on air, water, and soil.	Sustainable chemical analysis
PSO-3	Inculcate the spirit of originality, novelty, and necessity in scientific research and, thereby, develop a mindset to scientifically recognize, evaluate, and creatively solve research challenges and share knowledge in an interdisciplinary way to contribute to society's academic and industrial needs	Interdisciplinary skills
PSO-4	Proficiency in handling hazardous chemicals, recognizing common home chemicals' components, and applying them with caution. Visit chemical factories and industries with scientific curiosity to adopt safer life skills in a human-friendly and eco-friendly manner.	Safety and social responsibility
PSO-5	Foster a scientific mindset and critical thinking in Chemistry, promoting healthier attitudes towards individuals, communities, and cultures. Cultivate motivation for advanced studies and successful careers in academia, industry, research, and beyond.	Scientific perspective and student progression

Course and Credit Structure of FYUGP

The pathway preferably followed by the department will be Major with Minor or Major with multiple disciplines of study.

The Course and Credit Strcuture of FYUGP is given below:

Sem	DSC (4 Cr)	DSE (4 Cr)	AEC (3 Cr)	SEC (3 Cr)	MDC (3 Cr)	VAC (3 Cr)	Internship (credit-2)/ Project/ Additional Courses (credit-12)	Total courses	Total credits
I	A-1 B-1 C-1 D-1		AEC (Eng)-1 AEC(OL)-2		MDC-1			6	21
II	A-2 B-2 C-2 D-2		AEC (Eng)-3 AEC(OL)-4		MDC-2			6	21
III	A-3 B-3 C-3 D-3	DSE A -1			MDC (Kerala Studies)-3	VAC-1		6	22
IV	A-4 A-5	DSE A-2		SEC-1		VAC-2 VAC-3	Internship	6	23
V	A-6 A-7 A-8	DSE -3 DSE -4		SEC-2				6	23
VI	A-9 A-10 A-11	DSE -5 DSE -6		SEC-3				6	23
Total	A (11) B (3) C (3)	6	4	3	3	3	1*	36	133
EXIT OPTION AVAILABLE AND STUDENTS WILL BE AWARDED UG DEGREE WITH MAJOR IN A									
VII	A-12 A-13 B/C-4 B/C-5 B/C-6	DSE -7						6	24
VIII	MOOC courses A -14, A -15						Research Project/ Internship	2+1**/ 3***	20

							/Project or 03 courses -12Cr		
Total	A (15) B(3) C (3) B/C(3)	7	4	3	3	3	$1^{*}+1^{**}/3^{***}$	$44+1^{*}+1^{**}/3^{***}$	177

A – Major Discipline
B/C-Minor/Multiple discipline
* - Mandatory Internship at the end of Semester 4

** - Research Project/ Internship /Project as part of Honours with Research
*** - Additional courses of 4 credits each.
Cr - Credits

- **Research group project for students exiting after UG 3 years:** Students who propose to exit after 3 Year UG programme can do a group project with an extra two credits to obtain research experience in discipline-specific areas of the program. The BoS can decide the number of students for the group and the evaluation criteria.

- Students will be able to take other pathways permissible under **University of Kerala Four Year Under Graduate Programmes (UoK-FYUGP) Regulations, 2024,** subject to the availability of courses/ faculty/infrastructure of the college.

- The Board of Studies shall prepare and publish a list of online courses at different levels before the commencement of classes in the respective semester offered in various online educational platforms recognised by the academic council of the college, which can be opted by the students for acquiring additional credits.

Course Participation/Attendance-

1. A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if the student has completed 75% of the prescribed classroom activities in physical, online, or blended modes, as stipulated by the BoS, including any makeup activities as specified by the faculty of that particular course.
2. The reasons/cases of permissible authorised leave shall be specified by the college, with the approval of the Academic Council, ratified by the Governing Body.
3. The condonation facility shall be availed as per the existing University/college norms.

Assessment and Evaluation

1. The assessment of a course shall combine a Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).
2. For courses without practical/lab modules, 30% weightage shall be given for CCA and the remaining 70% of the weight shall be for the ESE.
3. CCA will have two sub-components: Formative Assessment (FA) and Summative Assessment (SA).

4. The CCA subcomponents will be given marks as per the following proportions:
    - Discipline specific summative assessment - 15% of the total
    - Course attendance (Formative) - 5 % of the total.
    - Discipline specific formative assessment - 10% of the total.
5. The details of summative and formative assessment criteria, including that of attendance, will be specified by each course coordinator at the beginning of the semester, with the approval of the respective Head of the Department/BoS Chairperson and the Principal, and will be published on the college website.
6. For courses with practical/lab modules, 40% weightage shall be given for CCA and the remaining 60% of the weight shall be for the ESE.
7. In such cases specified in the item above, the CCA subcomponents will be given marks as per the following proportions:
    - Discipline specific summative assessment - 10% of the total
    - Course attendance (Formative) - 5 % of the total.
    - Discipline specific formative assessment - 15% of the total.
    - Summative Assessment (Practical Record, Practical test, skill, etc). - 10% of the total

The above is given in detailed tabular form as follows:

Sl. No.	Activity	Percentage (%) of the total	
		Theory courses	Courses with practical
1.	Summative Assessment (written Test or any other discipline specific assessment tools like Open book test, Lab reports, problem-based assignments, individual or team project report, case study report, literature survey, book reviews, video/film/documentary productions, etc)	15	10
2.	Summative Assessment (Practical Record, Practical test, skill, etc)	-----------	10
3.	Formative Assessment (Attendance)	5	5
4.	Formative Assessment (Class room activities, observation of skills, viva voce, quiz, interview, oral presentations, in class discussions, computerized adaptive testing, group tutorial work, reflection writing assignments, field study reports, self and peer assessments, service-learning activities, etc.)	10	15
	Total	30	40

8. The Course Coordinator shall be responsible for evaluating all the components of CCA for the course in question. Any grievances regarding the same shall be submitted to the Course Coordinator within 5 days of the publication of the same on the department notice board or official class group. If the grievance is not settled

at the Course Coordinator level, the student is free to appeal to the Head of the Department, within the next 3 days, who will discuss the same in the Department Level Monitoring Committee (DLMC). If still needed, students can further appeal to the College Level Monitoring Committee (CLMC) or in essential situations the University Level Monitoring Committee (ULMC) in a time period as specified by these bodies.

9. Regarding evaluation, one credit will be evaluated for 20 marks in a semester; thus, a 4-credit course will be evaluated for 80 marks, and 3-credit courses for 60 marks. However, any changes to this if brought by the University will be followed.
10. The duration of the end semester examination of a course with 4 credits will be 2 hours and the same for a course with 3 credits may be 1.5 hours/2 hours.

General Mark Distribution Table

Course	Credit		Marks		Lecture			Practical		
4 credit courses	Lecture	Practical	Lecture	Practical	CCA (30%)		ESE (70%)	CCA (40%)		ESE (60%)
					SA (50%)	FA (50%)		SA (50%)	FA (50%)	
	4	0	80	0	12	12	56	0	0	0
	3	1	60	20	9	9	42	4	4	12
	2	2	40	40	6	6	28	8	8	24
	1	3	20	60	3	3	14	12	12	36
	0	4	0	80	0	0	0	16	16	48
3 credit courses	Credit		Marks		Lecture			Practical		
	Lecture	Practical	Lecture	Practical	CCA (30%)		ESE (70%)	CCA (40%)		ESE (60%)
					SA (50%)	FA (50%)		SA (50%)	FA (50%)	
	3	0	60	0	9	9	42	0	0	0
	2	1	40	20	6	6	28	4	4	12
	1	2	20	40	3	3	14	8	8	24
	0	3	0	60	0	0	0	12	12	36

Mark distribution for Internal Assessment

Mark distribution for Courses with Practical

(Theory-3 Credits & Practical-1 Credit)	Marks	(Theory-2 Credits & Practical-2 Credit)	Marks
Theory	9	Theory	6
Practical	4	Practical	8
Attendance	4	Attendance	4
Assignment	5	Assignment	2
Record	4	Record	4
		Lab Skill	4
Total	**26**	**Total**	**28**

Mark distribution for courses with Theory only

Internal Examination	Marks
Theory	12
Attendance	4
Assignment	4
Seminar/ Quiz/ Field Trip/ Industrial Visit/ Open Discussion	4
Total	**24**

Mark distribution for MDC/SEC/VAC

Internal Examination	Marks
Theory	9
Attendance	4
Assignment	5
Total	**18**

Letter Grades and Grade Point

1. A mark system is followed to evaluate each question. For each course in the semester, letter grades and grade points are introduced in a 10-point indirect grading system as per the guidelines given below.
2. The Semester Grade Point Average (SGPA) is computed from the grades to measure the student's performance in a given semester. The SGPA is based on the

current term's grades, while the Cumulative Grade Point Average (CGPA) is based on the grades in all courses taken after joining the programme of study.

3. The weighted grade point will be mentioned in the student's final grade cards, issued by the college, based on the marks obtained.
4. **The grades and grade points will be given as per the following format:**

Letter Grade	Grade Point	Percentage of marks (X) (CCA + ESE together)	Class
O (Outstanding)	10	$X \geq 95\%$	FIRST CLASS WITH DISTINCTION
A+ (Excellent)	9	$85\% \leq X < 95\%$	
A (Very Good)	8	$75\% \leq X < 85\%$	
B+ (Good)	7	$65\% \leq X < 75\%$	FIRST CLASS
B (Above Average)	6	$55\% \leq X < 65\%$	
C (Average)	5	$45\% \leq X < 55\%$	SECOND CLASS
$\boldsymbol{P\ (Pass)}^{*}$	4	$35\% \leq X < 45\%$	THIRD CLASS
F (Fail)	0	X< 35%	FAIL
Ab (Absent)	0		FAIL

- For a course PASS, separate minimum of 35% is needed for CCA and ESE.
- Less than 35% in either ESE or CCA is FAIL.

Computation of SGPA and CGPA

SGPA (Semester Grade Point Average) and CGPA (cumulative Grade Point Average) will be computed as follows:

1. The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in the semester. That is,

$$S_j = \frac{\sum(C_{ij} \times G_{ij})}{\sum C_{ij}}$$

where S_j is the SGPA in the jthsemester,
C_{ij} is the number of credits for the ith course in the jthsemester, and
G_{ij} is the the grade point scored by the student in the ith course in the jthsemester.

2. CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a programme. That is,

$$CGPA = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

where $S_i$is the SGPA in the ithsemester and

$\sum C_i$ is the total number of credits in the ith semester.

3. The SGPA and CGPA shall be rounded to 2 decimal points and reported in the transcripts.
4. **Requirement for the successful completion of a Semester**:

   SGPA of 4 or above and a PASS in all the courses, that is, minimum total of 35% mark in each course (CCA + ESE), with a separate minimum of 35% mark for both CCA and ESE. Appropriate and permissible rules of rounding off numbers may be adopted as per decisions of the Academic Council.
5. **Minimum Eligibility Criteria for 4 Year UG (Honours with Research)**
   - Students satisfactorily finishing all courses up to the 6th semester in the Department, with a CGPA of 7.5/10 or equivalent to 75% marks and above, will qualify to select the Honours programme with a Research Degree during the upcoming 7th and 8th semesters.
   - A relaxation of 0.5 score, i.e. CGPA of 7/10 or an equivalent relaxation of grade, will be allowed for those who belong to SC/ST/OBC (non-creamy layer)/Differently Abled, Economically Weaker Section (EWS) and other categories as per the UGC norms from time to time.

Dr. Suju C. Joseph
Chairman, BoS
Chemistry
Mar Ivanios College (Autonomous),
Thiruvananthapuram

Thiruvananthapuram

10-05-2024

List of courses offered in each Semester:

Semester I (Academic Level 100-199)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A1	MIUK1DSCCHE100.1	Inorganic Chemistry I	4	5	80
DSC B1	MIUK1DSCCHE110.1	Inorganic and Physical Chemistry	4	5	80
DSC C1	MIUK1DSCCHE120.1	Inorganic and Environmental Chemistry	4	5	80
DSC D1	MIUK1DSCCHE130.1	General Chemistry I	4	5	80
MDC 1	MIUK1MDCCHE100.1	Food and Nutrition	3	3	60
Semester II (Academic Level 100-199)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A2	MIUK2DSCCHE150.1	Organic Chemistry I	4	5	80
DSC B2	MIUK2DSCCHE160.1	Physical and Industrial Chemistry	4	5	80
DSC C2	MIUK2DSCCHE170.1	Organic and Bioinorganic Chemistry Chemistry for Biology	4	5	80
DSC D2	MIUK2DSCCHE180.1	General Chemistry II	4	5	80
MDC 2	MIUK2MDCCHE150.1	Fundamental Aspects of Environmental	3	3	80
Semester III (Academic Level 200-299)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A3	MIUK3DSCCHE200.1	Physical Chemistry I	4	5	80
DSC B3	MIUK3DSCCHE210.1	Electrochemistry and Dilute Solutions	4	5	80

DSC C3	MIUK3DSCCHE220.1	Biomolecules and Separation Techniques	4	5	80
DSC D3	MIUK3DSCCHE230.1	General Chemistry III	4	5	80
DSE 3.1	MIUK3DSECHE200.1	Environmental Chemistry I	4	4	80
DSE 3.2	MIUK3DSECHE201.1	Analytical Chemistry I	4	4	80
VAC 1	MIUK3VACCHE200.1	Laboratory Safety	3	3	80
Semester IV (Academic Level 200-299)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A4-I	MIUK4DSCCHE250.1	Inorganic Chemistry II	4	6	80
DSC A4-II	MIUK4DSCCHE251.1	Organic Chemistry II	4	5	80
DSE 4.1	MIUK4DSECHE250.1	Environmental Chemistry II	4	5	80
DSE 4.2	MIUK4DSECHE251.1	Analytical Chemistry II	4	5	80
SEC 1	MIUK4SECCHE200.1	Water Quality Analysis	3	3	60
VAC 2	MIUK4VACCHE250.1	Sustainable Chemistry	3	3	60
VAC 3	MIUK4VACCHE251.1	Scientific Communication and Ethics	3	3	60
INT	MIUK4INTCHE250	Internship Project	2	-	40
Semester V (Academic Level 300-399)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A5-I	MIUK5DSCCHE300.1	Inorganic Chemistry III	4	5	80
DSC A5-II	MIUK5DSCCHE301.1	Organic Chemistry III	4	4	80
DSC A5-III	MIUK5DSCCHE302.1	Physical Chemistry II	4	4	80
DSE 5.1	MIUK5DSECHE300.1	Environmental Chemistry III	4	4	80

DSE 5.2	MIUK5DSECHE301.1	Environmental Chemistry IV	4	5	80
DSE 5.3	MIUK5DSECHE302.1	Analytical Chemistry III	4	4	80
DSE 5.4	MIUK5DSECHE303.1	Analytical Chemistry IV	4	5	80
SEC 2	MIUK5SECCHE300.1	Phytochemical Techniques	3	3	60
Semester VI (Academic Level 300-399)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A6-I	MIUK6DSCCHE350.1	Organic Chemistry IV	4	4	80
DSC A6-II	MIUK6DSCCHE351.1	Physical Chemistry III	4	5	80
DSC A6-III	MIUK6DSCCHE352.1	Chemical Dynamics and Equilibria	4	4	80
DSE 6.1	MIUK6DSECHE350.1	Environmental Chemistry V	4	4	80
DSE 6.2	MIUK6DSECHE351.1	Environmental Chemistry VI	4	5	80
DSE 6.3	MIUK6DSECHE352.1	Analytical Chemistry V	4	4	80
DSE 6.4	MIUK6DSECHE353.1	Analytical Chemistry VI	4	5	80
SEC 3	MIUK6SECCHE350.1	Electroanalytical Techniques	3	3	60
Semester VII (Academic Level 400-499)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A7-I	MIUK7DSCCHE400.1	Advanced Inorganic Chemistry	4	4	80
DSC A7-II	MIUK7DSCCHE401.1	Advanced Organic Chemistry	4	5	80
DSC B7	MIUK7DSCCHE301.1	Coordination and Bioinorganic Chemistry	4	5	80
DSC C7	MIUK7DSCCHE302.1	Organic Chemistry and Biomolecules	4	4	80

DSC D7	MIUK7DSCCHE303.1	Physical Spectroscopy and Quantum Mechanics	4	4	80
DSE 7.1	MIUK7DSECHE400.1	Research Methodology and Ethics	4	4	80
Semester VIII (Academic Level 400-499)					
Course Type	**Course Code**	**Course Title**	**Number of credits**	**Number of hours per week**	**Total Marks**
DSC A8-I	MIUK8DSCCHE450.1	Online Course-I	4	4	80
DSC A8-II	MIUK8DSCCHE451.1	Online Course-II	4	4	80
RPH	MIUK8RPHCHE450	Honours with research Project	12	-	240

SEMESTER 1

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">CHEMISTRY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK1DSCCHE100.1</td></tr>
<tr><td>Course Title</td><td colspan="5">INORGANIC CHEMISTRY I</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSC A1</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Academic Level</td><td colspan="5">100 - 199</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>3 hours</td><td>-</td><td>2 hours</td><td>5</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">Plus two</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides an understanding of atomic structure, chemical bonding theories, environmental chemistry focusing on air, water, and soil pollution, and basics of analytical chemistry including volumetric analysis techniques. Through theoretical concepts, practical experiments, and case studies, students gain knowledge and skills essential for addressing complex issues in chemistry and environmental science.</td></tr>
</table>

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**ATOMIC STRUCTURE & PERIODICITY**		**9**
	1	Introduction to structure of atom, Rutherford and Bohr model of atom	1

	2	Dual nature of electron-de Broglie equation-matter waves and electromagnetic waves. Experimental verification by Davis and Germer method, Heisenberg's uncertainty principle- expression and significance.	1
	3	Wave mechanical concept of the atom-Schrodinger equation and its significance (derivation not required.)	1
	4	Quantum numbers- Pauli's Exclusion principle- Aufbau Principle- Hund's rule- Electronic configuration of atoms, classification of elements into s, p, d and f blocks	2
	5	Electronegativity- Pauling's scale, Mulliken and Allred- Rochow scale (including numerical problems),	2
	6	Effective nuclear charge, Slaters rule and its applications, diagonal relationship and anomalous behaviour of first element with other elements	2
II	**CHEMICAL BONDING**		**15**
	7	Overview of Chemical Bonding Theories: - Definition of chemical bonding. - Importance of understanding chemical bonding in chemistry and related fields.	1
	8	Valence Shell Electron Pair Repulsion (VSEPR) Theory - Explanation of VSEPR theory. - Predicting molecular geometry for molecules with bond pairs only. - Predicting molecular geometry for molecules with both bond pairs and lone pairs. - Application of VSEPR theory in predicting molecular properties.	2
	9	Valence Bond Theory (VBT) - Historical background and development of VBT. - Conditions of overlapping in VBT. - Types of overlapping (sigma, pi, delta). - Hybridization in molecules: sp, sp2, sp3, sp^3d, sp^3d^2. - Molecular orbital theory and its relation to VBT. - Limitations of VBT and its application to simple molecules.	2
	10	Molecular Orbital (MO) Theory - Introduction to MO theory. - Linear Combination of Atomic Orbitals (LCAO) method. - Formation of molecular orbitals in homonuclear diatomic molecules (C_2, B_2, N_2, O_2) and ions (O^{2+}, O^{2-}). - Formation of molecular orbitals in heteronuclear diatomic molecules (HF, NO, CO). - Calculations of bond order and its applications.	3

	11	Ionic Bonding - Explanation of ionic bonding, Ionic lattice energy of ionic compounds. - Bond-Lande equation and Born-Haber cycle. - Solvation energy and solubility of ionic solids. - Covalent character of ionic bonds. - Fajan's rules and their applications. - Polarity of covalent bonds. - Dipole moment and percentage of ionic character. - Relationship between dipole moment and molecular structure.	3
	12	Metallic Bonding - Overview of metallic bonding. - Free electron theory and band theory. - Explanation of conductance and malleability in metals.	1
	13	Secondary Forces - Explanation of hydrogen bonding. - Inter and intra molecular hydrogen bonding. - Applications of hydrogen bonding in biology, chemistry, and materials science. - Intermolecular interactions: ion-dipole interactions, van der Waals forces (dispersion forces, dipole-dipole interactions, ion-induced dipole interactions, dipole-induced dipole interactions).	2
	14	Case studies and Problem-solving Session Group problem-solving exercises related to molecular geometry, hybridization, bond calculations, and properties of molecules based on their bonding.	1
III	**ENVIRONMENTAL CHEMISTRY - AIR, WATER AND SOIL POLLUTION**		**9**
	15	Air pollution- Air pollution caused by fireworks, harmful effects of fireworks, acid rain, greenhouse effect, smog-classic and photochemical smog Ozone layer depletion, ozone hole, protection of ozone umbrella. Management of air pollution.	2
	16	Water pollution: Causes- heat, industrial waste, sewage water, detergents, agricultural pollutants Treatment of industrial waste water- Activated charcoal, synthetic resins, reverse osmosis and electro dialysis. Quality of drinking water- Indian Standard and WHO Standard - Dissolved oxygen – BOD, COD.	3
	17	Soil pollution: Pesticides, fertilizers, Industrial waste, Plastic. Control of plastic threat- importance of plastic identification codes and Plastic recycling, use of biodegradable plastics like PGA, PLA and PHBV.	2
	18	Control of pollution. Pollution Control Board – Duties and responsibilities	2

		Mention environmental movements (Plachimada, Silent valley, movement against Endosulfan, Narmada Bachavo Andolan and Chipko movement)	
IV	**BASICS OF ANALYTICAL CHEMISTRY**		**12**
	19	Measurement of physical properties: International system of units and definitions, scientific notation, significant figures.	2
	20	Mole concept and molar mass, Concentration of solutions: Molarity, Normality, Molality, Mole fraction.	2
	21	Principles of volumetric analysis, primary standard, secondary standard, standard solution. Accuracy, precision, sensitivity, and selectivity	1
	22	Theory of Acid- Base titrations: Acidimetry, Alkalimetry: Basic concepts, principle and illustration with suitable example. Theory of acid-base indicators	3
	23	Theory of Redox titrations: Titration of Fe^{2+} with $KMnO_4$ and $K_2Cr_2O_7$. Theory of redox indicators.	2
	24	Theory of complexometric titration: Metal ion - EDTA titration. Theory of metallochromic indicators. Precipitation titration: NaCl - $AgNO_3$ titration and use of potassium chromate as adsorption indicator.	2
V	**VOLUMETRIC ANALYSIS**		**30**
	25	**Section A: Volumetric Analysis (6 Experiments from Section A are compulsory)** 1. Preparation of standard solutions. 2. Neutralization Titrations a. Strong acid – Strong base b. Strong acid – weak base c. Weak acid – strong base. 3. Redox Titrations - Permanganometry: a. Estimation of oxalic acid. b. Estimation of sodium oxalate c. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.	15
	26	**Section B (Open ended experiments)** 1. Dichrometry 2. Iodometry & Iodimetry 3. Complexometry	15

References:

1. B.R. Puri L.R. Sharma, K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.

2. J.D. Lee, *Concise Inorganic Chemistry*, 5^{th} Edn., Wiley India Pvt. Ltd., 2008.
3. R. Gopalan, V.Ramalingam, *Concise Coordination Chemistry*, 1^{st} Edn.,Vikas Publishing House, New Delhi, 2001.
4. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, *Advanced Inorganic Chemistry*, 5^{th} Edn., Vol. I, S Chand, 2012.
5. G. S. Manku, *Theoretical Principles of Inorganic Chemistry*. McGraw-Hill Education; New edition (1 August 1982)
6. M.C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
7. J. E. Huheey, E.A. Keitler, R. L. Keitler, *Inorganic Chemistry-Principles of Structure and Reactivity*, 4^{th} Edn., Pearson Education, New Delhi,2013.
8. B.K. Sharma, *Industrial chemistry*, 11^{th} Edn., Goel publishing House, Meerut, 2000.
9. M.N. Greenwood, A. Earnshaw, *Chemistry of elements*, 2^{nd} Edn., Butterworth,1997.
10. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
11. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8^{th} Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

1. James E. House, *Inorganic Chemistry*, academic press, 2008.
2. W.U. Malik, G.D.Tuli, R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010.
3. F.A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry*, 6^{th} Edn., Wiley India Pvt. Ltd., New Delhi,2009.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Learn about quantum numbers, electron configurations, and periodic trends, enabling to classify elements and predict their properties accurately	U, Ap	1
CO-2	Learn to predict molecular geometry, hybridization, and bond properties, enabling to analyze and interpret the behavior of molecules in various chemical contexts.	U, An	1
CO-3	Apply the theories to real-world scenarios, developing critical thinking and analytical skills.	Ap	2
CO-4	Gain an understanding of pollution and management strategies.	U	1,2
CO-5	Learn about environmental movements aimed at addressing pollution issues and fostering awareness.	R, U	1,2
CO-6	Create strategies for promoting sustainable practices and raising awareness about pollution	Cr	1,2

	issues based on the principles learned from environmental movements		
CO-7	Proficiency in the application of the mole concept and concentration terms, enabling to perform accurate and precise chemical analyses and interpret the results effectively.	Ap	1.2
CO-8	Evaluate the accuracy and precision of chemical analyses performed using the mole concept and concentration terms, and critically assess the effectiveness of interpreting the results in understanding chemical processes and properties.	E	1,2
CO-9	Develop practical skills in chemical analysis and data interpretation, preparing for advanced laboratory work and real-world applications in analytical chemistry.	Ap, C	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: INORGANIC CHEMISTRY 1

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Learn about quantum numbers, electron configurations, and periodic trends, enabling to classify elements and predict their properties accurately	1	U, Ap	F, C	L	
CO-2	Learn to predict molecular geometry, hybridization, and bond properties, enabling to analyze and interpret the behavior of molecules in various chemical contexts.	1	U, An	M	L	
CO-3	Apply the theories to real-world scenarios, developing critical thinking and analytical skills.	2	Ap	M,P	L	
CO-4	Gain an understanding of	1,2	U	F	L	

	pollution and management strategies.					
CO-5	Learn about environmental movements aimed at addressing pollution issues, fostering awareness and promoting sustainable practices for a healthier environment.	1,2	R, U	F	L	
CO-6	Create strategies for promoting sustainable practices and raising awareness about pollution issues based on the principles learned from environmental movements	1,2	Cr	M	L	
CO-7	Proficiency in the application of the mole concept and concentration terms, enabling to perform accurate and precise chemical analyses and interpret the results effectively.	1,2	Ap	C	L	
CO-8	Evaluate the accuracy and precision of chemical analyses performed using the mole concept and concentration terms, and critically assess the effectiveness of interpreting the results in understanding chemical processes and properties.	1, 2	E	M	L	
CO-9	Develop practical skills in chemical analysis and data interpretation, preparing for	1,2	Ap, C	P	L	P

	advanced laboratory work and real-world applications in analytical chemistry.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	1	1	3	1	1	1	1	1	1
CO 2	3	3	1	1	1	3	2	2	1	2	1	1
CO 3	2	3	1	2	1	3	3	2	1	2	1	1
CO 4	3	3	1	2	1	3	2	3	1	2	1	1
CO 5	3	3	1	2	1	3	2	3	1	2	1	1
CO 6	3	3	1	2	1	3	2	3	1	2	1	1
CO 7	3	3	1	2	1	3	2	1	1	2	1	1
CO 8	3	3	1	2	1	3	2	1	1	2	1	1
CO 9	3	3	1	2	1	3	3	2	1	3	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK1DSCCHE110.1**				
Course Title	**INORGANIC AND PHYSICAL CHEMISTRY**				
Type of Course	**DSC B1**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course covers fundamental principles in the periodic classification of elements, chemical bonding, thermodynamics and thermochemistry, analytical principles, and lab safety, providing students with a comprehensive understanding of key concepts in chemistry. Through both theoretical learning and hands-on practicals in volumetric analysis, students develop essential skills for analytical chemistry and gain practical experience in experimental techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs 75

I		**PERIODIC CLASSIFICATION OF ELEMENTS**	**9**
	1	Quantum numbers and their significance, Concept of orbitals.	2
	2	Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, stability of filled and half-filled orbitals	2
	3	Electronic configuration and classification of elements in to s,p,d and f blocks.	1
	4	Periodic properties, Ionisation energy, Electronegativity and Electron affinity. Diagonal relationship.	2
	5	Important characteristics of representative elements: valency, oxidation states, ionic and covalent bond formation Important characteristics of transition elements: variable valency and oxidation states, formation of Complex compounds.	2
II		**CHEMICAL BONDING**	**9**
	6	Energetic of bond formation – Types of Chemical bonds – Energetics of ionic bond formation – Lattice energy – Born Haber Cycle - Fajan's rules.	2
	7	Polarity of covalent bond its relation with electronegativity Electro negativity scales – Paulings and Mullikan's approaches, factors influencing polarity Dipole moment – its relation to geometry.	2
	8	Hydrogen bond – inter and intra molecular – its consequences on boiling point, volatility and solubility.	1
	9	Concept of Hybridisation– sp, sp^2, sp^3, dsp^2, dsp^3, sp^3d^2, and sp^3d^3 with examples Explanation of bond angle in water and ammonia-VSEPR theory, geometry of molecules with bond pairs of electrons, bond pairs and lone pairs of electrons, limitations of VSEPR Theory.	2
	10	A brief review of molecular orbital approach, LCAO method – bond order, bond distance and stability of O_2, O_2^{2+}, O_2^{2-} , NO, NO^+, CO and HF.	2
III		**THERMODYNAMICS AND THERMOCHEMISTRY**	**18**
	11	First law of thermodynamics, mathematical form, intrinsic energy, enthalpy, reversible, process and maximum work, work of expansion of an ideal gas in reversible isothermal process.	3

	12	Heat capacity of gases at constant volume and constant pressure, derivation of $C_P - C_V = R$.	2
	13	Second law of thermodynamics, entropy and free energies Significance of Δ G, Δ H and available work Criteria of equilibrium, and spontaneity on the basis of entropy and free energy, Gibbs - Helmholtz equation.	4
	14	Enthalpies of formation, combustion, neutralization, solution and hydration	2
	15	Relation between heat of reaction at constant volume and constant pressure Variation of heat of reaction with temperature- Kirchoff's equation	3
	16	Hess's law and application – bond dissociation energies and bond energies of different types of bonds, their calculation and enthalpies of reaction	4
IV	**ANALYTICAL PRINCIPLES & LAB SAFETY**		**9**
	17	Analytical methods in Chemistry – Principles of volumetric analysis, primary standard, standard solution, Calculation of normality, molality and molarity of solutions	2
	18	Theory of acid - base titrations: Strong acid - Strong Base, Strong acid - weak base, Weak acid Strong base and weak acid-strong base (Explanation with titration curves) Redox titrations: Permanganometry-Fe^{2+} and $KMnO_4$ and dichrometry - Fe^{2+} and $K_2Cr_2O_7$, Theory of acid – base and redox indicators.	2
	19	Inorganic qualitative analysis, common ion effect- solubility product- precipitation and inter group separation of cations. Salting out process	2
	20	Chromatography- principle and applications of paper and thin layer chromatography,	2
	21	Lab safety **-** Risk, Hazard, Chemical Hazard**.**	1
V	**VOLUMETRIC ANALYSIS**		**30**
	22	**Section A: Volumetric Analysis (8 Experiments from Section A are compulsory)** 4. Preparation of standard solutions. 5. Neutralization Titrations d. Strong acid – Strong base e. Strong acid – weak base	15

		f. Weak acid – strong base. 6. Redox Titrations - Permanganometry d. Estimation of oxalic acid. e. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.	
	23	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add related experiments)** 1. Dichrometry 2. Iodometry & Iodimetry 3. Complexometry 4. Colorimetry	15

References

1. B.R Puri, L R Sharma K C Kalia, *Principles of Inorganic Chemistry*, Sobhanlal Nagin Chand & Co. New Delhi
2. Manas chanda, *Atomic structure and Chemical bonding in molecular spectroscopy*, Tata Mc Graw Hill.
3. S Glasstone, *Thermodynamics for Chemists*, Affiliated Eat West Publishers
4. J D Lee, *Concise Inorganic Chemistry*, ELBS.
5. R P Rastogi and R R Misra, *An Introduction to Thermodynamics*.
6. D.A Skoog, D M West, F J, Holler, S R Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brookes/Cole, Thomson Learning, Inc, USA, 2004.
7. Day and Underwood, *Quantitative analysis: Laboratory manual*.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the rules for filling electrons in atomic orbitals	U	1, 2
CO-2	Discuss theories of chemical bonding and their limitations	U	1, 2
CO3	Predict geometry of molecules from the type of hybridisation.	Ap	1, 2, 3
CO 4	Recognise fundamentals of thermodynamics and the predict spontaneity of reactions.	Ap	1, 2
CO 5	Critically select suitable indicators for acid base and redox titrations	E	3, 4
CO 6	Apply the basic principles in qualitative analysis and identify cation and anion	Ap	3, 4
CO 7	Discuss the basic principles of paper chromatography and thin layer chromatography	U	2, 3

CO 8	Identify the principles in analytical chemistry	U	2, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: INORGANIC AND PHYSICAL CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Discuss the rules for filling electrons in atomic orbitals	1, 2	U	F, C	L	
CO-2	Discuss theories of chemical bonding and their limitations	1, 2	U	F, C	L	
CO 3	Predict geometry of molecules from the type of hybridisation.	1, 2, 3	Ap	F, C	L	
CO 4	Recognise fundamentals of thermodynamics and the predict spontaneity of reactions.	1, 2	Ap	F, C	L	
CO 5	Critically select suitable indicators for acid base and redox titrations	3, 4	E	F, C, P	L	P
CO 6	Apply the basic principles in qualitative analysis and identify cation and anion	3, 4	Ap	C, P	L	P
CO 7	Discuss the basic principles of paper chromatography and thin layer chromatography	2, 3	U	C, P	L	P
CO 8	Identify the principles in	2, 3	U	F, C, P	L	P

	analytical chemistry					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	1	3	2	1	2	1	3	1	1	1
CO 2	2	3	3	1	2	1	2	2	3	2	2	2
CO 3	3	2	1	2	2	1	1	1	1	1	2	1
CO 4	2	1	1	2	2	2	2	3	2	1	2	2
CO 5	1	1	2	1	1	2	1	2	1	1	1	2
CO 6	2	2	1	2	1	3	2	1	2	2	1	1
CO 7	3	1	3	2	3	1	1	2	2	2	2	1
CO 8	1	2	2	1	3	3	1	3	3	1	2	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**
Course Code	**MIUK1DSCCHE120.1**
Course Title	**INORGANIC AND ENVIRONMENTAL CHEMISTRY**
Type of Course	**DSC C1**
Semester	I
Academic Level	100 - 199

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5

Pre-requisites	Plus Two
Course Summary	The course covers the periodic classification of elements, chemical bonding, organometallic chemistry, environmental pollution, and analytical principles, including volumetric analysis. Students learn about quantum numbers, orbital concepts, electron configuration, bond energetics, molecular geometry, and various analytical techniques for qualitative and quantitative analysis. They also gain an understanding of the biological, environmental, and industrial applications of chemistry.

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**

			75
1	**PERIODIC CLASSIFICATION OF ELEMENTS**		**9**
	1	Quantum numbers and their significance, Concept of orbitals.	2
	2	Orbital wise electron configuration, energy sequence rule – Pauli's principle, Hund's rule, stability of filled and half-filled orbitals.	2
	3	Electronic configuration and classification of elements in to s,p,d and f blocks	1
	4	Periodic properties, Ionisation energy, Electronegativity and Electron affinity. Diagonal relationship.	2
	5	Important characteristics of representative elements: valency, oxidation states, ionic and covalent bond formation Important characteristics of transition elements: variable valency and oxidation states, formation of Complex compounds.	2
II	**CHEMICAL BONDING**		**9**
	6	Energetic of bond formation – Types of Chemical bonds – Energetics of ionic bond formation – Lattice energy – Born Haber Cycle - Fajan's rules.	2
	7	Polarity of covalent bond its relation with electronegativity Electro negativity scales – Paulings and Mullikan's approaches, factors influencing polarity Dipole moment – its relation to geometry.	2
	8	Hydrogen bond – inter and intra molecular – its consequences on boiling point, volatility and solubility.	1
	9	Concept of Hybridisation– sp, sp^2, sp^3, dsp^2, dsp^3, sp^3d^2, and sp^3d^3 with examples Explanation of bond angle in water and ammonia - VSEPR theory, geometry of molecules with bond pairs of electrons, bond pairs and lone pairs of electrons, limitations of VSEPR Theory.	2
	10	A brief review of molecular orbital approach, LCAO method – bond order, bond distance and stability of O_2, O_2^{2+}, O_2^{2-} , NO, NO^+,CO and HF.	2
III	**ORGANOMETALLICS**		**9**
	11	Definition and classification, Organo metallic compounds of Mg, Sn, Li, Hg, Fe and their synthesis, applications	3

	12	Biological and environmental aspects of organic compounds – organometallic compounds in medicines – organomercury, organoboron, organosilicon and organo arsenic compounds	2
	13	Outline of preparation and uses Antitumour drugs, silylated derivatives of bioactive organic compounds in agriculture and horticulture	3
	14	Environmental aspects of Organometallic compounds	1
IV	**ENVIRONMENTAL POLLUTION AND ANALYTICAL PRINCIPLES**		**18**
	15	Air pollution: Composition of air, major causes of air pollution	2
	16	Pollutants in air-carbon monoxide, carbon dioxide, oxides of Nitrogen and sulphur, chlorofluorocarbons- effect of using refrigerators and air conditioners, Particulate matter- Acid rain, Greenhouse effect, ozone layer and its depletion	2
	17	Water pollution: causes- heat, industrial waste, sewage water, detergents, agricultural pollutants	2
	18	Treatment of industrial waste water- Activated charcoal, Reverse osmosis Quality of drinking water- Indian Standard and WHO standard- Dissolved oxygen- BOD, COD	2
	19	Soil pollution: pesticides, fertilizers, Industrial waste, Plastic.	1
	20	Principles of volumetric analysis- primary standard – standard solutions - normality and molarity	2
	21	Theory of acid - base titrations, permanganometric and dichrometric titrations, iodometric and complexometric titrations	2
	22	Theory of acid – base and redox indicators	2
	23	Beer- Lambert law- Principles of colorimetry – Estimation of Iron and phosphate	2
	24	Lab safety - Risk, Hazard, Chemical Hazard.	1
V	**VOLUMETRIC ANALYSIS**		**30**
	25	**Section A: Volumetric Analysis (5 Experiments from Section A are compulsory)** 7. Preparation of standard solutions. 8. Neutralization Titrations g. Strong acid – Strong base h. Strong acid – weak base	15

		i. Weak acid – strong base. 9. Redox Titrations - Permanganometry f. Estimation of oxalic acid. g. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.	
	26	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add related experiments)** 1. Dichrometry 2. Iodometry & Iodimetry 3. Complexometry 4. Colorimetry	15

References

1. B.R Puri, L R Sharma K C Kalia, Principles of Inorganic Chemistry, Sobhanlal Nagin Chand & Co. New Delhi
2. Manas chanda, Atomic structure and Chemical bonding in molecular Spectroscopy, Tata Mc Graw Hill.
3. Malik, Tuli, Madan, Selected Topics in Inorganic chemistry, S Chand.
4. J D Lee, Concise Inorganic Chemistry, ELBS
5. D.A Skoog, D M West, F J, Holler, S R Crouch, Fundamentals of Analytical Chemistry,8th Edn., Brookes/Cole, Thomson Learning, Inc, USA, 2004.
6. A. I. Vogel, Quantitative Analysis.
7. Day and Underwood, Quantitative analysis: Laboratory manual.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the rules for filling electrons in atomic orbitals	U	1, 2
CO-2	Discuss theories of chemical bonding and their limitations	U	1, 2
CO3	Predict geometry of molecules from the type of hybridisation.	Ap	1, 2
CO 4	Discuss the applications of organometallics.	U	1, 2, 3
CO 5	Critically select suitable indicators for acid base and redox titrations	E	2, 3
CO 6	Apply the basic principles in quantitative analysis	Ap	3, 4
CO 7	Discuss the factors affecting environmental pollution	U	3, 4, 5
CO 8	Identify the principles in analytical chemistry	U	1, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: INORGANIC AND ENVIRONMENTAL CHEMISTRY

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Discuss the rules for filling electrons in atomic orbitals	1, 2	U	F, C	L	
CO-2	Discuss theories of chemical bonding and their limitations	1, 2	U	F, C	L	
CO3	Predict geometry of molecules from the type of hybridisation.	1, 2	Ap	F, C	L	
CO 4	Discuss the applications of organometallics.	1, 2, 3	U	F, C	L	
CO 5	Critically select suitable indicators for acid base and redox titrations	2, 3	E	C, P	L	P
CO 6	Apply the basic principles in quantitative analysis	3, 4	Ap	C, P	L	P
CO 7	Discuss the factors affecting environmental pollution	3, 4, 5	U	F, C	L	
CO 8	Identify the principles in analytical chemistry	1, 4, 5	U	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	2	1	3	3	3	2	1	2	3	1
CO 2	2	3	2	3	2	2	3	2	1	1	2	1
CO 3	3	3	3	2	1	3	3	2	2	2	2	1
CO 4	2	1	3	3	3	3	3	2	1	1	3	1
CO 5	3	3	2	3	2	3	3	3	2	1	2	1
CO 6	2	1	3	2	1	3	3	3	2	2	3	1
CO 7	3	2	3	3	3	3	3	3	2	2	3	1
CO 8	3	2	3	2	3	3	3	3	2	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK1DSCCHE130.1**				
Course Title	**GENERAL CHEMISTRY I**				
Type of Course	**DSC D1**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	This course covers the fundamentals of scientific methodology, the evolution of chemistry, the contributions of notable scientists, chemistry's role in everyday life, lab safety, analytical principles, and practical experiments focusing on volumetric analysis and laboratory safety. Through theoretical understanding and hands-on experiments, students will gain essential knowledge and skills for a deeper comprehension of chemistry and its applications in various fields.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**METHODOLOGY OF CHEMISTRY**		**9**

	1	Definition of Science. Scientific methods - observation-posing a question - formulation of hypothesis- experiment – theory - law. Falsification of hypothesis - inductive and deductive reasoning- revision of scientific theories and laws.	3
	2	Evolution of Chemistry-ancient speculation on the nature of matter. Early form of chemistry - alchemy, origin of modern chemistry. Structure of chemical science: Scope, theory and experiment - branches of chemistry.	3
	3	Role of chemistry as a central science connecting physics, biology and other branches of science. Interdisciplinary areas involving chemistry: Nanotechnology and biotechnology.	3
II	**POPULAR SCIENTISTS IN CHEMICAL SCIENCE**		**9**
	4	Some popular scientists and their contributions to the evolution of chemistry - Antoine Lavoisier, Dmitri Mendeleev, Marie Curie, Robert Boyle, John Dalton, Linus Pauling, Joseph Priestley, Friedrich Wöhler, J.J. Thomson, Amedeo Avogadro	6
	5	Women scientists in chemical science - Rosalind Franklin, Alice Ball, Dorothy Hodgkin, Gertrude Elion	3
III	**CHEMISTRY IN EVERYDAY LIFE**		**9**
	6	Household materials – Major chemical ingredients (No structural formula and preparation needed), Match Box-Soap- detergent— cooking gas –tooth paste – shampoo hair - dye- nail polish- whitener-moth balls, house hold bleach	5
	7	Method of action and possible hazards/toxicity of explosive chemicals, propellants –fire crackers.	4
IV	**LAB SAFETY & ANALYTICAL PRINCIPLES**		**18**
	8	Lab safety measurements: Awareness of material safety data sheet (MSDS), safe storage and handling of hazardous chemicals, simple first aids; electric shocks, fire, cut by glass and inhalation of poisonous gas, Accidents due to acids and alkalies, burns due to phenol and bromine, disposal of waste chemicals, disposal of sodium and broken mercury thermometer, - R and S phrases (elementary idea only), Personal protective Equipment (PPE)	6
	9	Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Equivalent mass. Methods of expressing concentration: Molality, molarity, normality, ppm, and mole fraction.	12

		Dilution formula, Theory of volumetric analysis – Acid-base, redox, and complexometric titrations: acid-base, redox, and complexometric indicators. Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages. Accuracy & Precision (mention only).	
V	**PRACTICALS**		**30**
	10	1. **Laboratory Safety** - Importance of lab safety – Burns – Eye accidents – Cuts – Gas poisoning – Electric shocks –Treatment of fires – First Aid and Treatment of Fires- Precautions and preventive measures. 2. **Volumetric Analysis (Any 5 experiments)** • Preparation of standard solutions. • Neutralization Titrations (i) Strong acid – strong base (ii) Weak acid – strong base (iii) Strong acid – weak base • Redox Titrations Permanganometry: 1. Estimation of oxalic acid. 2. Estimation of Fe^{2+}/$FeSO_4.7H_2O$/Mohr's salt.	15
	11	3. **Open-ended experiments (Any 2).** a. Determination of hardness of water. b. Iodimetry and Iodometry: Estimation of Iodine/copper/ chromium. c. Determination of acetic acid content in vinegar by titration with NaOH. d. Determination of alkali content in antacid tablets by titration with HCl. e. Determination of available chlorine in bleaching powder. **(Other related experiments suggested by the teacher may be conducted)**	15

References:

1. C.N.R.Rao, *University General Chemistry*, MacMillan India (Ltd.)
2. Shashi Chowla; *Engineering Chemistry*, Danpat Rai Publication.
3. B.K. Sharma; *Industrial Chemistry*. Goel Publishing House, Meerut, 2003.
4. Singh, K., *Chemistry in Daily Life;* Prentice Hall of India, New Delhi, 2008.
5. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
6. 4. J. D. Lee, *Concise Inorganic Chemistry*, 5th edn., Blackwell Science, London, 2010.
7. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
8. Satya Prakash, *Advanced Inorganic Chemistry*, Volume 1, 5th Edition, S. Chand and
Sons, New Delhi, 2012.

9. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
10. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
11. *Vogels Textbook of Quantitative Chemical Analysis*, 6thEdn., Pearson Education Ltd.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Provide a comprehensive understanding of the scientific method and the evolution of chemistry from ancient speculation to modern principles.	R, U	1, 5
CO-2	Explore the interdisciplinary nature of chemistry and its pivotal role as a central science, fostering critical thinking and interdisciplinary problem-solving skills.	U, Ap	1, 3
CO-3	Realize the groundbreaking contributions of renowned scientists, nurturing a more inclusive understanding of the field's history and encouraging diversity in scientific pursuits.	R, U, Ap	2, 3
CO-4	Develop a heightened awareness of chemical safety in everyday life and the importance of responsible chemical usage.	U, Ap	4, 5
CO-5	Develop a comprehensive understanding of laboratory safety measures, leading to a safe and responsible laboratory environment.	U, Ap, An	3, 4, 5
CO-6	Master key concepts in chemistry, enabling to perform accurate and precise chemical analyses and experiments effectively.	U, Ap, An	4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: GENERAL CHEMISTRY I

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practica l (P)
CO-1	Provide a comprehensive understanding of the scientific method and the evolution of chemistry from ancient speculation to modern principles.	1, 5	R, U	F	L	

CO-2	Explore the interdisciplinary nature of chemistry and its pivotal role as a central science, fostering critical thinking and interdisciplinary problem-solving skills.	1, 3	U, Ap	F, C	L	
CO-3	Realize the groundbreaking contributions of renowned scientists, nurturing a more inclusive understanding of the field's history and encouraging diversity in scientific pursuits.	2, 3	R, U, Ap	F, C	L	
CO-4	Develop a heightened awareness of chemical safety in everyday life and the importance of responsible chemical usage.	4, 5	U, Ap	F, C	L	
CO-5	Develop a comprehensive understanding of laboratory safety measures, leading to a safe and responsible laboratory environment.	3, 4, 5	U, Ap, An	C, P	L	P
CO-6	Master key concepts in chemistry, enabling to perform accurate and precise chemical analyses and experiments effectively.	4, 5	U, Ap, An	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK1MDCCHE100.1**				
Course Title	**FOOD AND NUTRITION**				
Type of Course	**MDC 1**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Students should have a basic understanding of the various components present in different food items, their necessity, and their functions. Students must know the importance of eating healthy, nutritional food.				
Course Summary	This course provides a comprehensive understanding of the composition of food, food additives, food adulteration, dairy products and a brief idea of food processing and packaging.				

Syllabus:

Module	Unit	Content	45 Hrs
I		**INTRODUCTION TO FOOD AND NUTRIENTS**	**9**
	1	Functions of Food, Nutrients in Food- Energy Yielding Nutrients and Protective Nutrients (Vitamins and Minerals).	2
	2	Carbohydrates- Classification- Monosaccharides, Disaccharides, Oligosaccharides, Polysaccharides, Importance of Carbohydrates in diet**.**	2
	3	Proteins- Classification- Fibrous and Globular Proteins, Simple, Conjugate and Derived Protein, Denaturation of Protein	3

	4	Vitamins- Classification, Sources, Functions and Deficiency Diseases- Vitamin A, Vitamin B1 and B2, Vitamin C, Vitamin D, Vitamin E and Vitamin K.	2
II	**FOOD ADDITIVES**		**9**
	1	Food Colours- Permitted and Non-Permitted, Artificial Sweeteners, Flavour Enhancers, Stabilizers and Thickening Agents, Fat Emulsifiers, Flour Treatment Agents.	3
	2	Preservatives- Natural and Artificial Food Preservatives, Antioxidants, Nutritional Supplements, Food Safety and Standards Act.	2
	3	Nutrition - Measurement of Energy Value of Food, Calorific Value, Calorific Requirements.	2
	4	Digestion and Absorption of Food-Composition and Functions of Bile, Outline Study of Digestion and Absorption- Carbohydrates, Proteins and Fats.	2
III	**FOOD AND ADULTERATION**		**9**
	1	Modern Food Habits- An Introduction, Health Effects of Fast Food, Junk Food, Dehydrated Food and Instant Food.	2
	2	A Comparative Study of Traditional Food Habits and Modern Food Habits. Composition and Health Effects of Soft Drinks and Beverages.	3
	3	Common Adulterants in Different Foods and Their Health Effects and Detection- Milk, Ghee, Butter, Honey, Sweets, Chilli powder, Turmeric, Tea, Sugar and Salt, black pepper, Wheat and rice.	4
IV	**DAIRY PRODUCTS**		**9**
	1	Milk, Composition of Milk - Water, Protein, Lactose and Fat, Nutritive Value of Milk.	2
	2	Condensed Milk – Definition, Composition and Nutritive Value. Standardised Milk, Homogenised Milk, Flavoured Milk, Vitaminised Milk, Toned Milk.	2
	3	Butter - Composition - Theory of Churning – Desi Butter - Salted Butter. Ghee - Major Constituents - Rancidity, Prevention. Cream- Definition-Composition-Chemistry of Creaming Process.	3
	4	Milk powder - Definition - Making Milk powder - Drying Process, Quality Assurance – FSSAI, PFA, AGMARK	2
V	**FOOD PROCESSING AND PACKAGING**		**9**
	1	Food Processing - Definition, Levels and Purpose	2
	2	Traditional and Modern Methods- Heat Treatment, Fermentation, Pickling, Smoking, Drying, Curing, Freezing, Pasteurization, Ultra Heat Treatment.	4
	3	Consequences of Food Processing, Packaging Materials - Hazards, Future Prospects of Food Package.	3

References			
		Text books: 1. B. Srilakshm , "Food science, Seventh Edition" 2. S. Manay, "Food: Facts and Principles" 3. S. Sehgal, "A Laboratory Manual of Food Analysis" 4. H.D. Belitz, W. Grosch and P. Schieberle, "Food Chemistry" 5. J.M. de Man, "Principles of Food Chemistry" 6. S. Suzanne Nielsen, "Food Analysis" 7. L. H. Meyer, "Food Chemistry" 8. M. Sethi, E. S. Rao, "Food Science- Experiments and Applications". 9. N. N. Potter, J. H. Hotchkiss, "Food Science"	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify the components of food.	R, U	2
CO-2	Identify additives added to foods for various purposes.	U	4,5
CO-3	Acquire knowledge of adulteration and toxicity of food.	R, Ap	1,4
CO-4	Understand the various types of dairy products based on their composition.	R, U	2,3
CO-5	Understand the basic concepts of food processing and packaging.	U	1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: FOOD AND NUTRITION

Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practica l (P)
CO-1	Identify the components of food.	2	R, U	F, C	L	
CO-2	Identify additives added to foods for various purposes.	4,5	U	M	L	

CO-3	Acquire knowledge of adulteration and toxicity of food.	1,4	R, Ap	M,P	L	
CO-4	Understand the various types of dairy products based on their composition.	2,3	R, U	F	L	
CO-5	Understand the basic concepts of food processing and packaging.	1	U	F	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

SEMESTER II

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK2DSCCHE150.1**				
Course Title	**ORGANIC CHEMISTRY I**				
Type of Course	**DSC A2**				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course recalls basic concepts of organic chemistry and provides an understanding of stereochemistry and fundamentals of organic reaction mechanism. Through theoretical concepts and practical experiments students gain knowledge and skills to solve organic chemistry problems.				

Detailed Syllabus:

Module	Unit	Content	45 Hrs
I		**Introduction to Organic chemistry, Nomenclature, functional groups and reaction notations**	**12**
	1	Uniqueness of carbon: classification of organic compounds	2
	2	Functional groups (mention only), Review of basic rules of IUPAC nomenclature and IUPAC naming of organic compounds.	4

	3	Types of reagents: Electrophiles and Nucleophiles.	4
	4	Definition of reaction mechanism. Drawing of electron movements with arrows: curved arrow notation, Half headed and double headed arrows. Nature of bond fissions: Homolysis and heterolysis.	2
II		**Stereochemistry I**	**12**
	5	Representation of organic molecules: Fischer, Flying wedge, Sawhorse and Newman projection formulae. Conformational isomerism: conformation , Dihedral angle , Torsional strain	3
	6	Conformational analysis of ethane and n-butane including energy diagrams.	2
	7	Baeyer's strain theory, Sache-Mohr theory of strainless rings, Pitzer strain	3
	8	Conformation of cyclohexane (chair, boat and skew boat forms), axial and equatorial bonds, ring flipping, conformers of mono and dialkyl substituted cyclohexane.	4
III		**Stereochemistry II**	**12**
	9	Optical Isomerism: Chirality and elements of symmetry, DL notation, Enantiomers	2
	10	Optical isomerism in glyceraldehydes, lactic acid and tartaric acid Diastereoisomers, meso compounds.	2
	11	Cahn-Ingold-Prelog rules, R-S notations for optical isomers with one and two asymmetric carbon atoms, erythro and threo representations. Axial stereochemistry: atropisomerism and its designation - biphenyls, allenes.	2
	12	Racemic mixture, methods of resolution of Racemic mixture.	2
	13	Enantiomeric excess, Introduction to asymmetric synthesis, Optical activity in compounds not containing symmetric carbon atoms: Biphenyls and Allenes.	2
	14	Geometrical isomerism: Cis-trans, Syn-anti and E-Z notations.	1
	15	Geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes. Methods of distinguishing geometrical isomers using melting point, dipole moment, dehydration and cyclisation.	1
IV		**Organic Reaction Mechanism I**	**9**
	16	Electron displacement effects: Inductive effect, electromeric effect, mesomeric effect, resonance, hyperconjugative and steric effects.	2
	17	Acidity and basicity of organic compounds based on electron displacement effects: Acid characters of alcohols, phenols (phenol, o/m/p-cresols and o/m/p-nitro phenols) and carboxylic acids (aliphatic acids, mono, di, tri chloro acetic acids, Benzoic acid, o/m/p-nitro	3

		benzoic acids) and basic character of amines (aliphatic amines, aniline, N- & N,N-dimethyl aniline, o/m/p nitro anilines and o/m/p- toluidines)	
	18	Reaction intermediates: Carbocations, carbanions, carbenes, nitrenes free radicals, (hybridization, structure, classification, stability).	2
	19	Hyperconjugative effect on alkenes, alkyl benzenes. Dipole moment of propene and toluene	2
V		**Organic Chemistry Practical- Organic Qualitative Analysis**	**30**
	20	**Section A** Detection of Elements (Nitrogen, Sulphur and Halogen) using Lassaign's test	2
	21	Solubility Tests :a) Classification of compounds into water soluble/insoluble; b) Classification of compounds into ether soluble/insoluble c) Solubility in Na_2CO_3, d) Solubility in NaOH e) Solubility in HCl	2
	22	Tests for Aliphatic and Aromatic compounds: (i)Ignition test (ii)Nitration test	2
	23	Tests for saturated and unsaturated compounds: (i)Oxidation (ii) Bromination	2
	24	Tests to distinguish between following compounds: a) monocarboxylic acid and dicarboxylic acid ; b) Primary,secondary and tertiary amines ; c) monoamide and diamide; e) Aldehyde and ketone ; f) Reducing and non reducing sugars; g) monohydric phenols and dihydric phenols	3
	25	Reactions of common functional groups using known organic compounds.	4
	26	**Section B (Open ended experiments)** Systematic qualitative analysis with a view to characterization of the following functional groups a) Halo compounds :chlorobenzene, benzyl chloride; b) Phenols: phenol, o ,m ,p -cresols, naphthols, resorcinol ; c) Aldehydes and ketones: benzaldehyde, acetophenone,benzophenone; d) 4 Carboxylic acids: benzoic, phthalic, cinnamic and salicylic acids; e) Esters: ethyl benzoate, methyl salicylate ; f) Amides: benzamide, urea; g) Anilines: aniline, o,m, p - toluidines, dimethylaniline; h) Nitro compounds: nitrobenzene, o- & p- nitro toluene;	15

		i) Poly nuclear hydrocarbons: naphthalene, anthracene; j) Reducing and non reducing sugars: glucose and sucrose	

References			
For Theory			
		Text books: 1. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, S.Chand & Company, New Delhi. 2. L.G.Wade Jr, Organic Chemistry, Pearson Education, New Delhi. 3. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, Vikas Publishing House (Pvt) Ltd., New Delhi.. 4. S.C.Sharma and M.K.Jain, Modern Organic Chemistry, Vishal Publishing Company, New Delhi. 5. D.Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, New Age International Publizhers, New Delhi. 6. J.Clayden, N.Greeves and S.Warren, Organic Chemistry, Oxford University Press, New York. 7. I L Finar, "Organic Chemistry" Vol – 1, 5th Edition, Pearson Education, NewDelhi 8. Jagadamba Singh and Jaya Singh, Photochemistry and Pericyclic rections, New Age International, New Delhi. **For Further Reading** 1. P.S.Kalsi, Organic Reactions, Stereochemistry, and Mechanism, New Age International Publishers, New Delhi 2. R.T.Morrison, R.N.Boyd. Organic Chemistry, Pearson Education, New Delhi. 3. P.Y.Bruice, Essential Organic Chemisty, Pearson Education, New Delhi. 4. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, Pearson Education, New Delhi. 5. G.M. Louden, Organic Chemistry, Oxford University Press, New York. 6. E.L.Eliel, Stereochemistry of Carbon compounds, Tata McGraw Hill Publishing House, New Delhi.	

		7. J.March, Advanced Organic Chemistry, John Wiley & Sons., NY. 8. S.M.Mukerji and S.P.Singh, Reaction Mechanism in Organic Chemistry, McMillan Publishers. 9. R.O.C. Norman and J.M.Coxon, Principles of Organic Synthesis, CRC Press.	
For Practicals			
		Textbooks 1. A.I.Vogel, "A text book of Qualitative Analysis including semi micro methods" Longmans. 2. V.V.Ramanujam, "Semi micro Qualitative Analysis" 3. E.S.Gilreath "Qualitative Analysis using semi micro method" Mc Graw Hill 4. A.I.Vogel, "A text book of Qualitative Inorganic Analysis" Longmans 5. A.I.Vogel, "Elementary Practical Organic Chemistry" Longmans 6. J B Yadav,Advanced Practical Physical Chemistry, Goel ,Publishing House **For Further Reading** 1. Day and Raman, "Laboratory Manual of Organic Chemistry". 2. B.Viswanathan and P.S Raghavan , "Practical Physical Chemistry" 2005 Edn. Viva Books (Pvt.Ltd) 3. F.G Mann and B.C Saunders, "Practical Organic Chemistry" 4th Edn, Orient Longmann 4. A.Findlay, "Practical Physical Chemistry" Creative Media 5. R.C.Das and E.Behara, "Experimental Physical Chemistry", Tata Mc Graw Hill 6. N.K.,Vishnu, "Advanced practical organic chemistry" Vikas publishing house, New Delhi	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recalls the fundamentals of organic chemistry.	R	1
CO-2	Apply the electron displacement effects to compare acidity, basicity and stability of organic compounds/intermediates	A	1
CO-3	Judge the reaction mechanism of substitution and Elimination on the basis of the structure of alkyl halides.	R, U	2
CO-4	Summarise the chemistry of reaction intermediates.	Ap	2
CO-5	Discuss optical, geometrical and conformational isomerism of organic compounds.	U	2
CO-6	Predict the configuration of organic compounds using CIP rules	An	3
CO-7	Differentiate and identify organic compounds by their characteristic reactions towards standard reagents	An	4
CO-8	Practice systematic scientific procedure and prepare adequate report of them	Ap	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Organic Chemistry I;

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Recalls the fundamentals of organic chemistry.	1	R	F, C	L	
2	Apply the electron displacement effects to compare acidity, basicity and stability of organic compounds/intermediates	1	A	P		
3	Judge the reaction mechanism of substitution and Elimination on the basis of the structure of alkyl halides.	2	R, U	F,C,P		
4	Summarise the chemistry of reaction intermediates.	2	Ap	M		
5	Discuss optical, geometrical and conformational isomerism of organic compounds.	2	U	F,C		
6	Predict the configuration of organic compounds using CIP rules	3	An	M		
7	Differentiate and identify organic compounds by their characteristic reactions towards standard reagents	4	An	M		

8	Practice systematic scientific procedure and prepare adequate report of them	4	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	1	1	1	3	1	1	1	1	1	1
CO 2	2	1	1	1	1	3	3	1	1	2	1	1
CO 3	1	2	1	1	1	3	3	1	1	2	1	1
CO 4	1	2	1	1	1	3	2	1	1	1	1	1
CO 5	1	1	1	1	1	3	2	1	1	2	1	1
CO 6	1	1	2	1	1	3	3	1	2	2	1	1
CO 7	1	1	1	2	1	3	3	1	1	2	1	1
CO 8	1	1	1	2	1	3	2	1	2	2	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK2DSCCHE160.1**				
Course Title	**PHYSICAL AND INDUSTRIAL CHEMISTRY**				
Type of Course	**DSC B2**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course includes subjects in petrochemicals, catalysis, photochemistry, metallurgy, and nanomaterials and basic principles in the gaseous state. Students have practical experience in analytical procedures and acquire critical thinking skills through open-ended experiments such as gravimetric analysis and determination of physical constants, focused on inorganic qualitative analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**GASEOUS STATE**		**9**
	1	Maxwell's distribution of molecular velocities (No derivation), average, most probable and rms velocities	3
	2	Collision number and collision frequency, mean free path,	1
	3	Deviation of gases from ideal behaviour – Boyle temperature, derivation of vander waals constants and critical constants	2

	4	Law of corresponding states – reduced equation of state, Joule Thomson effect, liquefaction of gases – Linde's and Claude's processes.	3
II	**PETROCHEMICALS AND ALTERNATE SOURCES**		**9**
	5	Petrochemicals: - Introduction, Natural gas - CNG, LNG and LPG. Coal: classification based on carbon content- Carbonisation of coal	2
	6	Crude oil: constitution and distillation, composition and uses of important Fractions Ignition point, flash point and octane number- cracking Usage and depletion of petroleum products.	3
	7	Need for alternative fuel and Green Chemistry approaches for sustainable development:	1
	8	Introduction, Solar energy harvesting- photosynthesis Photo voltaic cell, conventional solar cells, nano structured solar cells, Hydrogen as the future fuel	3
III	**CATALYSIS AND PHOTO CHEMISTRY**		**9**
	9	General Characteristics of catalytic reactions. Different types of catalysis – examples	2
	10	Theories of catalysis (Outline of intermediate compound formation theory and adsorption theory).	2
	11	Enzyme catalysis – Michaelis-Menten mechanism.	2
	12	Photo Chemistry: - Laws of Photo Chemistry, Grothus – Drapter law, Beer Lambert's law, Einstein's laws, quantum yield, $H_2 – Cl_2$ reaction, $H_2 – Br_2$ reaction	2
	13	Fluorescence and phosphorescence, chemiluminescence and photo sensitization	1
IV	**METALLURGY & CHEMISTRY OF NANOMATERIALS**		**18**
	14	General principles of occurrence and extraction of metals, Concentration of ores- roasting, calcination and smelting	3
	15	General Methods of extracting metal from concentrated ore, examples Electro metallurgy-Metallurgy of Aluminium, Sodium-Pyrometallurgy	3

	16	Refining of crude metals: Distillation, Liquation, electrolytic and zone refining Chromatographic techniques and vapour phase refining (Mond's process and Van Arkel process) Metallurgy of titanium, cobalt, nickel, thorium and uranium	3
	17	Evolution of Nano science – Historical aspects – preparations containing nano gold in traditional medicine, Lycurgus cup – Faraday's divided metal etc. Nanosystems in nature.	2
	18	Preparation of Nano particles – Top – down approach and bottom – top approach, Sol – gel synthesis, colloidal precipitations, Co-precipitation, combustion technique.	3
	19	Properties of nano particles: optical, magnetic and mechanical properties.	2
	20	Applications of nano materials in electronics, robotics, computers, sensors, mobile electronic devices, Medical applications (use Au, Ag, ZnO and ZnO2 as examples)	2
V	**PRACTICALS: INORGANIC QUALITATIVE ANALYSIS**		**30**
	21	**I. REACTIONS OF THE FOLLOWING CATIONS:** Pb^{2+}, Ag^{+}, Bi^{3+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Mn^{2+}, Zn^{2+}, Ni^{2+}, Cd^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+} and NH_4^{+}. **II. SYSTEMATIC ANALYSIS OF TWO CATIONS IN A MIXTURE** The cations must be provided in solutions. A student must analyze **at least 8 mixtures** containing two cations each.	15
	22	**OPEN ENDED PRACTICALS: (Any 3 experiments are to be conducted - May be selected from the list or the teacher can add related experiments)** **III. GRAVIMETRIC ANALYSIS** a. Estimation of water of hydration in barium chloride crystals. b. Estimation of barium chloride solution. **IV. DETERMINATION PHYSICAL CONSTANTS** a. Determination of boiling points of common solvents (b.pt range 100°C - 130°C b. Determination of melting points of organic substances (m.pt range 100°C - 130°C)	15

References

1. B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, 46th Edn Vishal Publishing Co. New Delhi.
2. J E Huheey, E A Keiter, R L Keiter, O K Medhi, *Inorganic Chemistry*, 4th Edn. Pearson.
3. F A Cotton and Wilkinson, *Advanced Inorganic Chemistry*, John Wiley, New York.
4. P L Soni, O P Dharmarsha, U N Dash, *Textbook of Physical Chemistry*, 23rd Edn, Sultan Chand & Sons, New Delhi, 2011.
5. Gurudeep Raj, *Advanced physical chemistry*.
6. F Daniel and R A Alberty, *Physical chemistry*.
7. T Pradeep, *A Text book of Nanoscience and Nanotechnology*, Mc Graw Hill, New Delhi.
8. J V. V.Ramanujam, "*Semi micro Qualitative Analysis*"
9. E. S. Gilreath "*Qualitative Analysis using semi micro method*" Mc Graw Hill.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the effect of temperature on molecular velocities of gases and equation for real gases	U	1, 2
CO 2	Apply the principles in liquefaction of gases	U	1, 2
CO 3	Apply the importance of energy and environment conservation	Ap	1, 2, 3
CO 4	Get insight to the emerging area of nano and advanced materials	Ap	1, 2
CO 5	Apply the principles of physical Chemistry in Catalysis and photochemistry	E	3, 4
CO 6	Apply the basic principles in qualitative analysis and identify cation and anion.	Ap	3, 4
CO 7	Discuss the basic principles of metallurgy	U	2, 3
CO 8	Demonstrate the extraction of some metals used in daily life	U	2, 3

CO 9	Apply the principles in analytical chemistry to identify the cations	Ap	2, 3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL AND INDUSTRIAL CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the effect of temperature on molecular velocities of gases and equation for real gases	1, 2	U	F, C	L	
CO 2	Apply the principles in liquefaction of gases	1, 2	U	F, C	L	
CO 3	Apply the importance of energy and environment conservation	1, 2, 3	Ap	F, C	L	
CO 4	Get insight to the emerging area of nano and advanced materials	1, 2	Ap	F, C	L	
CO 5	Apply the principles of physical Chemistry in Catalysis and photochemistry	3, 4	E	F, C, P	L	
CO 6	Apply the basic principles in qualitative analysis and identify cation and anion.	3, 4	Ap	F, C, P	L	P
CO 7	Discuss the basic principles of metallurgy	2, 3	U	F, C	L	

CO 8	Demonstrate the extraction of some metals used in daily life	2, 3	U	F, C	L	
CO 9	Apply the principles in analytical chemistry to identify the cations	2, 3	Ap	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	1	1	2	3	2	1	2	1	2	1
CO 2	3	2	1	2	2	2	1	2	3	2	3	2
CO 3	1	1	2	1	2	1	2	1	2	2	3	1
CO 4	3	1	1	2	2	3	3	2	2	1	1	2
CO 5	2	2	1	2	3	2	1	1	2	2	1	2
CO 6	1	2	2	1	2	2	2	1	2	1	1	2
CO 7	3	2	1	1	3	2	1	3	1	2	3	1
CO 8	1	2	1	2	1	1	2	1	2	1	1	3
CO 9	2	2	1	1	2	1	1	3	1	2	3	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK2DSCCHE170.1**				
Course Title	**ORGANIC AND BIOINORGANIC CHEMISTRY**				
Type of Course	**DSC C2**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course covers the fundamentals of organic chemistry, stereochemistry, bioinorganic chemistry, medicinal chemistry, and practical organic qualitative analysis techniques. Students learn about the reactivity of organic compounds, stereochemical principles, biological roles of metals, pharmacognosy, and analytical methods for organic compound identification and purification.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**BASICS OF ORGANIC CHEMISTRY, SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS**		**9**
	1	Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications	2
	2	Dipole moment; Organic acids and bases; their relative strength.	1
	3	Homolytic and heterolytic fission with suitable examples. Curly arrow rules; Electrophiles and Nucleophiles; Nucleophilicity and basicity	2

	4	Types, shape and relative stability of carbocations, carbanions, free radicals and carbenes. Introduction to types of organic reactions - Addition, Elimination and Substitution reactions.	1
	5	General principles involved in the separation of precipitates, standards of purity, mixed melting point and boiling point	1
	6	Purification of solid organic compounds – extraction, use of immiscible solvents, solvent extraction, crystallization, fractional crystallization, sublimation, desiccants, vacuum drying. Purification of liquids – distillation, vacuum distillation, fractional distillation	2
II	**SOLUTIONS**		**9**
	7	Molarity, molality and mole fraction	1
	8	Colligative property-relative lowering of vapour pressure-elevation in boiling point-osmotic pressure	2
	9	Raoults Law-Ideal and non-ideal solutions. Completely Miscible Liquid Pairs-Vapour Pressure-composition curves, boiling point curves. Azeotropes and Fractional Distillation	3
	10	Partially miscible liquids-CST, phenol-water, nicotine-water systems-Effect of impurities on miscibility and CST	2
	11	Immiscible liquid pairs, steam distillation- Solvent extraction	1
III	**COLLOIDS**		**9**
	12	Colloidal state-Types of colloids-classification of colloids	2
	13	Preparation of Colloids-Purification of Colloids-Ultra filtration and electrodialysis. Kinetic, optical and electrical properties of colloids	3
	14	Stability of Colloids, Electrical double layer, Zeta Potential	2
	15	Coagulation of colloids, Application of Colloids	2
IV	**COORDINATION CHEMISTRY AND BIOINORGANIC CHEMISTRY**		**18**
	16	Nomenclature, coordination number and geometry	2
	17	Chelates-isomerism-Structural and Sterio Isomers	2
	18	Valence bond theory in octahedral and tetrahedra complexes-drawbacks of valence bond theory-high and low spin complexes	2

	19	Crystal field Splitting theory-postulates-CFS energy, stability of metal complexes based on CFSE-Applications of metal complexes in qualitative and quantitative analysis	3
	20	Bioinorganic Chemistry- Metalloporphyrin-cytochromes	3
	21	Chlorophyl- Photosynthesis and respiration. Haemoglobin and myoglobin, mechanism of O_2- CO_2 transportation.	3
	22	Nitrogen Fixation, carbon fixation and carbon cycle Biochemistry of iron toxicity and nutrition, essential and trace elements in biological systems.	3
V	**PRACTICALS: ORGANIC QUALITATIVE ANALYSIS**		**30**
	23	**Section A: Organic Qualitative Analysis (Any 5 compounds with different functional groups are compulsory)** Systematic analysis with a view to identify the organic compound (aromatic – aliphatic, saturated – unsaturated, detection of elements and detection of functional groups) – polynuclear hydrocarbons, alcohols, phenols, halogen compounds, nitro compounds, amino compounds, aldehydes, ketones, carboxylic acids, amides, urea, thiourea and esters. Only monofunctional compounds are to be given.	15
	24	**Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add experiments)** 1. Preparation of derivatives of above analysed organic compounds 2. Identification of Carbohydrates: Glucose, fructose, sucrose and starch. 3. TLC - Separation and identification- Determination of Rf value of o-and p-nitroanilines,o- and p-chloroanilines, p-chlorophenol and p-nitrophenol, p-chloroaniline and p–nitroaniline, benzil and o-nitroaniline or any two amino acids. 4. Coligative property-K_T, K_F, molecular mass determination 5. Critical Solution Temperature of Phenol-water system. 6. Analysis of Blood samples, Urine Sample 7. Some biochemistry experiments 8. Preparation of colloids	15

References

1. S M Khopkar, *Analytical chemistry*
2. Gurdeep Chatwal, *Chemistry of natural products Vol. 1*
3. P.L Soni, H.M. Chowla, *Text Book of Organic Chemistry*
4. I.L. Finar, *Organic Chemistry Vol 1 & 2*
5. Arun Bahl & B S Bahl, *Text Book of Organic Chemistry*

6. *Elementary practical organic chemistry. Part 2: Qualitative Organic analysis.* von A. I. Vogel. Longmans, Green & Co. Ltd., London.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO 1	Understand the fundamentals of organic chemistry	U	1, 2
CO 2	Apply the principles in purification of organic compounds	Ap	1, 2, 4
CO 3	Discuss different combinations of solutions and their properties	U	1, 2, 3
CO 4	Understand the properties of colloids and their applications	U	2, 3
CO 5	Discuss the influence of coordination and bioinorganic compounds in our life	Ap	1, 3, 4
CO 6	Apply the principles in analytical chemistry to identify the organic compounds	Ap	3, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ORGANIC AND BIOINORGANIC CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the fundamentals of organic chemistry	1, 2	U	F	L	
CO 2	Apply the principles in purification of organic compounds	1, 2, 4	Ap	F, C	L	

CO 3	Discuss different combinations of solutions and their properties	1, 2, 3	U	F, C, P	L	
CO 4	Understand the properties of colloids and their applications	2, 3	U	F, C	L	P
CO 5	Discuss the influence of coordination and bioinorganic compounds in our life	1, 3, 4	Ap	F, C	L	
CO 6	Apply the principles in analytical chemistry to identify the organic compounds	3, 4, 5	Ap	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK2DSCCHE180.1**				
Course Title	**GENERAL CHEMISTRY II**				
Type of Course	**DSC D2**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	This course provides an overview of nanoscience, green chemistry, biomolecules, environmental and fuel chemistry. Through understanding nano systems, green chemistry principles, biomolecule structures, environmental threats, and fuel sources, students will gain insights into the interdisciplinary nature of chemistry and its applications in addressing global challenges. Practical experiments complement theoretical learning, offering hands-on experience in chemical and environmental analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**INTRODUCTION TO NANO SCIENCE**		**9**
	1	Terminology. Scales of nano systems. Evolution of nanoscience- Historical aspects, preparations containing nano gold in traditional medicine. Lycurgus cup- Faraday's divided metal etc. Nano systems in nature.	3
	2	Different types of nanoparticles. Classification of nanomaterials based on dimension with examples for each 0D, 1D, and 2D. Carbon nanotubes, Types of Carbon nanotubes – SWCNT and MWCNT, important properties of carbon nanotubes and application of carbon nanotubes. fullerenes,	6

		grapheme - (basic concept only, no classification required) Applications of nanomaterials.	
II	**GREEN CHEMISTRY**		**9**
	3	Role of Chemical Industries in polluting the Environment. Limitations of conventional waste management and pollution prevention-birth of green chemistry.	2
	4	Introduction to the principles of green chemistry atom economy calculation (simple reactions), Production of Ibuprofen-less hazardous chemical syntheses, designing safer chemicals	3
	5	Bhopal gas tragedy- new greener syntheses, safer solvents and auxiliaries ionic liquids-super critical fluids CO_2 and H_2O, advantages of SCFs	3
	6	Green chemistry practices in research, educational and commercial laboratories- lab safety signs introduction to micro scale experiments.	1
III	**CHEMISTRY OF BIOMOLECULES**		**9**
	7	Carbohydrates - Introduction - classification, structure, common examples and biological significance.	2
	8	Introduction to lipids - classification to fats, phospholipids, steroids, and waxes, properties and biological functions	2
	9	Amino acids – essential amino acids – peptide bond formations – proteins, introduction to primary, secondary, tertiary and quaternary structures, protein denaturation, enzymes.	3
	10	Introduction to nucleic acids: DNA and RNA structure, functions, and types	2
IV	**ENVIRONMENTAL CHEMISTRY, FUEL CHEMISTRY**		**18**
	11	Nature of environmental threats and role of chemistry. Greenhouse effect, ozone layer and its depletion.	4
	12	Water pollution: Various factors affecting purity of water, sewage water, industrial waste, agricultural pollution such as pesticides, fertilizers, detergents, treatment of industrial waste water using activated charcoal, synthetic resins, reverse osmosis, electrodialysis. -Dissolved oxygen-BOD, COD	5
	13	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	3

		Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas — composition and uses. Uses of coal tar bases chemicals, requisites of a good metallurgical coke.	
	14	Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.	4
	15	Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.	2
V	**PRACTICALS**		**30**
	16	**A. (Any 5 experiments)** 1. Determination of dissolved oxygen in water. 2. Determination of total dissolved solid (TDS) in water 3. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate). 4. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-). 5. Analysis of carbohydrates 6. Study of some of the common bio-indicators of pollution. 7. Preparation of borax/ boric acid. 8. Analyse different lubricants and oils available in market 9. Emulsification of crude oil/lubricants in water. 10. Synthesis and characterization of any nano particle.	15
	17	**B. Open-ended experiments (Any 3).** **(From the above list or other related experiments suggested by the teacher may be conducted)**	15

References:

1. V. S. Muraleedharan and A. Subramania, *Nanoscience and nanotechnology*, Ane Books Pvt. Ltd. New Delhi, 2009.
2. T. Pradeep, *Nano: The Essentials*, McGraw-Hill education, New Delhi,2006.
3. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley & Sons, 2003.
4. Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
5. Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
6. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry* 7th Ed., W. H.
8. Freeman. Girard, J.E, (2011), *Principles of Environmental Chemistry*, Jones & Bartlett India Pvt. Limited.

9. Sodhi, G.S. ((2013), *Fundamental Concepts of Environmental Chemistry*, Narosa
10. Jain, P.C. & Jain, M. *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
11. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
12. Maria C Suros, Environmental Sampling and Analysis, CRC press, Taylor & Francis, 1997.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a basic understanding of nanoscience and nanomaterials.	R	1, 2
CO-2	Equip with the basic knowledge to apply green chemistry principles for sustainable and environmentally responsible chemical practices.	U, Ap	1, 2, 3
CO-3	Understand the structures, functions, and significance of biomolecules, enabling to know fundamental aspects of biochemistry and molecular biology	U, Ap	1, 2, 3
CO-4	Possess the knowledge on various environmental threats and gain basic ideas to develop sustainable solutions for various environmental challenges.	R, U, E	2, 3, 4
CO-5	Gain a basic understanding of energy sources, fuels, and lubricants, to analyze, select, and utilize appropriate resources for various applications.	R, U	2, 3, 4
CO-6	Develop essential laboratory skills, analytical techniques, and an understanding of environmental monitoring methods	Ap, An	2, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: GENERAL CHEMISTRY II

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Gain a basic understanding of	1, 2	R	F, C	L	

	nanoscience and nanomaterials.					
CO-2	Equip with the basic knowledge to apply green chemistry principles for sustainable and environmentally responsible chemical practices.	1, 2, 3	U, Ap	F, C	L	
CO-3	Understand the structures, functions, and significance of biomolecules, enabling to know fundamental aspects of biochemistry and molecular biology	1, 2, 3	U, Ap	F, C	L	
CO-4	Possess the knowledge on various environmental threats and gain basic ideas to develop sustainable solutions for various environmental challenges.	2, 3, 4	R, U, E	F, C	L	P
CO-5	Gain a basic understanding of energy sources, fuels, and lubricants, to analyze, select, and utilize appropriate resources for various applications.	2, 3, 4	R, U	F, C	L	P
CO-6	Develop essential laboratory skills, analytical techniques, and an understanding of environmental monitoring methods	2, 4, 5	Ap, An	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK2MDCCHE150.1**				
Course Title	**FUNDAMENTAL ASPECTS OF ENVIRONMENTAL CHEMISTRY**				
Type of Course	**MDC 2**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Plus Two				
Course Summary	Includes a brief introduction of environmental components, different types of pollution and some major environmental disasters.				

Detailed Syllabus:

Module	Unit	Content	45 Hrs
I		**BASIC CONCEPTS OF ENVIRONMENT**	**9**
	1	Types of Environments - Biotic and Abiotic, Environmental segments- Lithosphere, Hydrosphere, Biosphere and Atmosphere.	3
	2	Layers of Lithosphere, Layers of Atmosphere- Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere.	3
	3	Meaning of Ecology - Structure and Function of Ecosystem- Producers, Consumers, Decomposers.	2
	4	Ecological Succession- Food Chain and Ecological Pyramids.	1
II		**AIR POLLUTION**	**9**

	5	Pollution, Pollutants and its Classification, Contaminants.	2
	6	Air Pollution - Types of Gaseous Air pollutants-CO, CO_2, NO, NO_2, SO_2, SO_3, Smog - Sources and Effects on Environment.	3
	7	Consequences of Air pollution - Global warming, Greenhouse effect, Acid rain and Ozone layer Depletion-causes, effects and remedies.	4
III		**WATER POLLUTION**	**9**
	8	Point and Non point sources of water pollution. Water Quality Parameters- Dissolved Oxygen, BOD, COD, pH, Turbidity, Conductivity, Salinity (Qualitative idea only), Eutrophication.	3
	9	Major Water pollutants – Industrial Wastes, Sewage, Agricultural Pollutants, Radioactive Wastes, Detergents - Sources and Effects.	3
	10	Treatment of Waste Water- Filtration using Activated Charcoal and Ion Exchange Resins, Electrodialysis and Reverse osmosis	3
IV		**SOIL POLLUTION**	**9**
	11	Composition of soil- Inorganic and Organic Components in Soil- Micro and Macro nutrients,	3
	12	Soil pollutants - Industrial Wastes, Domestic Wastes, Agricultural Wastes and Radioactive Wastes - Sources and Effects.	3
	13	Solid Waste Management - Land Filling, Recycling, Incineration and Composting.	3
V		**ENVIRONMENTAL DISASTERS**	**9**
	14	Definition and types of disasters – Natural and Manmade.	2
	15	Disaster management - Mitigation, Preparedness, Response and Recovery.	3
	16	Major environmental disasters - Three Miles Island accident, Endosulfan tragedy in Kerala, Chernobyl Incident, Minamata disease.	4

References

Text books:

10. A.K. De, "Environmental Chemistry"
11. H.M. Saxena, "Environmental Geography".
12. G.W. Vanloon, S. J. Duffy, "Environmental Chemistry – a global perspective".
13. P.K. Gupta, "Methods in Environmental Analysis Water, Soil and Air".
14. V.P. Kudesia, "Environmental Chemistry".
15. G.S. Sodhi, "Fundamental Concepts of Environmental Chemistry".
16. .V Subramanian, "A Text Book of Environmental Chemistry", Wiley 2020.
17. C. Baird and M. Cann, "Environmental Chemistry", W.H. Freeman and Company, 2012.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the structure and composition of the atmosphere.	**U**	2
CO-2	Observe, realise and enlist the causes of air pollution.	**R, U**	2,4
CO-3	Understand the qualities of water, identify the causes and effects of water pollution and acquire knowledge of waste water treatment.	**U, R**	4
CO-4	Acquire a basic knowledge of Soil Pollution	**U**	4,5
CO-5	Review major environmental disasters	**R**	4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: FUNDAMENTAL ASPECTS OF ENVIRONMENTAL CHEMISTRY

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the structure and composition of the atmosphere.	2	U	F, C	L	
2	Observe, realise and enlist the causes of air pollution.	2,4	R, U	F	L	
3	Understand the qualities of water, identify the causes and effects of water pollution and acquire knowledge of	4	U, R	P, C	L	

	waste water treatment.					
4	Acquire a basic knowledge of Soil Pollution	4,5	U	F	L	
5	Review major environmental disasters	4	R	P, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

SEMESTER III

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK3DSCCHE200.1**				
Course Title	**PHYSICAL CHEMISTRY I**				
Type of Course	**DSC A3**				
Semester	3				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Basic awareness about General Chemistry 2. General idea about calculus and algebra				
Course Summary	This physical chemistry course covers a broad range of topics including solid state, liquid state, gaseous state, dilute solutions, and colloids, providing students with a comprehensive understanding of the properties and behaviors of matter at various states and concentrations. Through theoretical principles and practical experiments, students gain insights these topics and to apply their knowledge to solve real-world problems.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**SOLID STATE**		**9**
	1	Amorphous and Crystalline solids. Isotropy and anisotropy, size and shape of crystal, Interfacial angle. Types of crystals: molecular crystals, ionic crystals, covalent crystals and metallic crystals-examples and properties.	2
	2	Symmetry of crystals- plane of symmetry, axis of symmetry, centre of symmetry (definitions and basic idea only), Seven basic crystal systems, Space lattice and unit cell, Bravais lattices, (unit cell	2

		parameters and examples of 14 Bravais lattices), close packing structures of cubic lattices.	
	3	Law of constancy of interfacial angles, Laws of rational indices, Miller indices, Representation of lattice planes of cubic crystals, interplanar spacing in crystals, Determination of Avogadro number from crystallographic data.	2
	4	X-ray diffraction studies of crystals, Bragg's equation – derivation and applications, Rotating crystal and powder method. Structures of NaCl, CsCl, Rutile, Wurtzite, Zinc Blende and diamond. Imperfections in crystals. Stoichiometric and Nonstoichiometric defects, point defects – Schottky and Frenkel defects, F-centre	2
	5	Energy band theory of Conductor, Semiconductors and insulators, Glasses	1
II	**LIQUID STATE**		**9**
	6	Physical properties of liquids; vapour pressure, surface tension, viscosity, and Refractive Index and their determination. Factors affecting surface tension and viscosity, Interfacial tension, Surface active agent, Explanation of cleansing action of detergents.	3
	7	Determination of Surface tension- capillary rise and stalagnometer method Viscosity- Poiseuilles equation, Determination of viscosity- Ostwald's viscometer Refractive index determination by Abbe refractometer	3
	8	Liquid crystals- introduction, characterization of liquid crystals, Types –smectic, nematic and cholesteric liquid crystals- examples; Disc shaped liquid crystals, Polymer liquid crystals. uses of liquid crystals	3
III	**GASEOUS STATE**		**9**
	9	Ideal gas, Ideal gas equation, gas constant: values in different units ($JK^{-1}mol^{-1}$, L atm $K^{-1}mol^{-1}$, cal $K^{-1}mol^{-1}$) Dalton' Law of Partial pressure- Definition and mathematical expression. Postulates of Kinetic theory of Gases and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure	2

		dependence, relation between mean free path and coefficient of viscosity; variation of viscosity with temperature and pressure.	
	10	Maxwell distribution (equation only) and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy.	2
	11	Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases, Causes of deviation from ideal behaviour. Z-P plots of ideal gas and the real gases H_2, He, NH_3, CO and methane at 0°C, Z-P plots of N_2 at several temperatures.	2
	12	Vander Waals equation of state, its derivation and application in explaining real gas behaviour. Vander Waal's equation at low and high pressures and at high temperature.	1
	13	Law of corresponding states, liquefaction of gas, and inversion temperature. PV isotherm of Carbon dioxide, critical state, relation between critical constants and van der Waals constants, Correction factors, Experimental determination critical constants, Boyle temperature, Boyle temperature in terms of van der Waal's constant. Virial equation of state and virial coefficients. (no derivations)	2
IV	**DILUTE SOLUTIONS AND COLLOIDS**		**18**
	14	Dilute solutions: Binary solutions, Concentration- Molarity, Molality, Normality and Mole fraction. (numerical problems)	2
	15	Raoult's Law for solutions of non-volatile solutes, vapour pressure of ideal solutions and relative lowering of vapour pressure.	1
	16	Colligative properties- lowering of vapour pressure; elevation of boiling point and depression in freezing point; molal elevation constant, molal depression constant, Thermodynamic derivation of ΔT; Osmosis and Osmotic pressure, van't Hoff equation; Isotonic, hypertonic and hypotonic solutions, Abnormal molecular mass and van't Hoff factor, Determination of degree of dissociation and association, Reverse osmosis (numerical problems).	4
	17	Experimental determination of molecular mass of solutes by cooling curve method, Rast's and Beckmann methods	2
	18	Colloids: Classification of colloids – Preparation of colloids	2
	19	Purification of colloids – dialysis, electrodialysis, hot dialysis, ultra filtration and ultracentrifugation	2

	20	Kinetic, optical and electrical properties of colloids – Tyndall effect & applications - Ultra microscope, Electrical double layer and zeta potential - Coagulation of colloids, Hardy-Schulz rule, Gold number, sedimentation and streaming potential	3
	21	Gels: Elastic and non-elastic gels, Imbibition and syneresis, Micelles and critical micelle concentration	1
	22	Application of colloids – Cottrell precipitator, purification of water and delta formation.	1
V	**PRACTICALS: PHYSICAL CHEMISTRY PRACTICALS**		**30**
		A minimum of 5 practical experiments (Minimum one each from A & B)	
	23	**A. Lowering of freezing point** Determination of K_f of solid solvent using a solute of known molecular mass. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine) Determination of molecular mass of the solute using a solvent of known K_f. (Solvent: Naphthalene, biphenyl) (Solute: Naphthalene, biphenyl, 1,4-dichlorobenzene, diphenylamine)	
		B. Depression of transition temperature Determination of molal transition point depression constant (K_t) of salt hydrate using solute of known molecular mass. (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose). Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (K_t). (Salt hydrates: sodium thiosulphate penta hydrate, hydrated sodium acetate) (solutes: Urea, Glucose)	
	24	**C. Surface tension:** Determination of Surface tension of any three liquids Surface tension of binary mixtures and determination of concentration of an unknown mixture	
	25	**D. Viscosity:** Determination of viscosity of any three liquids Viscosity of binary mixtures and determination of concentration of an unknown mixture	
	26	**E. Refractive index experiments:** Determination of refractive indices of any three liquids	

		Refractive indices of KCl solutions of different concentrations and determination of concentration of unknown KCl solution	
	27	**F. Solid state:** Indexing powder XRD patterns and determination of unit cell parameters of simple and/or bcc and/or fcc systems (Instructors must provide the powder XRD patterns and ask students to index it and calculate unit cell parameters)	

References:

Textbooks

1. P W Atkins, Julio de Paula, *Elements of Physical Chemistry*, 7th Edition, Oxford University Press.
2. P W Atkins, Julio de Paula, James Keeler *Physical Chemistry, molecular Thermodynamics and Kinetics*, 11th Edition, Oxford University Press.
3. R L Madan, *Physical Chemistry*, Mc Graw Hill.
4. Samuel Glasstone and David Lewis *Elements of Physical Chemistry*, Macmillan.
5. Puri, Sharma & Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co.
6. P. C. Rakhit, *Physical Chemistry*, Sarat Book House, Calcutta.
7. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd.

For Further Reading

1. R J Selby and RA Alberty, *Physical Chemistry*, John Wiley &sons.
2. Ira N Levin, *Physical Chemistry*, 5th Edition, MacGraw-Hill Education.
3. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house.
4. G W Castellan, *Physical Chemistry*, Narosa Publishing House.
5. B. Viswanathan, P. S. Raghavan, *A Practical Physical Chemistry*, Viva Books.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a clear understanding of the structure and behaviour of solids to equip for its applications in materials science, electronics, and engineering.	U	1,3
CO-2	Possess a comprehensive understanding of the physical properties of liquids and liquid crystals	U	1,2,3,4
CO-3	Gain insight into the behaviour and applications of liquid crystals, leading to their utilization in various technologies such as displays, sensors, and optical devices.	U, Ap	1,2,3,4

CO-4	Understand the behaviour of gases, ranging from the ideal gas equation to the complexities of real gases	U	1,2,3,4
CO-5	Gain the idea of the principles governing dilute solutions, including concentration units such as molarity, molality, normality, and mole fraction and apply in analytical measurements.	U, Ap	1,2, 4
CO-6	Gain insights into phenomena like coagulation, gels, and micelles, to address complex challenges in related fields.	R, U, Ap	1,2,3,4
CO-7	Hands-on experience in conducting experiments related to the physical properties of solutions and solids	U, Ap, E	1,2,4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL CHEMISTY I

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Gain a clear understanding of the structure and behaviour of solids to equip for its applications in materials science, electronics, and engineering.	1,3	U	F, C	L	
CO-2	Possess a comprehensive understanding of the physical properties of liquids and liquid crystals	1,2,3, 4	U	F, C	L	
CO-3	Gain insight into the behaviour and applications of liquid crystals, leading to their utilization in various technologies such as displays, sensors, and optical devices.	1,2,3, 4	U, Ap	F, C	L	
CO-4	Understand the behaviour of gases, ranging from the ideal gas equation to the complexities of real gases	1,2,3, 4	U	F, C	L	
CO-5	Gain the idea of the principles governing dilute solutions, including concentration units such as molarity, molality, normality, and mole fraction	1,2, 4	U, Ap	F	L	

	and apply in analytical measurements.					
CO-6	Gain insights into phenomena like coagulation, gels, and micelles, to address complex challenges in related fields.	1,2,3, 4	R, U, Ap	F, C	L	
CO-7	Hands-on experience in conducting experiments related to the physical properties of solutions and solids	1,2,4, 5	U, Ap, E	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	3	1	1	3	2	1	1	1	1	1
CO 2	3	3	3	3	1	3	2	1	1	1	1	1
CO 3	3	3	3	3	1	3	3	1	1	1	1	1
CO 4	3	3	3	3	1	3	2	1	1	1	1	1
CO 5	3	3	1	3	1	3	3	1	1	1	1	1
CO 6	3	3	3	3	1	3	3	1	1	1	1	1
CO 7	3	3	1	3	3	3	3	3	2	2	2	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY
Course Code	**MIUK3DSCCHE210.1**
Course Title	**ELECTROCHEMISTRY AND DILUTE SOLUTIONS**
Type of Course	**DSC B3**
Semester	III
Academic Level	200 - 299

Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5

Pre-requisites	Plus two
Course Summary	The course gives students a thorough understanding of the fundamentals of physical chemistry and how they are applied in real-world situations. Topics covered include chemical and ionic equilibrium, electrochemistry, crystalline states, dilute solutions, and binary liquid systems. Students have practical experience in conducting physical chemistry experiments and analyzing experimental data through practical activities that help them build important laboratory skills.

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I	**CHEMICAL AND IONIC EQUILIBRIUM**		**9**
		Reversible reactions – K_P, K_C, and K_X and their inter relationships – Free energy change and chemical equilibrium (thermodynamic derivation)	2
		Influence of pressure and temperature on the following reactions. (i) $N_2 + 3H_2 \rightarrow 2NH_3$ (ii) $PCl_5 \rightarrow PCl_3 + Cl_2$ (iii) $2SO_2 + O_2 \rightarrow 2SO_3$ Le Chatelier's principle and the discussion of the above reactions on its basis.	2

		Concepts of Acids and Bases, Arrhenius, Lowry-Bronsted, and Lewis concepts. HSAB Principle. Levelling effect.	1
		pH and its determination by potentiometric method. Buffer solutions – Henderson equation, Acidic and basic buffers-examples.	2
		Hydrolysis of salts – degree of hydrolysis and hydrolytic constant, Derivation of relation between Kw and Kh for salts of strong acid – weak base, weak acid - strong base and weak acid – weak base.	2
II	**ELECTRO CHEMISTRY**		**9**
		Application of conductance measurements. Conductometric titrations involving strong acid – strong base, strong acid – weak base, weak acid – strong base and weak acid – weak base.	2
		EMF – Galvanic cells, measurement of emf, cell and electrode potential, IUPAC sign convention, Reference electrodes, SHE and calomel electrode, standard electrode potential,	2
		Nernst equation, anion and cation reversible electrodes, redox electrode with examples, quinhydrone electrode, glass electrode	3
		Concentration cell without transference, potentiometric titration, Fuel cells – H 2 – O2 and hydrocarbon – O2 type.	2
III	**CRYSTALLINE STATE**		**9**
		Isotropy and anisotropy – symmetry elements in crystals – the seven crystal systems. Miller indices, Bravais lattices, primitive, bcc and hcc of cubic crystals	3
		Representation of lattice planes of simple cubic crystal - Density from cubic lattice dimension – calculation of Avogadro number	2
		Bragg equation, diffraction of X-rays by crystals – single crystal and powder method. Detailed study of structures of NaCI and KCl crystals.	4
IV	**DILUTE SOLUTIONS AND BINARY LIQUID SYSTEMS**		**18**
		Molarity, molality, Normality and mole fraction Colligative property – relative lowering of vapour pressure – elevation in boiling point – depression in freezing point – osmotic pressure – experimental determination of osmotic pressure – Isotonic solution – reverse osmosis	5

		Abnormal molecular mass - van't Hoff factor. (Numerical Problems to be worked out)	4
		Completely miscible liquid pairs, vapour pressure - composition curve, boiling point composition curve	3
		Ideal and non- ideal solutions, fractional distillations, azeotropes	3
		Partially miscible liquids - CST, phenol- water, nicotine-water system- Effect of impurities on miscibility and CST, Immiscible liquid pairs.	3
V	**PRACTICALS: PHYSICAL CHEMISTRY EXPERIMENTS**		**30**
		A minimum of 5 practical experiments out of which at least one each from sections I, II and III must be performed and reported.	
	23	**I. Conductometry**	5
		1. Determination of cell constant 2. Conductometric titration of NaOH using HCl	
	24	**II. Potentiometry**	6
		3. Potentiometric titration of Fe^{2+} versus $Cr_2O_7^{2-}$ 4. Potentiometric titration of KMnO4 versus KI	
	25	**III. Experiments with Partially miscible liquid pairs**	3
		5. Critical solution temperature of phenol –water system 6. Influence of KCl (impurity) on the miscibility temperature of Phenol-water system. Determination of concentration of given KCl solution	
	26	**IV. Adosrption Experiments**	6
		7. Freundlich and Langmuir isotherms for adsorption of oxalic acid on active charcoal. 8. Determination of unknown concentration of oxalic acid using isotherm.	
	27	**V. Calorimetry**	5
		9. Determination of water equivalent of Calorimeter and heat of neutralization of strong acid and strong base	
	28	**VI. Partition experiments**	5
		10. Partition coefficient of iodine between CCl_4 and H_2O or Partition coefficient of ammonia between $CHCl_3$ and H_2O	

References

1. P L Soni, O P Dharmarsha, U N Dash, *Textbook of Physical Chemistry*, 23rd Edn, Sultan Chand & Sons, New Delhi, 2011.

2. Gurudeep Raj, *Advanced physical chemistry*
3. F Daniel and R A Albert, *Physical chemistry*
4. N.M. Kapoor, *Physical Chemistry.*
5. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Illustrate Le Chatelier's principle and predict the effect of pressure and temperature on reactions	U, Ap	1, 2
CO-2	Categorise the nature of different salt solutions in daily life and calculate the pH	U, Ap, An	2, 3
CO3	Construct electrochemical cells with different electrodes	U, Ap	2, 3
CO 4	Calculate the strength of different solutions using conductometric / Potentiometric method.	Ap, E	2, 3
CO 5	Identify the different crystals and draw their structures	An, E	1, 2
CO 6	Understand different colligative properties and calculate molecular mass of solute	U, R, Ap	1, 2
CO 7	Explain CST of liquid pairs and identify the effect of electrolyte on it	R, E	1, 2
CO 8	Apply the principles in physical chemistry experiments	Ap. E	2, 3, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ELECTROCHEMISTRY AND DILUTE SOLUTIONS

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO1	Illustrate Le Chatelier's principle and predict the effect of pressure and temperature on reactions	1, 2	U, Ap	F, C	L	
CO2	Categorise the nature of different salt solutions in daily life and calculate the pH	2, 3	U, Ap, An	F, C	L	P
CO3	Construct	2, 3	U, Ap	F, C	L	

	electrochemical cells with different electrodes					
CO 4	Calculate the strength of different solutions using conductometric / Potentiometric method.	2, 3	Ap, E	F, C	L	P
CO 5	Identify the different crystals and draw their structures	1, 2	An, E	F, C, P	L	
CO 6	Understand different colligative properties and calculate molecular mass of solute	1, 2	U, R, Ap	F, C	L	P
CO 7	Explain CST of liquid pairs and identify the effect of electrolyte on it	1, 2	R, E	F, C	L	P
CO 8	Apply the principles in physical chemistry experiments	2, 3, 5	Ap. E	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1	3	2	1	1	2	1	1	1	2	3	2	1
CO 2	1	3	2	2	3	1	3	1	3	2	3	1
CO 3	2	1	1	3	1	2	3	2	2	1	2	2
CO 4	2	1	2	1	2	1	2	1	1	1	1	2
CO 5	1	1	2	3	2	2	3	1	2	2	1	2
CO 6	2	1	2	2	2	3	2	2	3	1	1	3
CO 7	2	2	1	3	1	2	1	1	1	1	1	2
CO 8	2	1	1	3	1	2	3	2	3	3	2	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK3DSCCHE220.1**				
Course Title	**BIOMOLECULES AND SEPARATION TECHNIQUES**				
Type of Course	**DSC C3**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course covers chromatography principles and applications, biochemistry of amino acids, proteins, and nucleic acids, analysis of oils, fats, alkaloids, vitamins, and terpenes, carbohydrate and natural polymer chemistry, and practical organic preparations and analytical techniques. Students gain comprehensive knowledge and practical skills in organic chemistry, biochemistry and analytical chemistry.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**CHROMATOGRAPHY**		9
		Outline study of Adsorption and partition chromatography	2
		Principle and applications of column, paper, thin layer, ion- exchange and gas chromatography	2
		Principle and applications of HPL, Rf and Rt value of various chromatographic techniques	1
		Paper chromatographic separation of amino acids and sugars Separation of a mixture of dyes by column chromatography.	2

		Principle and applications of TLC	2
II	**AMINO ACIDS, PROTEINS & NUCLEIC ACIDS**		**9**
		Classification and properties of aminoacids Synthesis of glycine, alanine and tryptophan	2
		Polypeptides and proteins, peptide linkage, peptide synthesis Primary, secondary, tertiary and quaternary structure of proteins, Test for proteins	3
		Enzymes – Characteristics, catalytic action, theory of enzyme catalysis – Michaelis – Menton theory- Co-enzymes	2
		RNA, DNA – their biological role, hydrolysis of nucleoproteins, elementary idea regarding the structure of nucleic acids Replication of DNA- Transcription and Translation - Genetic code	2
III	**OILS, FATS, ALKALOIDS, VITAMINS AND TERPENES**		**9**
		Oils and Fats: Occurrence and extraction-Analysis of oils and fats saponification value, iodine value and acid value	2
		Alkaloids: - Extraction and structural elucidation of conine and importance of quinine, morphine and codeine	3
		Terpenes: Classification- Isoprene and special isoprene rule-Isolation of essential oils citral and geraniol (No structural elucidation)	2
		Vitamins: - Classification and structure, functions and deficiency diseases (structures of vitamin A, B1 and C but no structural elucidation	2
IV	**CARBOHYDRATES AND NATURAL POLYMERS**		**18**
		Classification. Configuration- glyceraldehyde, erythrose, threose, ribose, 2-deoxy ribose, arabinose, glucose, fructose and mannose	3
		Preparation and properties of glucose and fructose	3
		Pyranoside structures of glucose and fructose, furanoside structure of fructose (structure elucidation not expected) Mutarotation and epimerization Properties and structure of sucrose. (structure elucidation not expected)	4
		Structure of starch and cellulose (Elementary idea only)	2

		Natural rubber – Isolation, vulcanisation - characteristics and applications	3
		Synthesis and applications of biodegradable polymers – PLA, PGA, **PHBV, PHB, Nylon – 2 –nylon - 6**	4
V	**PRACTICALS – Organic Preparations, Dyes, Food analysis, Drug analysis, Fertilizer analysis**		**30**
		Section A (Any 8 Experiments from Section A are compulsory) Organic preparation: 1. Acetylation of salicylic acid or aniline 2. Benzoylation of phenol or aniline 3. Nitration of Acetanilide or nitrobenzene 4. Halogenation: Bromination of acetanilide 5. Oxidation of benzaldehyde/Toluene/Benzyl chloride 6. Hydrolysis of ethyl acetate and benzamide 7. Methyl orange 8. Picric acid 9. Phenyl urea 10. Methylene blue Purification of organic compounds Purity of organic compounds – MP and BP Recrystallisation of organic compounds Preparation of dyes Preparation of aspirin TLC of simple organic compounds- cresol, napthol, nitrobenzene	15
		Section B (Open ended: Any 3 experiments are to be conducted - May be selected from the list or the teacher can add experiments) 1. Dichrometric titrations: 2. Iodimetry and Iodometry 3. Complexometric titrations: 4. Complexometric Titration: Determination of calcium content in milk. 5. Precipitation Titration: Determination of salt content in potato chips 6. Estimation of saponification value of fats/oils. 7. Determination of hardness of water. 8. Determination of available chlorine in bleaching powder. 9. Redox Titration: Determination of Vitamin C Content in Tablets.	15

		10. Complexometric Titration: Determination of Magnesium Content in Antacids. 11. Precipitation Titration: Determination of Chloride Content in Saline Solutions. 12. Redox Titration: Determination of Iron Content in Iron Supplements 13. Complexometric Titration: Determination of Zinc Content in Zinc Supplements. 14. pH meter: Determination of pH of Fertilizer Solution.	

References

1. B. K. Sharma, *Instrumental methods of Chemical Analysis*.
2. D.A Skoog, D M West, F J, Holler, S R Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brookes/Cole, Thomson Learning, Inc, USA,2004
3. B. K. Sharma, *Industrial Chemistry*
4. Dr, U. Satyanarayana and Dr. U. Chakrapani, *Biochemistry*, Books and Allied (P) Ltd
5. J. L. Jain, Sunjay Jain, Nitin Jain, *Fundamentals of Biochemistry*, S. Chand & Co. Ltd.
6. R K Murray, DK Granner, PA Mayers, VW Rodwell, *Harper's Biochemistry*, Prentiace- Hall International Editions.
7. I. L Finar, *Organic Chemistry – Vol. 1*
8. *Vogel's Textbook of Practical Organic Chemistry* Furniss, B.S.; Hannaford, A.J.; Rogers, V. Smith, P.W.G.; Tatchell, A.R., 5th ed., Pearson Education.
9. *Practical Organic Chemistry,* Mann, F.G.; Saunders, B.C., 4th ed., Pearson Education.
10. *Comprehensive Practical Organic Chemistry – Preparation and Quantitative Analysis* Ahluwalia, V.K.; Aggarwal, R. Universities Press.
11. *Advanced Practical Organic Chemistry,* Vishnoi, N.K., 3rd ed., Vikas Publishing House, New Delhi, 2010.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the principle and applications of chromatography and electrophoresis	U	1, 2
CO-2	Classify amino acids, proteins, carbohydrates and vitamins. Identify and distinguish the structure of amino acids, peptides, proteins and nucleic acids	Ap	1, 2
CO 3	Draw the structure of amino acids, carbohydrates.	Ap	1, 2, 4
CO 4	Explain the preparation and reactions of amino acids and carbohydrates	An	1, 2, 3
CO 5	Discuss the extraction process and general properties of natural products -oils, fats, terpenes and alkaloids	U	2, 3
CO 6	Apply the basic principles in Organic chemistry	Ap	1, 3, 4

	experiments		
CO 7	Prepare medicinal compounds	E	3, 4, 5
CO 8	Identify the principles in analytical chemistry for prepare and purify organic compounds.	Ap	3, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: BIOMOLECULES AND SEPARATION TECHNIQUES

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Discuss the principle and applications of chromatography and electrophoresis	1, 2	U	F	L	
CO-2	Classify amino acids, proteins, carbohydrates and vitamins. Identify and distinguish the structure of amino acids, peptides, proteins and nucleic acids	1, 2	Ap	F, C	L	
CO 3	Draw the structure of amino acids, carbohydrates.	1, 2, 4	Ap	F, C, P	L	
CO 4	Explain the preparation and reactions of amino acids and carbohydrates	1, 2, 3	An	F, C	L	
CO 5	Discuss the extraction process and general properties of natural products -oils, fats, terpenes and alkaloids	2, 3	U	F, C	L	P
CO 6	Apply the basic principles in Organic chemistry experiments	1, 3, 4	Ap	C, P	L	P
CO 7	Prepare medicinal compounds	3, 4, 5	E	C, P	L	P
CO 8	Identify the principles in analytical chemistry for prepare and purify	3, 4, 5	Ap	C, P	L	P

	organic compounds.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	3	2	2	3	3	3	1	1	2	1
CO 2	2	3	3	1	1	3	2	2	2	1	2	1
CO 3	3	2	3	3	2	2	2	3	2	1	2	1
CO 4	3	3	2	3	3	3	3	3	1	2	1	2
CO 5	3	3	2	3	3	2	3	3	2	2	1	1
CO 6	3	3	2	2	3	3	2	2	1	1	1	1
CO 7	2	3	3	1	1	3	2	2	2	1	2	1
CO 8	3	2	3	3	2	2	2	3	2	1	2	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK3DSCCHE230.1**				
Course Title	**GENERAL CHEMISTRY III**				
Type of Course	**DSC D3**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course delves into the chemistry behind drugs, food additives, energy production and storage, fertilizers, explosives, and polymers. Through theoretical exploration and practical experiments, students will gain a comprehensive understanding of the synthesis, properties, and applications of these substances, contributing to fields such as medicine, agriculture, energy, and materials science. The course emphasizes the interdisciplinary nature of chemistry and its significance in addressing societal needs and challenges related to health, food safety, energy, and environmental sustainability.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**CHEMISTRY OF DRUGS & FOOD ADDITIVES**		**18**
	1	Classification of drugs- analgesic, antipyretic, antibiotic, hypnotics, sulpha drugs, antacids, antimalarials with examples – Mode of action of sulpha drugs	6
	2	Structure of aspirin, sulphaguanidine, Paracetamol Drugs of plant origin-anticancer compounds from plants (elementary idea only)	3
	3	Food additives – definition. Preservatives (examples), Food colours - permitted and non-permitted (examples), Toxicology. Flavours - natural and synthetic (examples)	3

	4	Artificial sweeteners (examples), Emulsifying agents (examples), Antioxidants (examples), Leavening agents (examples) and Flavour enhancers (examples). Importance of food additives.	3
	5	Soft drinks - formulation and health effects. Health drinks. Fast foods and junk foods and their health effects. Food adulteration (with examples). Food laws and standards. Food Safety and Standards Act, 2006.	3
II	**CHEMISTRY FOR ENERGY PRODUCTION & STORAGE**		**9**
	6	Primary and secondary batteries, battery components and their role	2
	7	Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery.	4
	8	Fuel cells, Solar cell and polymer cell.	3
III	**FERTILIZERS & EXPLOSIVES**		**9**
	9	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.	6
	10	Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.	3
IV	**POLYMERS**		**9**
	11	Introduction. Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions.	3
	12	Typical examples: Polyethylene, polypropylene, PVC, phenol-formaldehyde and melamine formaldehyde resins, polyamides (nylons) and polyesters.	4
	13	Natural rubber: structure, latex processing methods, vulcanization and uses.	
	14	Synthetic rubbers: SBR, nitrile rubber and neoprene. Biodegradability of polymers, environmental hazards. Recycling of plastics.	2
V	**PRACTICALS**		**15**
	15	• **Experiments** • Analyse pH of Soaps, Detergents, Soft Drinks using pH meter	

		• Saponification Value of Oil, determination of adulteration in coconut oil • Determination of Nutrient content in fertilizers (by any standard method) • Synthesis of any polymers. • Visit to a polymer research lab and understand the polymerisation and characterization techniques. • Visit to a fertilizer/pharma industry and understand the industrial process	
	16	**B. Open-ended experiments (Any 3).** **(From the above list or other related experiments suggested by the teacher may be conducted)**	15

References:

1. D. Sriram and P. Yogeeswari, *Medicinal Chemistry* 2nd edn. Pearson, 2011.
2. G R Chatwal and Anand, *Synthetic Drug* Himalaya Publishing House, New Delhi.
3. G. R. Chatwal, *Organic Chemistry of Natural Products* Vol. I and II, Himalaya Publishing House, New Delhi.
4. B. Sreelakshmi, *Food Science,* New Age International, New Delhi.
5. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
6. P. C. Jain & M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
7. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
8. B. K. Sharma: Engineering Chemistry, Goel Publishing House, Meerut.
9. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
10. S.L. Tisdale; W. L. Nelson and J. D. Beaton, *Soil Fertility and Fertilizers,* Macmillan Publishing Company, New York, 1990.
11. K. H. Buchel, *Chemistry of Pesticides,* John Wiley & Sons, New York, 1983.
12. V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, *Polymer Science*, 2nd edn., New Age International Pvt. Ltd., 2015.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand of drug classification and mode of action, facilitating basic pharmacological knowledge.	R, U	1, 2
CO-2	Facilitate the understanding of food additives, their functions, regulations, and health effects, enabling to make contributions to food industry with safety and quality assurance.	U, Ap	2, 3
CO-3	Understanding of various types of batteries and energy storage devices, empowering to contribute to advancements in renewable energy technology and	U. Ap	1, 2

	sustainable energy solutions.		
CO-4	Gain knowledge on manufacturing processes, properties, and applications of fertilizers and explosives, for roles in related industries.	R, U, An	3, 4
CO-5	Study polymer chemistry, including its biodegradability and recycling, preparing for careers in related with a focus on sustainability and innovation.	U, Ap, An	1, 2
CO-6	Hands-on training by simple chemical experiments on related fields.	Ap. An	3, 4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: GENERAL CHEMISTRY III

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand of drug classification and mode of action, facilitating basic pharmacological knowledge.	1, 2	R, U	F, C	L	
CO-2	Facilitate the understanding of food additives, their functions, regulations, and health effects, enabling to make contributions to food industry with safety and quality assurance.	2, 3	U, Ap	F, C	L	
CO-3	Understanding of various types of batteries and energy storage devices, empowering to contribute to advancements in renewable energy technology and sustainable energy	1, 2	U. Ap	F, C	L	

	solutions.					
CO-4	Gain knowledge on manufacturing processes, properties, and applications of fertilizers and explosives, for roles in related industries.	3, 4	R, U, An	F, C	L	
CO-5	Study polymer chemistry, including its biodegradability and recycling, preparing for careers in related with a focus on sustainability and innovation.	1, 2	U, Ap, An	F, C	L	
CO-6	Hands-on training by simple chemical experiments on related fields.	3, 4, 5	Ap. An	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">CHEMISTRY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK3DSECHE200.1</td></tr>
<tr><td>Course Title</td><td colspan="5">ENVIRONMENTAL CHEMISTRY I</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE 3.1</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Academic Level</td><td colspan="5">200 - 299</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Fundamental concept of Environmental Chemistry
2. Terminology associated with Environment</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides students with the knowledge of ecosystem and the different types of pollution caused by human activities. This course enlightens the students about the need to protect and conserve our environment for future generation. The course also highlights the green protocols and methodology being adopted for preserving the Environment.</td></tr>
</table>

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**ENVIRONMENT AND ITS COMPONENTS**		**9**
	1.1	Introduction, components of environment - biotic, abiotic and energy components	1
	1.2	Environmental segments- atmosphere, hydrosphere, lithosphere and biosphere	1
	1.3	Biodistribution of elements	1

	1.4	General concepts of biological cycles - Carbon cycle, Nitrogen cycle, Phosphorous cycle, Sulphur cycle and Oxygen cycle	4
	1.5	Concepts and scope of environmental chemistry	1
	1.6	Environmental perspectives, environment and society	1
II	**ECOLOGY AND ECOSYSTEM**		**9**
	2.1	Ecology - elementary idea. Food chain - Grazer and Detritus food chain. Food web. Ecological pyramid	2
	2.2	Ecosystem - concept, components, function and classification	2
	2.3	Productivity in an ecosystem - primary and secondary productivity	1
	2.4	Wetlands - elementary idea	1
	2.5	Biodiversity, sustainable ecosystem	1
	2.6	Population and environment: Human population and distribution, urbanization	2
III	**ENERGY RESOURCES**		**9**
	3.1	Natural Resources - classification, Water resources, Forest resources, Wood as a direct fuel, Land resources, Mineral resources, Energy resources	2
	3.2	Renewable and non-renewable energy resources. Renewable energy resources - Bio fuel & biomass energy, Tidal energy, Hydro power, Wind energy, Wave energy, Solar energy	3
	3.3	Hydrogen as a next generation fuel	1
	3.4	Non-renewable energy resources - nuclear fuels and fossil fuels	1
	3.5	Conservation of natural resources. Future energy resources. Sustainable use of resources	2
IV	**ENVIRONMENTAL POLLUTION, ETHICS AND LAWS**		**18**
	4.1	Pollution - definition and its classification. Pollutants, classification of pollutants based on source and physical state	3

	4.2	Causes, effect and control measures of thermal pollution, nuclear pollution, noise pollution, marine pollution and Industrial pollution - Cement, textile, sugar, paper industry, fertilizer, leather, thermal and nuclear power plants	5
	4.3	Environmental ethics: Issues and possible solutions, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act	5
	4.4	Rio declaration, Montreal protocol, Kyoto protocol. Environmental management - objectives and components. National conservative strategies, Environmental audit -Types	5
V	**OPEN ENDED MODULE:** **Learning through problem solving, seminars, open discussions, assignment discussions, quizzes, open book exams etc**		**15**
	1	Introduction to Environmental Components and segments	
	2	Concept of biological cycles and Food chain	
	3	Classification of Natural Energy Resources and its conservation	
	4	Classification of Pollutants and Types of Pollution	
	5	Introduction to environmental laws and legislation	

References:

1. *Introduction to Environmental Chemistry*, Seventh Edition, New Age International Publishers
2. Gray W. van Loon & Stephen J. Duffy, *Environmental Chemistry*: A Global Perspective, Oxford University Press
3. H. Kaur, *Environmental Chemistry*, Pragati Prakashan
4. V.K Ahluwalia, *Environmental Chemistry*, Second Edition, Ane Books Pvt. Ltd.
5. Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause, Robert L. Strong, *Chemistry of the Environment*, Second Edition, Academic Press
6. Asim K. Das, *Environmental Chemistry with Green Chemistry*, Books and Allied (P) Ltd.
7. G S Sodhi, *Fundamentals Environmental Chemistry*, Second Edition, Narosa Publishing House

Course Outcomes

No.	Upon completion of the course the graduate will beable to	CognitiveLevel	PSO addressed
CO-1	Help to understand environmental components, environmental segments and various biogeochemical cycles	U	**2**
CO-2	Understand the scope of environmental chemistry and investigate the relationship of society with environment	U	**2,4**
CO-3	Help students to learn the dynamics of ecosystem including food chains, explore the importance of biodiversity and their need to conserve the biodiversity	U	**2,4**
CO-4	Develop an understanding of various energy resources and principles undertaken for the conservation of energy resources	U,R	**2,4**
CO-5	Identifying the sources and types of environment pollution such as air pollution, water pollution, soil pollution, industrial pollution and exploring the relationship between Population and Environment	U,A	**2,4**
CO-6	**Exploring the environmental laws and policy frameworks for protecting the environment and will reflect on ethical principles, values, and philosophies related to human interactions with the environment**	**U**	**2,4,5**

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Chemistry I

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Help to understand Environmental components, Environmental segments and various biogeochemical cycles	3,2	U	F,C	L	
CO-2	Understand the scope of environmental chemistry and investigate the relationship of society with environment	3,2	U	C	L	
CO-3	Help students to learn the dynamics of ecosystem including food chains, explore the importance of biodiversity and their need to conserve the biodiversity	3,2	U	F,C	L	
CO-4	Develop an understanding of various Energy resources and principles undertaken for the conservation of energy resources	3,2	U,R	F,C	L	
CO-5	Identifying the sources and types of environment pollution such as air pollution, water pollution, soil pollution Industrial pollution and exploring the relationship between Population and Environment	3,2	U,A	F	L	

CO-6	Exploring the environmental laws and policy frameworks for protecting the environment and will reflect on ethical principles, values, and philosophies related to human interactions with the environment	3,2	U	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	3	1	1	1	2	1	3	1	1	1	2
CO 2	2	3	1	1	1	1	1	3	1	1	1	2
CO 3	2	3	1	2	1	1	1	3	1	1	1	2
CO 4	2	3	1	2	1	1	1	3	2	1	1	2
CO 5	1	3	1	2	1	1	1	3	2	1	1	2
CO 6	1	3	1	2	1	2	1	3	2	1	1	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	MIUK3DSECHE201.1				
Course Title	**ANALYTICAL CHEMISTRY I**				
Type of Course	**DSE** 3.2				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	1. General Chemistry 2. Equilibrium Principles				
Course Summary	This course provides students with the knowledge and skills necessary to understand the principles and practices of analytical chemistry, including the scope, function and analytical perspective of the field. Students will learn about various analytical techniques, methods for sample preparation and analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Analytical Chemistry**		**9**
	1.1	Scope, function, The Analytical Perspective, Analytical Problems and their solutions, Trends in Analytical Methods and Procedures, Introduction to the terms used in analytical chemistry	3
	1.2	Qualitative and Quantitative Analysis, Sampling	2
	1.3	The analytical process: Steps in the analytical process	1
	1.4	Validation of a method, Use of literature, Analyze Versus Determine	3

II	**Basic Tools of Analytical Chemistry**		**9**
	2.1	The Laboratory Notebook, Laboratory Basic Equipments & Measurements: Volumetric Glassware (Volumetric flasks, Pipettes, Syringe pipettes, Burettes & Use of volumetric Glassware,) The Analytical Balance	2
	2.2	Units for Expressing Concentration: Molarity and Formality, Normality, Molality, Weight, Volume, and Weight-to-Volume Ratios, Converting Between Concentration Units, p-Functions	3
	2.3	Stoichiometric calculations, Selection of glassware, Preparation of standard acid & base solutions	2
	2.4	Other apparatus: Blood samplers, Desiccators, furnaces & ovens, hoods, wash bottles, Centrifuges & filters	2
III	**Language of Analytical Chemistry**		**9**
	3.1	Analysis, Determination, Measurement, Techniques, Methods, Procedures and Protocols, Classifying Analytical Techniques, Use of Literature	2
	3.2	Selecting an Analytical Method: Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness, Scale of Operation, Equipment, Time and Cost, Making the Final Choice	3
	3.3	Developing the Procedure & Standardizing Analytical Methods: Compensating for Interferences, Calibration and Standardization, Sampling, Validation, Analytical signals, Calibrating the signals, and Sensitivity determination.	3
	3.4	Protocols, The Importance of Analytical Methodology	1
IV	**Chemical Equilibrium and Semi-micro Qualitative Inorganic Analysis**		**18**
	4.1	Reversible Reactions and Chemical Equilibria, Thermodynamics and Equilibrium Chemistry, Le-Chatelier's Principle, the law of mass action, Factors affecting chemical reactions in solutions	4
	4.2	Solubility product, Common Ion Effect, Fractional precipitation, Effect of acids, temperature and solvent on the solubility of a precipitate	4

	4.3	Introduction to semi-micro qualitative inorganic analysis, The study of reactions of cations and anions on the semi-micro scale	3
	4.4	Preliminary tests, systematic analysis and Confirmatory tests for anions on the semi micro scale, Modifications of separation procedures in the presence of interfering anions	3
	4.5	Preparation of solution for cation testing, separation and identification of cations into groups (I, II A, II B, III A, III B, IV & V) on the semi-micro scale	4
V	**Open Ended Module: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc.**		**15**
	1	Select an analytical method used in a specific industry (e.g., pharmaceuticals, environmental monitoring). Discuss the process of validation and standardization for this method, including the use of literature, compensating for interferences, and calibration techniques	
	2	Identify, categorize and describe the uses of apparatus and equipment commonly found in an analytical chemistry laboratory. Provide detailed explanations of the principles behind the operation of each instrument, as well as their applications in qualitative and quantitative analysis	
	3	Perform stoichiometric calculations and demonstrate the selection and proper use of volumetric glassware, including volumetric flasks, pipettes, syringe pipettes and burettes. Practice the preparation of standard acid and base solutions and conduct titrations to determine concentration	
	4	Discuss the importance of proper instrument maintenance, calibration and troubleshooting to ensure accurate and reproducible measurements	
	5	Examine the theory and procedures involved in semi-micro qualitative inorganic analysis	
	6	Discuss the systematic approach to testing for anions and cations, including preliminary tests, confirmatory tests and separation techniques	

	7	Highlight the challenges and considerations in identifying and eliminating interfering groups	

References:

1. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Textbook of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
3. D. J. Holme and H. Perk, *Analytical Biochemistry*, 3rd edition, Prentice Hall, 1998.
4. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
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6. G. Svehla, *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*, Longman, 5th edition, 1979.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the scope, function and analytical perspective of analytical chemistry, the steps involved in the analytical process, gain proficiency in validating analytical methods	U	1,2
CO-2	Learn units for expressing concentration, perform conversions between concentration units, and stoichiometric calculations and prepare standard acid and base solutions	Ap,R	1
CO-3	Learn to select analytical methods, develop procedures and standardize analytical methods.	E	1,2
CO-4	Learn about the common ion effect and its impact on equilibrium, systematic analysis techniques on a semi-micro scale for cations and anions,	An	1
CO-5	Applies the knowledge in basics of Analytical chemistry and semimicro qualitative analysis in problem solving	Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY 1

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the scope, function, and analytical perspective of analytical chemistry, the steps involved in the analytical process, gain proficiency in validating analytical methods	2,1,2	U	F, C	L	
CO-2	Learn units for expressing concentration, perform conversions between concentration units, and stoichiometric calculations and prepare standard acid and base solutions.	2,2	Ap, R	C, P	L	
CO-3	Learn to select analytical methods, develop procedures and standardize analytical methods.	2,2	E	C, P	L	
CO-4	Learn about the common ion effect and its impact on equilibrium, systematic analysis techniques on a semi-micro scale for cations and anions,	2,2	An	C, P	L	
CO-5	Applies the knowledge in Basics of Analytical chemistry and semi-micro qualitative analysis in problem solving	2,1,2	Ap	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	1	1	1	3	1	1	1	1	1
CO 2	3	1	1	1	1	1	2	1	1	1	1	1
CO 3	2	3	1	1	1	1	2	1	1	1	1	1
CO 4	1	2	1	1	1	1	1	1	1	1	1	1
CO 5	3	2	1	1	1	1	1	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK3VACCHE200.1**				
Course Title	**LABORATORY SAFETY**				
Type of Course	**VAC 1**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Plus Two				
Course Summary	This course provides comprehensive training on laboratory safety protocols, chemical hazards, proper handling of chemicals and apparatus, safety equipment usage, emergency procedures, and laboratory waste management, with a focus on Indian regulations and challenges. Students will gain essential knowledge and skills to ensure safe and responsible practices in chemical laboratories, emphasizing compliance with legal frameworks and environmental protection.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**INTRODUCTION TO LAB SAFETY**	**9**
	1	Introduction, Eye Protection-Clothing- Gloves, Laboratory Protocol - Laboratory Visitors - Comportment in the Laboratory	4
	2	Housekeeping-Cleaning Glassware - Inhaling Harmful Chemicals – Distillations – Extraction – Refrigerators - Disposal - General Disposal Guidelines.	5

II	**CHEMICAL HAZARDS**		**9**
	3	Toxicity, Explosivity, Flammability, Corrosivity, Exposure Limits, Sources of Information, Material Safety Data Sheets (MSDSs), Understanding an MSDS, Labels, Reading MSDSs and Labels, Physical hazards, Environment hazards and symbols	4
	4	The Properties of Chemicals, Learning Chemistry from an MSDS, Classifying Hazardous Chemicals - Solvents and Their Hazards - Acids and Bases - A Few Examples of Toxic Materials - Organic Peroxides and Peroxide Formers, Physical hazards, Environment hazards and symbols	5
III	**WORKING WITH CHEMICALS AND APPARATUS**		**9**
	5	Equipment Use - Laboratory Hoods, Precautions for Using Electrical Equipment, Centrifuges, Using Steam, Using High-Pressure Air, Ultraviolet Lamps.	4
	6	Controlling Temperature - Oil and Sand Baths, Cooling Baths and Cold Traps, Dry Ice Cooling Baths and Cold Traps, Cryogenic Liquid Cooling Baths and Cold Traps, Working with Reduced Pressure.	5
IV	**SAFETY EQUIPMENT AND EMERGENCY PROCEDURES**		**9**
	7	General Information, Fires - Fire Prevention, dealing with a Fire, Personal Injuries Involving Fires	5
	8	Chemicals on Skin, Clothing, and Eyes, Other Personal Injury Accidents, Spill Cleanup	4
V	**LABORATORY WASTE MANAGEMENT**		**9**
	9	Introduction to waste management, Chemical waste disposal, glass disposal, emergency procedures, Response to incidents and accidents	3
	10	Indian regulations on chemical and hazardous waste management, Brief idea on Legal Framework on Chemical and Hazardous Waste in India, Issues and Challenges in Production, Storage and Transport of Chemicals in India:	6

References

1. *Safety in Academic Chemistry Laboratories, volume 1, Accident prevention for college and university students*, 7th Edn (ISBN 0-8412-3863-4), American Chemical Society Washington, DC.
2. *Techniques of Safety Management* (ISBN: 978-18-8-558139-6), Dan Petersen, McGraw-Hill Book Co. Ltd., New York, N.Y. USA.
3. *Hazardous Chemical Data Book* (ISBN:081-551072-1), G. Weiss, Noyes Data Corporation, Park Ridge, New Jersey, N.Y. (USA).
4. *Environmental Health & Safety Management*, Nicholas & Madelyn, Jaico Publishing House, Mumbai.
5. *Hazardous waste management, Volume II, Characterisation and treatment process*, Sukalyan Sen Gupta.
6. *Solid and Hazardous waste management*, 2nd edition, M.N.Rao.
7. *Handbook on chemicals & hazardous waste management & handling in India*, MOEFCC.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Proficiency in implementing laboratory safety measures, including proper attire and eye protection, adherence to laboratory protocols, and maintaining a safe environment	C	4
CO-2	Identify physical and environmental hazards and symbols associated with various substances.	R	4
CO-3	Proficiency in the safe and effective use of laboratory equipment and temperature control methods	U	3
CO-4	Competence in fire safety protocols, including prevention measures, effective response to fires, and procedures for managing personal injuries caused by fires or chemical exposure	An	1
CO-5	Proficiency in waste management practices and effective response to incidents and accidents in laboratory settings	An	2
CO-6	Understanding of Indian regulations governing chemical and hazardous waste management and legal framework, issues, and challenges related to the production, storage, and transport of chemicals.	U	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: LABORATORY SAFETY

Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Proficiency in implementing laboratory safety measures, including proper attire and eye protection, adherence to laboratory protocols, and maintaining a safe environment	4	C	F, C	L	
CO-2	Identify physical and environmental hazards and symbols associated with various substances.	4	R	C, P	L	
CO-3	Proficiency in the safe and effective use of laboratory equipment and temperature control methods	3	U	P	L	
CO-4	Competence in fire safety protocols, including prevention measures, effective response to fires, and procedures for managing personal injuries caused by fires or chemical exposure	1	An	C, P	L	
CO-5	Proficiency in waste management practices and effective response to incidents and accidents in	2	An	P	L	

	laboratory settings					
CO-6	Understanding of Indian regulations governing chemical and hazardous waste management and legal framework, issues, and challenges related to the production, storage, and transport of chemicals.	5	U	C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

SEMESTER IV

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4DSCCHE250.1**				
Course Title	**INORGANIC CHEMISTRY II**				
Type of Course	**DSC A4-I**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	2 hours	-	4 hours	6
Pre-requisites	Plus two				
Course Summary	This course offers a comprehensive study of compounds of non-transition elements, covering various topics such as glass manufacturing, boron compounds, phosphorus oxides, halogen compounds, noble gases, inorganic polymers, and nuclear chemistry. Additionally, it includes practical experiments in inorganic qualitative analysis and preparations of inorganic compounds, providing students with hands-on experience in the laboratory.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**COMPOUNDS OF NON-TRANSITION ELEMENTS**		**12**
	1	Manufacture and uses of the Glass. Different types of glasses, silicates, zeolites and silicones.	3
	2	Borax - boron hydrides, boron nitrides, borazole and carboranes. Oxides and oxyacids of phosphorus.	3
	3	Refractory carbides, nitrides, salt like carbides, borides and silicides.	1
	4	Oxides and oxyacids of halogens (structure only). Inter halogen compounds, pseudo halogens	3

	5	Noble gases-uses, Xenon compounds– structure and hybridization in Xenon fluorides and oxides	2
II	**NUCLEAR CHEMISTRY**		**6**
	6	Nuclear Stability and Decay Modes: Nuclear stability: factors influencing nuclear stability, neutron-to-proton (n/p) ratio. Packing fraction, mass defect, and binding energy	1
	7	Fundamentals of Radioactivity. Introduction to natural radioactivity. Decay constant: definition and significance. Half-life and average life: definitions and calculations. Derivation of decay constant (brief overview, not detailed derivation)	2
	8	Disintegration Series and Modes of Decay. Overview of disintegration series. Modes of decay: alpha (α), beta (β), positron emission, and electron capture. Artificial transmutation and artificial radioactivity	1
	9	Measurement of Radioactivity: GM counter, Wilson cloud chamber, and scintillation counter	1
	10	Nuclear Reactions and Applications. Nuclear fission: atom bomb. Nuclear fusion: hydrogen bomb. Applications of radioactivity: 14C dating, rock dating, neutron activation analysis, isotope tracers, dosimetry. Applications in Medicine and Merits/Demerits of Nuclear Technology	1
III	**CHEMISTRY OF NANO MATERIALS**		**6**
	11	Evolution of Nanoscience. Historical overview of nanoscience: from ancient times to the modern era. Key milestones and discoveries in nanoscience and nanotechnology. Contributions of early scientists and researchers to the development of nanoscience. Significance of nanoscience in various fields, including materials science, medicine, and electronics	1
	12	Preparations of Nanoparticles. Introduction to nanoparticle preparation methods. Top-down approaches: techniques such as lithography and etching. Bottom-up approaches: methods including sol-gel synthesis, colloidal precipitation, coprecipitation, combustion techniques, sonochemistry, hydrothermal technique, and high-energy ball milling. Comparison of different synthesis methods in terms of efficiency, scalability, and applications.	2

	13	Carbon Nanotubes and Fullerenes. Definition and structure of carbon nanotubes (CNTs) and fullerenes. Properties and unique characteristics of CNTs and fullerenes.	1
	14	Properties of Nanoparticles. Overview of the properties of nanoparticles. Optical properties: examples of nanoparticles exhibiting optical phenomena (e.g., plasmonic nanoparticles). Magnetic properties: discussion on magnetic nanoparticles and their applications in magnetic resonance imaging (MRI) and drug delivery. Mechanical, thermal, and catalytic properties of nanoparticles with relevant examples	1
	15	Applications of Nano Materials. Introduction to nano sensors and quantum dots. Basic principles of nano sensors and their applications in various fields. Application of quantum dots in displays, solar cells, and biomedical imaging.	1
IV	**PRINCIPLES OF QUALITATIVE ANALYSIS**		**6**
	16	Introduction to Qualitative Analysis: Definition and significance of qualitative analysis in chemistry. Basic principles of qualitative analysis: separation, detection, and identification of ions or compounds. Overview of the qualitative analysis process: systematic approach and testing schemes. Importance of qualitative analysis in research, industry, and environmental monitoring.	1
	16	Solubility Equilibria in Qualitative Analysis: Solubility product (Ksp) and its importance in qualitative analysis. Predicting solubility of salts and formation of precipitates. Common ion effect and its impact on solubility equilibria. Selective precipitation and separation of ions based on solubility rules	2
	18	Identification of Cations in Qualitative Analysis: Systematic analysis of cations: principles, procedures and chemistry Identification of Group I cations: Ag^{+}, Hg_2^{2+}, and Pb^{2+} ions Identification of Group II cations: Cu^{2+}, Bi^{3+}, and Cd^{2+} ions Identification of Group III cations: Fe^{3+}, Al^{3+}, and Cr^{3+} ions	1
	19	Identification of Anions in Qualitative Analysis: Systematic analysis of anions: principles, procedures and chemistry	1

		Identification of Group I anions: Cl^-, Br^-, and I^- ions Identification of Group II anions: S^{2-}, SO_3^{2-}, and CO_3^{2-} ions Identification of Group III anions: PO_4^{3-}, NO_3^-, and CH_3COO^- ions	
	20	Applications of Qualitative Analysis: Real-world applications of qualitative analysis in various industries and fields. Case studies highlighting the importance of qualitative analysis in forensic science, environmental monitoring, and pharmaceuticals. Future trends and advancements in qualitative analysis techniques.	1
V	**PRACTICALS: INORGANIC QUALITATIVE ANALYSIS**		**60**
	I	**Qualitative Inorganic Analysis (Micro Analysis)**	**42**
	21	Studies of the reactions of the following basic radicals with a view to their identification and confirmation: Lead, Copper, Bismuth, Cadmium, Tin, Antimony, Ferrous, Ferric ions, Aluminium, Chromium, Zinc, Manganese, Cobalt, Nickel, Calcium, Strontium, Barium, Magnesium, Potassium and Ammonium ions/radicals	10
	22	Studies of the reactions of the following acid radicals with a view to their identification and confirmation: Carbonate, Sulphide, Nitrite, Nitrate, Fluoride, Chloride, Bromide, Iodide, Borate, Acetate, Oxalate, Chromate, Phosphate and Sulphate anions.	10
	23	Systematic qualitative analysis by microscale methods of salt mixtures containing two acidic and two basic radicals from the above list (more than one interfering radical should be avoided). **(Minimum 10 mixtures are to be analysed)**	22
	II	**Inorganic Preparations (Open ended – Minimum 4 preparations)**	**18**
	24	Preparations of 1. Potash alum 2. Hexamine cobalt Chloride 3. Tetramine copper Sulphate 4. Mohr’s salt 5. Microcosmic salt 6. Sodium cobalt nitrate 7. Sodium nitroprusside 8. Manganese phthalocyanin 9. Potassium trioxalatochromate 10. Potassium trioxalatoferrate	

References:

12. B.R. Puri L.R. Sharma, K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
13. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd., 2008.
14. R. Gopalan, V.Ramalingam, *Concise Coordination Chemistry*, 1st Edn.,Vikas Publishing House, New Delhi, 2001.
15. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, *Advanced Inorganic Chemistry*, 5th Edn., Vol. I, S Chand, 2012.
16. G. S. Manku, *Theoretical Principles of Inorganic Chemistry*. McGraw-Hill Education; New edition (1 August 1982)
17. M.C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
18. J. E. Huheey, E.A. Keitler, R. L. Keitler, *Inorganic Chemistry-Principles of Structure and Reactivity*, 4th Edn., Pearson Education, New Delhi,2013.
19. B.K. Sharma, *Industrial chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
20. M.N. Greenwood, A. Earnshaw, *Chemistry of elements*, 2nd Edn., Butterworth,1997.
21. J V. V. Ramanujam, "*Semi micro Qualitative Analysis*"
22. E. S. Gilreath "*Qualitative Analysis using semi micro method*" Mc Graw Hill.
23. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

4. James E. House, Inorganic Chemistry, academic press, 2008.
5. W.U. Malik, G.D.Tuli, R.D. Madan, selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 2010.
6. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley India Pvt. Ltd., New Delhi,2009.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain an understanding of various materials such as glasses, boron compounds, phosphorus oxides, refractory materials, halogen compounds and noble gas compounds	U	1

CO-2	Equip with the knowledge and skills to analyze nuclear phenomena and evaluate the benefits and drawbacks of nuclear technology in various fields.	An	2
CO-3	Gain a comprehensive understanding of the historical development of nanoscience and nanotechnology, including key milestones and discoveries.	U	2
CO-4	Enhance their problem-solving and critical thinking skills by analyzing and comparing various methods for synthesizing nanoparticles across various fields.	An	2
CO-5	Enhance problem-solving skills by providing practical insights into qualitative analysis applications in various industries.	An	2
CO-6	Proficiency in qualitative inorganic analysis techniques, enabling to accurately identify cations and anions in complex mixtures.	An	2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Inorganic Chemistry II

Credits: 2:0:2 (Lecture: Tutorial: Practical)

CO No.	CO	PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Gain an understanding of various materials such as glasses, boron compounds, phosphorus oxides, refractory materials, halogen compounds, noble gases, and inorganic polymers.	1	U	F, C	L	
CO-2	Equip with the knowledge and skills	2	An	P, M	L	

	to analyze nuclear phenomena and evaluate the benefits and drawbacks of nuclear technology in various fields.					
CO-3	Gain a comprehensive understanding of the historical development of nanoscience and nanotechnology, including key milestones and discoveries.	2	U	F, C	L	
CO-4	Enhance their problem-solving and critical thinking skills by analyzing and comparing various methods for synthesizing nanoparticles across various fields.	2	An	P, M	L	
CO-5	Enhance problem-solving skills by providing practical insights into qualitative analysis applications in various industries.	2	An	P	L	P
CO-6	Proficiency in qualitative inorganic analysis techniques, enabling to accurately identify cations and anions in complex mixtures.	2	An	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4DSCCHE251.1**				
Course Title	**ORGANIC CHEMISTRY II**				
Type of Course	**DSC A4-II**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Plus Two				
Course Summary	The course gives a basic idea regarding aromaticity, reaction mechanisms and reaction intermediates. This will enable the students to write the reaction mechanism through suitable intermediates. As an initial step, the preparations and reactions of alcohols, phenols and ethers are included in the course.				

Detailed Syllabus:

Module	Unit	Content	Theory 45 Hrs
I	**Arenes and Aromaticity**		**12**
	1	Concept of aromaticity- Heat of hydrogenation and Heat of combustion of benzene-Electron delocalization and resonance-Representation of Benzene and Benzene derivatives-Nomenclature of Aromatic Compounds	2
	2	Huckel's rule -Benzenoid and non-benzenoid compounds – Application to cyclic conjugated systems- antiaromatic, homoaromatic and non - aromatic compounds.	2
	3	Monocyclic, bicyclic and tricyclic aromatic hydrocarbons-structure of benzene, naphthalene and anthracene (elucidation not expected) Aromatic monocyclic compounds with one heteroatom.	2

	4	Chemical properties: mechanism of electrophilic substitution – nitration sulphonation, halogenation, Friedel Craft's alkylation and acylation;	2
	5	Directive influence of functional group in mono-substituted benzene; Directive influence in disubstituted benzene (Introduction only)	2
	6	Carcinogenicity and toxicity of polynuclear hydrocarbons	2
II	**Organic Reaction Mechanism II**		**12**
	7	Aliphatic nucleophilic substitutions: mechanism of SN1 and SN2 mechanisms. reactions, Effect of nature of substrate and solvent in substitution reactions, Stereochemistry of SN reactions, Stereospecificity and Stereoselecticity in SN reactions, Walden Inversion.	2
	8	Neighbouring group participation (anchimeric assistance): Participation of lone pair of electrons in substitution reaction	2
	9	Electrophilic substitution reactions in benzene: Mechanism of halogenation, nitration, sulphonation and Friedel Craft's alkylation and acylation, energy profile diagram.	2
	10	Ring activating and deactivating groups with examples.	2
	11	Orientation effect in mono substituted benzene - –OH, $-NH_2$, NO_2, $-CH_3$, -CHO, COOH and halogens.	2
	12	Aromatic nucleophilic substitution – Uni and bimolecular displacement mechanism -Elimination and Addition mechanisms (Benzyne) and Chichibabin reaction.	2
III	**Organic Reaction Mechanism III**		**12**
	13	Elimination reaction: 1,1 and 1,2 eliminations, mechanisms of E1 and E2 reactions, Regioselectivity in elimination reactions (Hoffmann and Saytzeff rule and Bredt's rule).Stereo chemical pathways of elimination: Syn and Anti eliminations.	3
	14	Substitution vs Elimination.	3
	15	Addition reactions: mechanism of addition of bromine and hydrogen halides, Ozone to double bonds, Regioselectivity in addition reaction (Markownikoff's rule and peroxide effect). stereo aspects, effect of substituents on the rate of additionsCis and trans Hydroxylation of cycloalkenes.	3
	16	Diels Alder addition, 1,2- and 1,4- additions in 1,3- butadiene.	3
IV	**Alcohols, Phenols and Ethers**		**9**
	17	Alcohols: Preparation- From alkenes (hydration. Hydroborationoxidation, oxy-mercuration demercuaration) and carbonyl compounds (reduction and with Grignard reagent	2

	18	Chemical properties: Reactions involving cleavage of O-H, bonds (acidity and esterification), oxidation (with PCC, Collins reagent, Jones reagent and K2Cr2O7) and catalytic dehydrogenation	2
	19	Distinction between primary, secondary and tertiary alcohols. Biofuel – ethanol and biodiesel	1
	20	Dihydric alcohols: Oxidative cleavage – Lead tetra acetate, periodic acid – Pinacol-pinacolone rearrangement	1
	21	Phenols: Preparation from halobenzens, cumene and sulphonic acid. Chemical properties: – Bromination, nitration, sulphonation	1
	22	Reimer-Tiemann reaction (mechanism not required), Kolbe reaction, Liebermann's nitroso reaction Distinction between alcohols and phenols.	1
	23	Ethers: Preparation by Williamson's synthesis. Reactions of ethers: Cleavage by HI– Ziesel's method of estimation of methoxy group	1
V	**Organic Chemistry Practical- Organic Quantitative Analysis, Determination of Physical constants, Preparations and separation techniques**		**Practicals 30**
		Quantitative Analysis	
	24	a) Estimation of phenol	3
	25	b) Estimation of Aniline	3
	26	c) Determination of physical constants; i) Determination of melting point of an organic compound; ii) Determination of boiling point of an organic compound;	3
		Organic Preparations and separations	
	27	a) Halogenation :Bromination of acetanilide	3
	28	b) Nitration of Acetanilide or nitrobenzene	3
	29	c) Oxidation of benzaldehyde/Toluene/Benzyl chloride	2
	30	d) Acetylation of salicylic acid or aniline	2
	31	e) Benzoylation of phenol or aniline	2
	32	f) Hydrolysis of ethyl acetate and benzamide	2
	33	g) Preparation of Soap (Demonstration only)	2
	34	d) Steam distillation –Extraction of essential oil from citrus fruits/eucalyptus leaves (demonstration only)	2
	35	e) Chromatography (demonstration only): i) TLC of simple organic compounds (using TLC sheets); ii) *Paper chromatographic separation of	2

		mixture of inks and sugars; iii) Column chromatographic separation of a mixture of dyes	
	36	f) Recrystallization of any five different classes of organic compounds	1

References

<u>For Theory</u>

<u>Text books:</u>

1. A. Bahl and B. S. Bahl, Advanced Organic Chemistry, S. Chand & Company, New Delhi.

2. L. G. Wade Jr, Organic Chemistry, Pearson Education, New Delhi.

3. K. S. Tewari, N. K. Vishnoi and S. N. Mehrotra, A textbook of Organic Chemistry, Vikas Publishing House (Pvt) Ltd., New Delhi..

4. S. C. Sharma and M. K. Jain, Modern Organic Chemistry, Vishal Publishing Company, New Delhi.

5. D. Nasipuri, Stereochemistry of Organic Compounds: Principles and Applications, New Age International Publishers, New Delhi.

6. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Oxford University Press, New York.

7. I L Finar, "Organic Chemistry" Vol – 1, 5th Edition, Pearson Education, New Delhi

8. Jagadamba Singh and Jaya Singh, Photochemistry and Pericyclic reactions, New Age International, New Delhi.

<u>Further Reading</u>

1. P. S. Kalsi, Organic Reactions, Stereochemistry, and Mechanism, New Age International Publishers, New Delhi

2. R. T. Morrison, R. N. Boyd. Organic Chemistry, Pearson Education, New Delhi.

3. P. Y. Bruice, Essential Organic Chemistry, Pearson Education, New Delhi.

4. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, Pearson Education, New Delhi.

5. G.M. Louden, Organic Chemistry, Oxford University Press, New York.

6. E. L. Eliel, Stereochemistry of Carbon compounds, Tata McGraw Hill Publishing House, New Delhi.

7. J. March, Advanced Organic Chemistry, John Wiley & Sons., NY.

8. S. M. Mukerji and S. P. Singh, Reaction Mechanism in Organic Chemistry, McMillan Publishers.

9. R.O.C. Norman and J. M. Coxon, Principles of Organic Synthesis, CRC Press.

For Practicals

Textbooks

1. A. I. Vogel, "A text book of Qualitative Analysis including semi micro methods" Longmans.

2. V. V. Ramanujam, "Semi micro Qualitative Analysis"

3. E. S. Gilreath "Qualitative Analysis using semi micro method" Mc Graw Hill

4. A. I. Vogel, "A text book of Qualitative Inorganic Analysis" Longmans

5. A. I. Vogel, "Elementary Practical Organic Chemistry" Longmans

6. J. B. Yadav, Advanced Practical Physical Chemistry, Goel ,Publishing House

Further Reading

1. Day and Raman, "Laboratory Manual of Organic Chemistry".

2. B. Viswanathan and P.S Raghavan , "Practical Physical Chemistry" 2005 Edn. Viva Books (Pvt. Ltd)

3. F.G Mann and B.C Saunders, "Practical Organic Chemistry" 4th Edn, Orient Longmann

4. A. Findlay, "Practical Physical Chemistry" Creative Media

5. R. C. Das and E. Behara, "Experimental Physical Chemistry", Tata Mc Graw Hill

6. N. K., Vishnu, "Advanced practical organic chemistry" Vikas publishing house, New Delhi

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain aromaticity, orientation effect and mechanism of aromatic electrophilic substitution.	U	1
CO-2	Plan an aromatic electrophilic substitution reaction	Ap	1,3
CO-3	Predict the outcome of organic reactions	Ap	1,3

CO-4	Demonstrate the method of determination of reaction mechanism	Ap	1,3
CO-5	Describe the preparation of hydroxyl compounds and ethers..	R	1
CO-6	Distinguish primary, secondary & tertiary alcohols	U	1
CO-7	Develop curiosity in systematically analyzing and quantifying organic compounds	An	1,2,4
CO-8	Apply the principles and techniques in organic chemistry, thereby developing skill in designing an experiment to synthesize and purify organic 1,2compound	An	1,2,3
CO-9	Determine physical constants of organic compounds and preparation of soaps	An	1,2
CO-10	Separate organic compounds by TLC/paper/column chromatographic techniques	An	1,2
CO-11	Practice systematic scientific procedure and prepare adequate report of them	An	1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Course Title: Organic Chemistry II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain aromaticity, orientation effect and mechanism of aromatic electrophilic substitution.	1	U	F, C	L	
2	Plan an aromatic electrophilic substitution reaction	1,3	Ap	C,P, M	L	
3	Predict the outcome of organic reactions	1,3	Ap	C,P,M	L	
4	Demonstrate the method of	1,3	Ap	C,P	L	

	determination of reaction mechanism					
5	Describe the preparation of hydroxyl compounds and ethers..	1	R	P	L	
6	Distinguish primary, secondary & tertiary alcohols	1	U	U, P	L	
7	Develop curiosity in systematically analysing and quantifying organic compounds	1,2,4	An	U, C, P		P
8	Apply the principles and techniques in organic chemistry, thereby developing skill in designing an experiment to synthesize and purify organic compound	1,2,3	An	U, C, P		P
9	Determine physical constants of organic compounds and preparation of soaps	1,2	An	U, C, P		P
10	Separate organic compounds by TLC/paper/column chromatographic techniques	1,2	An	U, C, P		P
11	Practice systematic scientific procedure andprepare adequate report of them	1,2,3	An	U, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	2	3	2	1	1	1	1	1
CO 2	3	2	2	1	2	3	2	1	1	1	3	1
CO 3	3	2	2	1	2	3	2	1	1	1	3	1
CO 4	3	2	2	1	2	3	2	1	1	1	3	1
CO 5	3	2	2	1	2	3	2	1	1	1	1	1
CO 6	3	2	2	1	2	3	2	1	1	1	1	1
CO 7	3	3	2	2	2	3	3	1	1	1	2	2
CO 8	3	3	3	3	2	3	3	1	2	2	8	2
CO 9	3	3	2	2	2	3	3	1	2	2	2	2
CO 10	3	3	2	2	2	3	3	1	2	2	2	2
CO 11	3	3	3	2	2	3	3	1	3	3	3	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4DSECHE250.1**				
Course Title	**ENVIRONMENTAL CHEMISTRY II**				
Type of Course	**DSE 4.1**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	**Total Hours/Week**
	4	3hours	-	2	**5**
Pre-requisites	**1. Fundamental concept of Aquatic chemistry** **2. General chemistry**				
Course Summary	**This course provides students with the knowledge of the chemical processes and interactions that occur in natural waters, including oceans, rivers, lakes, and groundwater. This course also describes about water pollution and its consequences. This course also highlights the methods of determining water quality parameters and treatment of waste water.**				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction to Aquatic Chemistry**	**9**
	1.1	Aquatic Chemistry: Introduction, structure and physico-chemical properties of water	1
	1.2	Composition of water bodies-ocean, lakes, streams, rivers and wetlands	2
	1.3	Acid-base reaction, redox reactions in water	1

	1.4	Colloidal materials in water. Chemical speciation, Biomagnification	2
	1.5	Aquatic biochemical process- Microbially mediated redox reactions, carbon transformation by bacteria, nitrogen transformation by bacteria, microbial transformation of phosphorus and Sulphur	3
II	**Water Pollution**		**9**
	2.1	Introduction, water pollutants - types, sources	2
	2.2	Eutrophication - causes, effects and control, trace elements in water	1
	2.3	Organic matter in water- origin and environmental issues. Inorganic pollutants- acid mine drainage, heavy metals (Hg, Pb,As,Cd)	2
	2.4	Sediments, radioactive materials. Soaps and detergents-Environmental impacts of water pollution	2
	2.5	Health effects of water pollution	2
III	**Water Quality Analysis**		**18**
	3.1	Objectives of water analysis, Chemical substances affecting potability (Basic concepts and determination)- colour by platinum cobalt method & colorimetric method, odour, turbidity by Jackson Candle Turbidimeter & nephelometer, conductivity - electrical conductivity, pH by electrometric method	4
	3.2	Acidity and Alkalinity by Titrimetric method, Chloride by Mohr's method, Total Solid - suspended solids & dissolved solids and Hardness by complexometric method. Hardness of water- types of hardness and removal	4
	3.3	Chemical substances affecting health (Basic Concepts and Determination) - Ammonia by Spectrophotometric Nessler's Method, Sulphate by Volumetric Method, Sulphide, Phosphate by Spectrophotometric Method, Fluoride by Spadns Method	6

	3.4	Chemical substances indicative of pollution (Basic Concepts and Determination) - Dissolved Oxygen by Modified Winkler Method, COD, BOD, Total Organic Carbon by TOC Analyser	4
IV	**Waste Water Treatment**		**9**
	4.1	Criteria of water purity. Waste water treatment methods- Conventional water treatment methods- aeration, settling or sedimentation, coagulation, filtration and disinfection	4
	4.2	Advanced waste water treatment methods: reverse osmosis, electrodialysis, nutrient removal	4
	4.3	Water conservation - concept and significance	1
V	**Water Quality analysis Practicals I**		**30**
	1	Preliminary examination of different water samples (Colour, Odour, Temperature, Turbidity, p^H) - Minimum 5 samples	
	2	Determination of conductivity of water - Using conductivity meter - Minimum 3 samples	
	3	Percentage of chlorine available in bleaching powder - Minimum 3 samples	
	4	Measurement of chloride, sulphate and salinity of water sample by simple titration method ($AgNO_3$ and potassium chromate) - Minimum 3 samples	
	5	Determination of DO, BOD and COD - Minimum 3 samples	

References:

1. Balram Pani, *Text Book of Environmental Chemistry*, I.K International Publishing House Pvt Ltd
2. A.K De, *Environmental Chemistry* Seventh Edition, New Age International Publishers
3. Gray W. van Loon & Stephen J. Duffy, *Environmental Chemistry: A Global Perspective*, Oxford University Press
4. H. Kaur, *Environmental Chemistry*, Pragati Prakashan
5. V. K Ahluwalia, *Environmental Chemistry*, Second Edition, Ane Books Pvt. Ltd.

6. Asim K. Das, *Environmental Chemistry with Green Chemistry*, Books and Allied (P) Ltd.
7. G. S Sodhi, *Fundamentals Environmental Chemistry*, Second Edition, Narosa Publishing House
8. S. M. Khopkar, *Environmental Pollution Analysis*, Wiley Eastern Ltd, New Delhi
9. S. S. Dara, *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Able to describe the chemical composition and physico-chemical properties of water	U	1,2
CO-2	Describe the main sources of water pollution, the main types of pollutant and their environmental impacts	U,R	2,4
CO-3	Describe the types of hardness of water; disadvantages and the methods for their removal	U,Ap	1,2
CO-4	Understand the appropriate methods and principle behind the practical protocols	Ap	1,2,4
CO-5	Outline how sewage may be treated before discharge to the environment and realise the importance of water conservation	U	1,2
CO-6	Comprehensive understanding of fundamental principles and analytical methods essential for evaluating the quality of water	U,A	1,2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL CHEMISTRY II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

	CO		Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Able to describe the chemical composition and physico-chemical properties of water	3,1	U	C	L	
CO-2	Describe the main sources of water pollution, the main types of pollutant and their environmental impacts	3,2	U,R	F,C	L	
CO-3	Describe the types of hardness of water; disadvantages and the methods for their removal	3,2	U,Ap	C	L	
CO-4	Understand the appropriate methods and principle behind the practical protocols	3,2 ,5	Ap	F,C	L	
CO-5	Outline how sewage may be treated before discharge to the environment and realise the importance of water conservation	3,2	U	F,C	L	
CO-6	Comprehensive understanding of fundamental principles and analytical methods essential for evaluating the quality of water	3,2 ,5	U,A	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	3	1	1	1	1	1	1	1	2	2	1
CO 2	1	3	1	1	2	1	1	3	1	1	1	1
CO 3	1	2	1	1	1	1	1	2	1	1	1	1
CO 4	1	3	1	3	3	1	1	3	1	3	3	3
CO 5	1	2	1	1	1	1	1	3	1	1	1	2
CO 6	1	3	1	1	1	1	1	2	1	1	2	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4DSECHE251.1**				
Course Title	**ANALYTICAL CHEMISTRY II**				
Type of Course	**DSE 4.2**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	1. Basic Chemistry 2. Mathematical Skills 3. Familiarity with laboratory techniques, safety procedures and basic equipment handling is necessary for conducting experiments and analyses in the course				
Course Summary	Theoretical concepts & Experimental procedures in quantitative analysis and data analysis techniques.				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I		**Errors & their Minimization in Chemical Analyses**	**9**
	1.1	Limitations of analytical methods, Accuracy & Precision, Classification of errors: Determinate & Indeterminate Errors, Minimisation of errors	4
	1.2	Significant figures, Absolute and relative uncertainty, Propagation of uncertainty	2
	1.3	Rules of Computing, Problems, Ways of expressing accuracy	3
		Statistical Data Treatment and Evaluation	**9**

II	2.1	Statistical Analysis of Data: Standard Deviation, Confidence Limit, Tests of Significance, Rejection of a Result: Q Test, F-test	3
	2.2	Linear Least Squares, Correlation Coefficient and Coefficient of Determination, Detection Limits	2
	2.3	Statistics of Sampling, Distribution of Measurements and Results: Probability Distributions and Confidence Intervals for Populations and samples	4
III	**Titrimetric Methods of Analysis**		**18**
	3.1	Titrimetric analysis, Classification of reactions in titrimetric analysis, Standard solutions, Equivalents, normalities and oxidation numbers, Preparation of standard solutions Primary and secondary standards	3
	3.2	Neutralisation Titrations: Neutralisation Indicators, Neutralization curves (a strong acid with a strong base, a weak acid with a strong base, a weak base with a strong acid, a weak acid with a weak base), Choice of indicators in neutralisation reactions	4
	3.3	Redox titrations: Electrode potential, Change of the electrode potential during redox titration, Detection of the endpoint in redox titrations	3
	3.4	Oxidation with $KMnO_4$, $K_2Cr_2O_7$, Cerium (IV) Sulphate, Redox Process involving Iodine	2
	3.5	Complexation Titrations: Introduction, Types of EDTA titrations, Titration of mixtures, selectivity, masking and demasking agents, Metal ion indicators, Standard EDTA solutions, Some practical considerations: pH, concentration of metal ion, amount of indicator, endpoint and colour change	3
	3.6	Precipitation titrations: Precipitation reactions, Determination of endpoints in precipitation reactions.	3
IV	**Gravimetric Analysis**		**9**
	4.1	Introduction to gravimetric analysis, Precipitation methods, The colloidal state, Supersaturation and precipitate formation, The purity of the precipitate: Co-precipitation	3
	4.2	Conditions of precipitation, Precipitation from homogeneous solution, Washing the precipitate, Ignition of the precipitate	3

	4.3	Quantitative separations based upon precipitation methods: Fractional precipitation, Organic precipitants, Volatilisation or evolution methods	3
V	**Analytical Chemistry Practical**		**30**
		PART A **(All experiments in section A are compulsory)**	
	1	Calibration of Analytical Equipment	
	2	Cleaning & Sterilization of Glassware	
	3	Titrimetric estimation of acetic acid content in vinegar	
		PART B **(Any 5 experiments from B and C need to be done)**	
	1	Titrimetric estimation of Ascorbic acid in orange juice, Vitamin C tablets	
	2	Excel Basics for Statistical Analysis of Laboratory Data	
		PART C	
	1 2 3 4 5 6 7 8 9 10	Estimation of carbonate and hydroxide present together in mixture. Estimation of carbonate and bicarbonate present together in a mixture. Estimation of free alkali present in different soaps Estimation of Fe(II) using standardized $KMnO_4$ solution Estimation of oxalic acid using standardized $KMnO_4$ solution Estimation of Fe(II) with $K_2Cr_2O_7$ using internal indiator Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator Iodimetric titration of Vitamin C Estimation of Magnesium (or Zinc) ions by Complexometry Determination of Total Hardness of Water by Complexometry	

References:

1. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Text book of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7^{th} edition, 1996.
3. D. J. Holme and H. Perk, Analytical Biochemistry, 3rd edition, Prentice Hall, 1998.
4. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
5. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the limitations of analytical methods, classify errors and learn methods for minimizing errors. Apply significant figures, learn rules for computing, and understand absolute and relative uncertainty as well as propagation of uncertainty	U,Ap	1,2
CO-2	Analyze statistical data & apply statistical methods for small data sets and detection limits, Understand the concepts of rejection of a result	An, U	1,2
CO-3	Understand theoretical considerations in titrimetric analysis and classification of reactions, gain proficiency in different titrimetric methods	U	2
CO-4	Gain knowledge of gravimetric analysis, precipitation methods and quantitative separations based on precipitation	U	2
CO-5	Understand the importance of equipment calibration in analytical chemistry, learn proper cleaning and sterilization techniques for different types of glassware & get practical skills in computer based statistical analysis & volumetric titrations	Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the	1,2	U,Ap	F	L	

	limitations of analytical methods, classify errors and learn methods for minimizing errors. Apply significant figures, learn rules for computing and understand absolute and relative uncertainty, as well as propagation of uncertainty	1,2				
CO-2	Analyze statistical data & apply statistical methods for small data sets and detection limits, Understand the concepts of rejection of a result	1,2, 2	An,U	F,C	L	
CO-3	Understand the concept of titrimetric analysis and classification of reactions, gain proficiency in different titrimetric methods	1,2, 2	U	F,C	L	
CO-4	Gain knowledge of gravimetric analysis, precipitation methods, and quantitative separations based on precipitation	1,2	U	C	L	
CO-5	Understand the importance of equipment calibration in analytical chemistry, learn proper cleaning and sterilization techniques for different types of glassware & get practical skills in computer based statistical analysis &	1,2, 1,2	Ap	P		P

	volumetric titrations					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	1	1	3	1	1	1	1	1
CO 2	3	1	1	1	1	1	3	1	1	1	1	1
CO 3	3	2	1	1	1	1	1	1	1	1	1	1
CO 4	1	1	1	1	1	1	1	1	1	1	1	1
CO 5	3	2	1	1	2	2	2	1	1	1	1	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4SECCHE200.1**				
Course Title	**WATER QUALITY ANALYSIS**				
Type of Course	**SEC 1**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Plus Two				
Course Summary	The course cover water quality parameters, different types of water, removal of hardness of water, qualitative and quantitative analysis of different contaminant of water, different types of contaminant of water and real sample analysis f water and its application in environment.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		WATER QUALITY ANALYSIS	**45**
I	**QUALITY PARAMETERS FOR DRINKING WATER**		**9**
	1	Contaminants Vs pollutants	1

	2	Water quality parameters and their interaction	2
	3	Physical and chemical characteristics - turbidity, colour – temperature - chemical constituents, taste, colour, acidity, alkalinity - CO_2, pH.	6
II	**HARD AND SOFT WATER**		**9**
	4	Classification of water, difference between soft and hard water	2
	5	Causes of hardness, removal of temporary and permanent hardness	3
	6	Standard for drinking water as per WHO and BIS specifications, application in environmental situation.	4
III	**QUALITATIVE AND QUANTITATIVE ANALYSIS**		**9**
	7	Chloride, Nitrite, nitrate, phosphate, ammonia	3
	8	BOD, COD, DO, pH	3
	9	Estimation of hardness of water, Jar test- water quality enhancement.	3
IV	**CHEMICAL AND BIOLOGICAL CONTAMINATION OF WATER**		**9**
	10	Chemical contaminant- classification- inorganic, organic-health effects, and removal.	5
	11	Biological contaminants- type of contaminants, health effects and remedial measures.	4
V	**REAL SAMPLE ANALYSIS - CASE STUDIES**		**9**
	12	Collection of samples from different area – Hands on training	6
	13	Application in environment	3

REFERENCES

1. **De., Environmental Chemistry, 6th Edition, New Age International.**
2. **P.K.Goel, Water Pollution, Causes, Effects and Control, New Age International.**
3. **Kochu Baby Manjooran, Modern Engineering Chemistry (Kerala University), Kannatheri Publications.**
4. **Shashi Chowla, Engineering Chemistry, Dhanpat Rai Publishing Company.**
5. **P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 15th edition, 2015.**
6. **Dr.K. Mukkanti, S. Chand &Camp Ltd Environmental studies.**
7. **R.K. Trivedi and P.K. Geol, Chemical and biological method for water pollution**

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand important parameters for measuring water quality.	U	1
CO-2	Develop awareness about water quality criteria and standards, and their relation to public health and environment	Ap	2
CO3	Apply water quality tests and analyze how the parameters relate to each other.	An	3,4
CO - 4	Classify water into soft and hard	Ap	2
CO - 5	Identify the contaminants in water and skill to develop water analysis	E	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: WATER QUALITY ANALYSIS
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand important parameters for measuring water quality.	1	U	F	L	
2	Develop awareness about water quality criteria and standards, and their relation to public health and environment	2	Ap	C	L	
3	Apply water quality tests and analyze how the parameters relate to each other.	3,4	An	P	L	
4	Classify water into soft and hard	2	Ap	F, P	L	
5	Identify the contaminants in water and skill to develop water	3	E	M	L	

	analysis					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PS O1	PS O2	PS O3	PS O4	PS O 5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	1	3	1	1	3	2	1	1	1	1	1
CO 2	3	3	3	3	1	3	2	1	1	1	1	1
CO 3	3	3	3	3	1	3	3	1	1	1	1	1
CO 4	3	3	3	3	1	3	1	1	1	1	1	1
CO 5	3	3	1	3	1	3	3	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK4VACCHE250.1**				
Course Title	**SUSTAINABLE CHEMISTRY**				
Type of Course	**VAC 2**				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Plus Two				
Course Summary	The course covers biomass assessment, techniques, waste management, biofuel, bio hydrogen production, polymers from biomass, corrosion management and renewable energy resources.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**INTRODUCTION TO BIOMASS**		**9**
	1	Biomass: Biomass resources, types, production, classification, and characterisation	3
	2	Techniques for biomass assessment.	2
	3	Concept of Waste segregation, management, and treatment.	4
II	**BIOFUEL**		**9**

	4	Bio ethanol and Biodiesel Production - Economics - Recent developments. Energy farming	3
	5	Biomass to gaseous fuel production-, Biogas technology - biogas plants – design consideration – applications.	3
	6	Bio hydrogen Production, Concept of Bio refinery.	3
III	**POLYMERS FROM BIOMASS**		**9**
	7	Natural biopolymers: proteins (silk, wool, hair etc.), polysaccharides, collagen	3
	8	Biopolymers from renewable resources- casein, natural rubber, and cellulose.	3
	9	Biosynthesis of biodegradable polymers (polyhydroxyalkanoates etc). Synthetic biopolymers: polylactic acid and its co-polymers, aliphatic polyesters, polyethylene oxides.	3
IV	**CORROSION MANAGEMENT**		**9**
	10	Corrosion: Erosion and corrosion, wet corrosion and dry corrosion, Factors affecting corrosion	3
	11	Coatings as a method of corrosion prevention (Tinning, Galvanizing, Painting Electroplating, Anodising). Cathodic protection and Anodic protection.	3
	12	Corrosion resistant materials – alloys – Details different types of steel, properties and applications, anti-rest solutions	3
V	**RENEWABLE ENERGY SOURCES**		**9**
	13	Fundamentals of Sustainable Energy & Development	2
	14	Introduction to Renewable Energy – Need of switching to Renewable Energy sources, Difference between Renewable & Non-renewable sources	3
	15	Main sources – solar, wind, tidal, biomass, geothermal - Applications, Advantages & Disadvantages of Renewable Energy.	4

REFERENCES

1. **Ted Weyland, Bioenergy: Sustainable Perspectives, Callisto Reference. ISBN: 978-1-632-39633-4.**
2. **Corrosion and corrosion control Ublig, H. H. Latest edition.**

3. **Kulkarni, V. and Ramachandra, T.V., "Environment Management", TERI Press. 2009.**
4. **Non-conventional Energy Sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers.**
5. **Capareda S, Introduction to biomass energy conversion, CRC Press. ISBN: 978-1-466-51333-4.**
6. **Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons. ISBN: 978-0- 470-72111-7.**
7. **Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Bioenergy (Energy and the Environment), CRC Press. ISBN: 978-1-498-71698-7.**
8. **Yebo Li and Samir Kumar Khanal, Bioenergy: Principles and Applications, Wiley-Blackwell. ISBN: 978-1-118-56831-6.**

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss various biomass resources, techniques of assessment and waste management.	U	4
CO-2	Apply the production of bio hydrogen fuel	Ap	5
CO- 3	Synthesis of biodegradable polymers from biomass	Ap	3
CO- 4	Develop methods for producing corrosion resistant materials	Ap	3
CO- 5	Discuss various types of renewable energy resources and their advantages	U	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: SUSTAINABLE CHEMISTRY
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Discuss various biomass resources, techniques of assessment and waste management	4	U	F	L	
2	Apply the production of bio hydrogen fuel	5	Ap	P	L	
3	Synthesis of biodegradable polymers from biomass	3	Ap	C, P	L	
4	Develop methods for producing corrosion resistant materials	3	Ap	M	L	
5	Discuss various types of renewable	5	U	F,C	L	

	energy resources and their advantages					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK4VACCHE251.1**				
Course Title	**SCIENTIFIC COMMUNICATION AND ETHICS**				
Type of Course	**VAC 3**				
Semester	IV				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Plus Two				
Course Summary	The course covers scientific communication methods, data bases, intellectual property rights, ethics for publication and metrices for journal.				

Detailed Syllabus:

Module	Unit	Content	Hrs
		SCIENTIFIC COMMUNICATION AND ETHICS	**45**
I	**METHOD OF SCIENTIFIC COMMUNICATION**		**9**
	1	Need for science communication - Importance and use of science communication	1
	2	Public Understanding of Science (PUS) - Science popularization: programmes, organizations, individuals - Method of science - Scientific temper	3

	3	Sources of scientific information – books, scientific reports, scientific journals, magazines, feature syndicates, leaflets, tabloids, wall magazines, speeches, seminars, press releases, databases, encyclopaedias on science, etc	3
	4	Comparative study of science sections and supplements carried in Indian / foreign newspapers and science magazines.	2
II	**SCIENTIFIC DIGITAL DATA BASE**		**9**
	5	Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, Metrics: h-index, g-index, i10 index, altmetrics. E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers.	3
	6	Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-Databases, ChemSpider, Science Direct, SciFinder, Scopus.	3
	7	Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.	3
III	**INTELLECTUAL PROPERTY RIGHT**		**9**
	8	Concepts and Evolution: Introduction to Intellectual Property Rights,	1
	9	Evolution of Intellectual Property Laws. Standards and Concepts in Intellectual Property,	2
	10	Law of Intellectual Property and Ethical Issues, Knowledge Driven Economy and IPR	3
	11	Intellectual Property Rights in India and abroad. Law of Patents.	3
IV	**ETHICS IN PUBLICATIONS**		**9**
	12	Publication ethics: definition, introduction and importance,	2
	13	Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.	3
	14	Conflicts of interest, Copy right, royalty, Plagiarism, citation, acknowledgement, reproducibility and accountability.	4
V	**METHODS OF SCIENTIFIC RESEARCH AND WRITING SCIENTIFIC PAPERS:**		**9**

	15	Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.	3
	16	Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.	6

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1. **Jane Gregory and Steve Miller, *Science in Public: Communication, Culture, and Credibility, Plenum,* New York, 1998.**
2. **James G, Paradis and Muriel L. Zimmerman, *The MIT Guide to Science and Engineering Communication.* MIT Press, UK, 2002.**
3. **Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology,* RBSA Publishers Bird, A. (2006). Philosophy of Science. Routledge.**
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5. **P. Chaddah (2018) *Ethics in Competitive Research: Do not get scooped; do not get plagiarized,* ISBN: 978-9387480865.**
6. **Resnik, D.B. (2011). *What is ethics in research and why is it important.* National Institute of Environmental Health Science, 1-10.**
7. ***Practicing communication ethics.* Boston, MA: Allyn & Bacon.**
8. **Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry.* Oxford University Press.**
9. **Dawson, C. (2002). *Practical research methods.* UBS Publishers, New Delhi.**

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Discuss the scientific communication methods and sources of scientific information	U	2
CO-2	Analyse the different scientific databases	An	2, 3
CO- 3	Discuss the IPR, Laws and patent	U	5
CO- 4	Discuss the publication ethics and conflict of interest	U	3
CO- 5	Discuss the impact factor of journals, citation index and metrics	U	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: SCIENTIFIC COMMUNICATION AND ETHICS
Credits: 3:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Discuss the scientific communication methods and sources of scientific information	2	U	F	L	
2	Analyse the different scientific databases	2, 3	An	C	L	
3	Discuss the IPR, Laws and patent	5	U	F	L	
4	Discuss the publication ethics and conflict of interest	3	U	C	L	
5	Discuss the impact factor of journals, citation index and metrics	5	U	C, F	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

SEMESTER V

MAR IVANIOS COLLEGE (AUTONOMOUS)

Discipline	CHEMISTRY				
Course Code	**MIUK5DSCCHE300.1**				
Course Title	**INORGANIC CHEMISTRY III**				
Type of Course	**DSC A5-I**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Plus two 2. Basic idea in general chemistry				
Course Summary	This course deals with the electronic configuration, general characteristics, stability of oxidation states, and the formation of complexes by transition and inner transition elements, their color, magnetic, and catalytic properties, along with the preparation, properties, and uses of their specific compounds. Furthermore, the course covers coordination chemistry, organometallic and bioinorganic chemistry, metallurgy, and practical experiments in gravimetric analysis, providing students with a holistic understanding of the chemistry of transition and inner transition elements.				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I	**TRANSITION AND INNER TRANSITION ELEMENTS**		**9**

	1	Electronic Configuration and General Characteristics - Overview of transition elements and inner transition elements - Electronic configuration - General characteristics including oxidation states, ionization enthalpy, and enthalpy of atomization - Variation of ionization enthalpy across the 3d series - Introduction to standard electrode potentials (E^o M^{2+}/M & E^o M^{3+}/M^{2+}).	2
	2	Stability of Higher Oxidation States and Formation of Complexes - Factors affecting stability of higher oxidation states - Formation of complexes and ligand interactions - Importance of coordination chemistry in transition metal complexes	1
	3	Colour, Magnetic Property, and Catalytic Property - Explanation of colour in transition metal complexes (d-d transitions) - Magnetic properties including paramagnetism and diamagnetism - Catalytic properties and their industrial applications - Explanation of relativistic effects in heavier transition elements	2
	4	Preparation, Properties, and Uses of Specific Compounds - Detailed study of $K_2Cr_2O_7$, $KMnO_4$, and $TiCl_4$ - Preparation methods, physical and chemical properties - Industrial and laboratory uses of these compounds - Important applications of transition metals in various fields	2
	5	Electronic Configuration, General Properties, and Reactions of Lanthanides and Actinides - Introduction to lanthanides and actinides - Electronic configurations and general properties - Reactions and similarities with transition elements - Overview of unique properties, applications of lanthanides and actinides	2
	COORDINATION CHEMISTRY		**18**

II	6	Ligands and Their Classifications - Introduction to ligands in coordination chemistry - Classification of ligands based on donor atoms: monodentate, bidentate, polydentate - Classification based on charge: anionic, cationic, neutral - Discussion on coordination number and coordination geometry	1
	7	Nomenclature of Complexes - Guidelines for naming coordination compounds - Nomenclature of complexes with simple and complex ligands - Examples illustrating the naming process	1
	8	EAN Rule, Chelates, and Stability of Complexes - Explanation of the EAN (Effective Atomic Number) rule - Concept of chelation and chelating ligands - Factors affecting the stability of complexes: size and charge of metal ion, nature of ligands, and coordination number	2
	9	Isomerism in Complexes - Overview of structural isomerism and stereoisomerism in coordination compounds - Types of structural isomerism: linkage isomerism, coordination isomerism, and ionization isomerism - Types of stereoisomerism: geometrical isomerism and optical isomerism	2
	10	Bonding in Complexes - V.B. Theory - Introduction to Valence Bond Theory (V.B. Theory) for coordination compounds - Explanation of bonding between metal ion and ligands - Hybridization and overlap of atomic orbitals - Limitations and applications of V.B. Theory	2
	11	Crystal Field Theory (CFT) Applied to Various Complex Geometries - Overview of CFT	2

		- Application of CFT to octahedral, tetrahedral, and square pyramidal complexes - Explanation of splitting of d orbitals in the presence of ligands - Factors affecting crystal field splitting: nature of metal ion, ligand strength, and geometry of complex	
	12	Factors Affecting Crystal Field - Detailed discussion on factors influencing crystal field splitting energy - Ligand field stabilization energy (LFSE) - Effects of coordination number, ligand field strength, and nature of ligands on crystal field splitting - Applications of crystal field theory in predicting magnetic properties and colours of coordination compounds.	1
	13	Spectrochemical Series and Crystal Field Stabilization Energy (CFSE) - Introduction to the spectrochemical series - Explanation of ligands' ability to cause d-orbital splitting - Relationship between ligand strength and splitting energy - Calculation and significance of CFSE - Examples illustrating the spectrochemical series and CFSE values	1
	14	Magnetic Properties and Colour of Metal Complexes - Explanation of magnetic properties: paramagnetism, diamagnetism, and ferromagnetism - Factors influencing magnetic behaviour in metal complexes - Relationship between electronic configuration, CFSE, and magnetic properties - Relationship between ligand field strength, d-d transitions, and colour in metal complexes	1
	15	Effects of Crystal Field Splitting - Overview of crystal field splitting in octahedral complexes - Explanation of the effects of crystal field splitting on electronic configuration and stability - Relationship between ligand field strength and the magnitude of splitting - spectrochemical series	1

	16	Jahn-Teller Effect and Tetragonal Distortion - Introduction to the Jahn-Teller effect in transition metal complexes - Explanation of distortion in coordination geometries caused by Jahn-Teller effect - Focus on tetragonal distortion of octahedral complexes - Examples illustrating the Jahn-Teller effect in coordination chemistry	1
	17	Application of Coordination Compounds in Metallurgy and Analysis - Overview of the role of coordination compounds in metallurgical processes - Application of coordination compounds in qualitative and quantitative analysis - Use of EDTA (Ethylenediaminetetraacetic acid) as a complexometric titrant - Examples of complexometric titrations and their significance in analytical chemistry	1
	18	Reactions of Metal Complexes - Labile and Inert Complexes - Explanation of labile and inert metal complexes - Ligand substitution reactions: S_N1 and S_N2 mechanisms - Factors influencing the rate of ligand substitution reactions - Examples illustrating labile and inert complexes and their reactions - Ligand substitution reactions and their applications - Review of key concepts including spectrochemical series, CFSE, magnetic properties, crystal field splitting, Jahn-Teller effect, and application in metallurgy and analysis - Summary of the importance of coordination compounds in various fields.	2
	ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY		**9**
	19	Definition and Nomenclature of Organometallic Compounds - Introduction to organometallic compounds - Definition and significance in chemistry - Nomenclature guidelines for organometallic compounds.	1
	20	Classification and 18-Electron Rule - Classification of organometallic complexes as sigma, pi, and mixed complexes	1

III		- Explanation of the 18-electron rule in organometallic chemistry - Examples illustrating the application of the 18-electron rule	
	21	Metal Carbonyls - Overview of metal carbonyls - Classification into mononuclear and polynuclear complexes - Detailed study of metal carbonyls with examples using Fe, Co, and Ni - Preparation methods and key properties of metal carbonyls	1
	22	Bonding in Organometallic Compounds - Explanation of bonding in organometallic compounds without using Molecular Orbital Theory (MOT) - Detailed analysis of bonding in specific compounds like ferrocene, dibenzene chromium, and Ziese's salt - Introduction to dinitrogen complexes and their bonding characteristics	2
	23	Applications of Organometallic Compounds - Overview of the diverse applications of organometallic compounds - Industrial applications in catalysis, synthesis, and materials science - Environmental and pharmaceutical applications	2
	24	Bioinorganic Chemistry - Introduction to bioinorganic chemistry and the role of metal ions in biological systems - Detailed study of the biochemistry of iron in hemoglobin and myoglobin - Elementary understanding of the structure and mechanism of action of hemoglobin and myoglobin	2
	METALLURGY		**9**
	25	Methods of Concentration of Ore - Overview of ore concentration techniques - Gravity separation: principles and applications - Froth flotation: process and its significance in mineral processing - Magnetic separation: principles and applications in separating magnetic ores	1

IV		- Leaching: introduction to different leaching methods such as acid leaching and cyanide leaching - Electrostatic separation: principles and applications in separating non-conductive minerals - Automated ore sorting: modern techniques for ore sorting based on optical properties or sensors - Dewatering: methods to remove water from concentrated ore slurry	
	26	Preliminary Processes - Calcination and Roasting - Definition and importance of calcination and roasting in metallurgy - Explanation of calcination and roasting processes - Differences between calcination and roasting - Examples illustrating the application of calcination and roasting in ore treatment	1
	27	Methods of Extracting Metal from Concentrated Ore - Overview of electrometallurgy as a method for extracting metals from ores - Metallurgy of Aluminium: Bayer's process, Hall-Héroult process - Sodium-pyrometallurgy: extraction of sodium by Downs process - Pyrometallurgy: principles and applications in extracting metals from ores using heat - Discussion on specific examples of pyrometallurgical processes	2
	28	Metallurgy of Iron and Zinc - Detailed study of the metallurgy of iron, including blast furnace process and refining methods - Metallurgy of zinc: overview of the extraction process from zinc blende (sphalerite)	1
	29	Aluminothermy, Auto-reduction, and Hydrometallurgy - Explanation of aluminothermy and its applications in extracting metals - Auto-reduction: self-reduction processes in metallurgy - Hydrometallurgy: principles and applications of extracting metals using aqueous solutions.	1

	30	Metallurgy of Silver and Gold - Overview of the metallurgy of silver and gold -Methods of extraction including cyanidation, amalgamation, and smelting - Importance of purification steps in obtaining high-purity silver and gold	1
	31	Purification of Crude Metal - Explanation of purification techniques such as distillation, liquation, and zone refining - Electrorefining: principles and applications in refining metals like copper - Chromatographic techniques: separation methods based on differential migration - Introduction to vapor phase refining processes like Mond's process and Van Arkel process	2
V	**PRACTICALS: GRAVIMETRIC ANALYSIS**		**30**
		A minimum of 5 practical experiments from any sections must be performed and reported.	
	32	**A. Estimations using silica crucible**	
		Estimation of water of crystallization in hydrated Barium chloride	
		Estimation of Barium as Barium sulphate	
		Estimation of sulphate as Barium sulphate	
		Estimation Iron as Fe_2O_3	
		Estimation Calcium as $CaCO_3$	
		Estimation Aluminium as Al_2O_3	
		Estimation Magnesium as $Mg_2P_2O_7$	
	33	**B. Estimations using sintered crucible**	
		Magnesium as oxinate	
		Nickel as nickel dimethyl glyoximate	
		Copper as copper thiocyanate	
		Silver as silver chloride	

	34	**C. Colorimetry**	
		Determination of Fe^{3+} using thiocyanate	
		Determination of ammonia using Nessler's reagent.	

References:

24. B.R. Puri L.R. Sharma, K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
25. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd., 2008.
26. R. Gopalan, V.Ramalingam, *Concise Coordination Chemistry*, 1st Edn.,Vikas Publishing House, New Delhi, 2001.
27. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, *Advanced Inorganic Chemistry*, 5th Edn., Vol. I, S Chand, 2012.
28. G. S. Manku, *Theoretical Principles of Inorganic Chemistry*. McGraw-Hill Education; New edition (1 August 1982)
29. M.C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
30. J. E. Huheey, E.A. Keitler, R. L. Keitler, *Inorganic Chemistry-Principles of Structure and Reactivity*, 4th Edn., Pearson Education, New Delhi,2013.
31. B.K. Sharma, *Industrial chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
32. M.N. Greenwood, A. Earnshaw, *Chemistry of elements*, 2nd Edn., Butterworth,1997.
33. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
34. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

7. James E. House, Inorganic Chemistry, academic press, 2008.
8. W.U. Malik, G.D.Tuli, R.D. Madan, selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 2010.
9. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley India Pvt. Ltd., New Delhi,2009.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the electronic configuration, general properties, and reactions of lanthanides and actinides, including their unique properties and applications	R, U	1,2
CO-2	Understand the principles and theories in coordination chemistry, including ligand classification, nomenclature of	R, U	1,2

	complexes, and factors influencing the stability of complexes.		
CO-3	Gain proficiency in applying various theoretical models to analyze and predict the properties of coordination compounds, including their magnetic behaviour, colour, and stability.	Ap	1,3
CO-4	Gain insights into the applications of organometallic compounds in various fields such as catalysis, materials science, and bioinorganic chemistry.	Ap, U	1,3
CO-5	Gain insight into the metallurgy of specific metals, enabling to comprehend the practical aspects of metallurgical processes and their applications in industry.	E, Ap	4,5
CO-6	Develop skills in quantitative analysis, data interpretation, and laboratory techniques, enabling them to apply these methods effectively in practical scenarios and contribute to advancements in analytical chemistry.	C, Ap	1,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: INORGANIC CHEMISTRY III

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the electronic configuration, general properties, and reactions of lanthanides and actinides, including their unique properties and applications	1,2	R, U	F, C	L	
CO-2	Understand the principles and theories in coordination chemistry, including ligand classification,	1,2	R, U	C	L	

	nomenclature of complexes, and factors influencing the stability of complexes.					
CO-3	Gain proficiency in applying various theoretical models to analyze and predict the properties of coordination compounds, including their magnetic behaviour, colour, and stability.	1,3	Ap	C, P	L, T	
CO-4	Gain insights into the applications of organometallic compounds in various fields such as catalysis, materials science, and bioinorganic chemistry.	1,3	Ap, U	C	L, T	
CO-5	Gain insight into the metallurgy of specific metals, enabling to comprehend the practical aspects of metallurgical processes and their applications in industry.	4,5	E, Ap	C	L, T	
CO-6	Develop skills in quantitative analysis, data interpretation, and laboratory techniques, enabling them to apply these methods effectively in practical scenarios and contribute to	1,3,4	C, Ap	C, M		P

	advancements in analytical chemistry.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK5DSCCHE301.1**				
Course Title	**ORGANIC CHEMISTRY III**				
Type of Course	**DSC A5-II**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Plus Two 2. Basic idea about stereochemistry, reaction mechanism				
Course Summary	The Course deals with preparation, properties and uses of different alcohols, carbonyl compounds, carboxylic acids, sulphonic acid and its derivatives. The course also covers topics on different organic nitrogen compounds- its classification, preparation, reactions and its separation. Classification, reactions and properties of carbohydrates, organometallics compounds and properties of different active methylene compounds are also discussed in the course.				

Detailed Syllabus:

Module	Unit	Content	60 Hrs
I		**Aldehydes and Ketones**	**12**
	1	Preparation: Oxidation of primary and secondary alcohols using PCC, reduction of esters using DIBAL-H, Rosenmund reduction, Gattermann-Koch formylation and Friedel-Craft's acylation Chemical properties: Nucleophilic addition (HCN, $NaHSO_3$, RMgX and ROH)	3

	2	Addition-elimination reaction (with ammonia and ammonia derivatives). Addition reactions of unsaturated carbonyl compounds: Michael addition. Reduction using Metal hydrides (mechanism expected), MPV reduction, Clemmenson and Wolff-Kishner reduction	3
	3	Oxidation: with KMnO4, Tollen's reagent, Fehling solution, Br2 water, Oppenaur oxidation, Baeyer-Villiger oxidation	2
	4	Acidity of α-hydrogen: Aldol, Claisen-Schmidt, Benzoin, Perkin and Knovenagel condensations (mechanism not expected).	2
	5	Haloform reaction – Iodoform test – Cannizaro reaction (mechanism not expected) and Beckmann rearrangement (mechanism not expected).	2
II		**Carboxylic acids, Sulphonic acid and their Derivatives**	**12**
	6	Preparation: Hydrolysis of nitrile, carboxylation of Grignard reagent and oxidation of alkyl benzenes.	3
	7	Chemical properties: HVZ reaction, Decarboxylation – Kolbe electrolysis (Mechanism expected), Curtis reaction. Ascent and descent series in aliphatic carboxylic acids	3
	8	Preparation, properties and uses of anthranilic acid, cinnamic acid, citric acid, lactic acid, oxalic acid, adipic acid and phthalic acid.	2
	9	Formation of acid derivatives – acid chlorides, amides, acid anhydrides and esters – comparison of reactivity of acid derivatives. Preparation of coumarin – Fries rearrangement (Mechanism expected)	2
	10	Preparation and reactions of benzene sulphonic acid, toluene sulphonic acid and benzene sulphonyl chloride – Importance of tosyl group – synthesis and application of saccharin.	2
III		**Organic Nitrogen compounds**	**12**
	11	Nitrocompounds: Nitro-acitautomerism, Nef's reaction. Reduction of nitrobenzene in various media. Preparation of nitro toluenes, nitro compounds as explosives.	2
	12	Amines: Classification – Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides – Hoffmann's bromamide reaction, Schmidt reaction, Gabriel phthalimide synthesis.	2
	13	Chemical properties: Carbyl amine reaction, conversion of amines to alkene (Hoffmann elimination with mechanism), acylation, reaction with nitrous acid and Mannich reaction.	2

	14	Electrophilic substitution reactions of aniline: halogenation, sulphonation and nitration by amino protection (acetylation). Benzidine rearrangement (mechanism expected).	2
	15	Separation of mixture of amines – methods to distinguish primary, secondary and tertiary amines. Distinction between aliphatic and aromatic amines.	2
	16	Preparation and synthetic applications of diazonium chloride and diazomethane	2
IV		**Carbohydrates**	**12**
	17	Classification and nomenclature of monosaccharides, configuration of monosaccharides.	3
	18	Reactions of glucose and fructose – Determination of open chain structure of D-glucose and D-fructose.	3
	19	Anomers and mutarotation in glucose - cyclic structure – pyranose and furanose forms – Haworth projection formula – chair conformations. Epimers and epimerization – Interconversion of aldoses and ketoses – chain lengthening and shortening of aldoses.	3
	20	Disaccharides – reactions and structure of sucrose -Polysaccharides – Structure of starch and cellulose (structural elucidation not required) – Industrial applications of cellulose-Paper Industry, Textile Industry, Rayon.	3
V		**Organometallics and Active Methylene compounds**	**12**
	21	Organomagnesium compounds: Grignard reagent: Preparation – Reaction with compounds containing acidic hydrogen, carbonyl compounds, cyanides and CO2.	3
	22	Organo lithium compounds: Preparation – Reaction with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO2.	3
	23	Organo zinc compounds: Preparation of dialkyl zinc – Reaction with active hydrogen compounds, acid halides and alkyl halides, Reformatsky reaction (mechanism expected)	2
	24	Li dialkylcuprates – Preparation and reaction with aliphatic/aromatic/vinyl halides.	2

	25	Active methylene compounds – examples. Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected), tautomerism, Synthetic applications of acetoacetic ester.	2

References

For Theory

Text books

1. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, S.Chand& Company, New Delhi.

2. L.G.Wade Jr, Organic Chemistry, Pearson Education, New Delhi.

3. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, Vikas Publishing House (Pvt) Ltd., New Delhi..

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7. Helena Dodzuik, Introduction to supramolecular chemistry, Springer.

For further reading:

1. L.M. Lehn, Supramolecular Chemistry, VCH.

2. M.M.Sreevastava and Rashmi Sanghi, Green Chemistry for environment, Narosa Publishing House.

3. R.T.Morrison, R.N.Boyd. Organic Chemistry, Pearson Education, New Delhi.

4. P.Y.Bruice, Essential Organic Chemisty, Pearson Education, New Delhi.

5. G.M. Louden, Organic Chemistry, Oxford University Press, New York.

6. V.K.Ahluwaliya, Organic Reaction Mechanisms, Narosa Publishing House, New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the preparation and reactions of carbonyl compounds, carboxylic acids, sulphonic acids, amino and nitro compounds, carbohydrates	R, A, U	1,2
CO-2	Plan synthesis of derivatives of carbonyl compounds, carboxylic acids and sulphonic acids	A	1
CO-3	Distinguish primary, secondary & tertiary amines.	U	3
CO-4	Write reaction steps in ascending & descending of interconversion of aldose and ketose, chain lengthening and shortening of aldoses.	Ap	4
CO-5	Explain the structure of glucose, fructose, sucrose, starch and cellulose.	A	1,3
CO-6	Describe the preparation and reactions of organo Mg, Li, Zn and Cu compounds	U, Ap	1
CO-7	Classify reaction mechanism with suitable examples	A	1,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ORGANIC CHEMISTRY III

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Describe the preparation and reactions of carbonyl compounds, carboxylic acids, sulphonic acids, amino and nitro	1,2	R, A, U	F	L	

	compounds, carbohydrates					
2	Plan synthesis of derivatives of carbonyl compounds, carboxylic acids and sulphonic acids	1	A	P	L	
3	Distinguish primary, secondary & tertiary amines.	3	U	C	L	
4	Distinguish primary, secondary & tertiary amines.	4	Ap	C	L	
5	Explain the structure of glucose, fructose, sucrose, starch and cellulose.	1,3	A	M	L	
6	Describe the preparation and reactions of organo Mg, Li, Zn and Cu compounds	1	U, Ap	C, P	L	
7	Classify reaction mechanism with suitable examples	1,5	A	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	1	1	1	1	2	2	1	1	1	1
CO 2	2	1	1	1	1	2	2	1	2	1	1	2
CO 3	1	1	2	1	1	1	1	3	1	1	1	1
CO 4	1	1	1	3	1	2	1	1	3	1	3	1
CO 5	3	1	2	1	1	1	1	3	1	1	1	1
CO 6	3	1	1	1	1	1	2	1	1	1	2	1
CO 7	2	1	1	1	3	1	2	1	1	3	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK5DSCCHE302.1**				
Course Title	**PHYSICAL CHEMISTRY II**				
Type of Course	**DSC A5-III**				
Semester	5				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Essential conditions for understanding quantum mechanics, spectroscopy, statistical thermodynamics, group theory, non-spectroscopic methods, and instrumental methods of analysis include a strong grasp of fundamental principles such as wave-particle duality, electromagnetic radiation interactions, statistical ensembles, symmetry operations, and analytical techniques. 2. Proficiency in mathematical techniques including algebra and calculus, experimental methodologies, data interpretation, and their applications in various scientific disciplines is crucial for mastering these subjects.				
Course Summary	This course provides a comprehensive understanding of Quantum Mechanics, delving into wave-particle duality, Schrödinger's equation, and energy quantization. Spectroscopy techniques,				

	including rotational spectroscopy, vibrational spectroscopy, electronic spectroscopy, Raman, NMR and ESR, are explored for molecular analysis and structural elucidation. Additionally, students study Statistical Thermodynamics and Group Theory for molecular symmetry analysis. The Instrumental Methods of Analysis provides an in-depth understanding of modern analytical techniques and their applications.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**QUANTUM MECHANICS**		**12**
	1	Quantum mechanical operators, Postulates of quantum mechanics, Schrödinger equation and its application to particle in one-dimensional box (complete solution) - quantization of energy levels, zero-point energy, normalization of wave functions, probability distribution functions, nodal properties.	4
	2	Extension to three-dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.	4
	3	Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule: Schrödinger equation, transformation to spherical polar coordinates. Separation of variables (Preliminary treatment).	4
II	**SPECTROSCOPY I**		**12**
	4	Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.	4
	5	Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic	4

		molecules, modes of vibration. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches	
	6	Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	4
III	**SPECTROSCOPY II**		**12**
	7	Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.	3
	8	NMR spectroscopy: Principle of NMR, nuclear spin. HNMR, Interaction of nuclear spin with external magnet. Energy level splitting, Precession.	2
	9	Chemical shift. Delta and tau scales. Presentation of NMR spectra, Low resolution spectra and high-resolution spectra, -Spin-spin coupling	2
	10	Electron spin resonance spectroscopy: Principle, Types of substances with unpaired electrons, interaction of electron magnet with external magnet.	2
	11	Energy level splitting. Lande splitting factor, presentation of ESR spectrum, the normal and derivative spectra. Hyperfine splitting. Simple examples of methyl and benzene radicals	3
IV	**STATISTICAL THERMODYNAMICS & GROUP THEORY**		**12**
	12	Statistical thermodynamics: introduction, types of statistics-MB, BE and FD. Fermions and bosons, Phase space, system, assembly and ensemble-types of ensembles and uses. Thermodynamic probability, Boltzmann distribution law and Partition function (no derivation).	3
	13	Thermodynamic functions in terms of partition functions -internal energy, enthalpy, pressure, work function and free energy function	2
	14	Symmetry element and operation, definition of mathematical group, sub group, Point group. Identification of symmetry elements and point groups for different molecules. H_2O, NH_3, BF_3, C_2H_2, C_6H_6, CH_4, SF_6.	5
	15	Construction of Group multiplication table of C_2V. The great orthogonality theorem (without proof) and its importance.	2

V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions on real life applications, assignment discussions, Quizzes, Open book exams, etc.**	**12**

References:

1. Ira N. Levine, *Quantum Chemistry*, Delhi: PHI Learning, 2014.
2. R L Madan, *Quantum Mechanics and Analytical Techniques*, NEP 2020 Uttar Pradesh Latest Edition 2023 By S. Chand's.
3. *A Text book of Quantum Mechanics*, PM Mathews & K Venkatesan, 2nded, Tata McGraw Hill, (2011).
4. *Introduction to Quantum Mechanics*, David Griffiths, 2nded., Pearson, (2015).
5. C.N. Banwell, *Fundamentals of Molecular Spectroscopy*, Tata McGraw-Hill Education.
6. Manas Chanda, "*Atomic structure and Chemical bonding in Molecular Spectroscopy*", Tata McGraw Hill.
7. A. Salahuddin Kunju and G. Krishnan, *Group Theory and its Applications in Chemistry*, PHI Learning Pvt. Ltd.
8. B. R Puri, L. R Sharma,M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Company.
9. Ramakrishnan and M S Gopinathan, *Group Theory in Chemistry*, Vishal Publishing Co.
10. J. E. Huheey,E. A. Keiter, R. L. Keiter, O. K. Medhi. *Inorganic Chemistry*, 4th Edn. Pearson, 2006.
11. D. A. Skoog, F. James Holler. S.R. Crouch. *Principles of Instrumental analysis*, 6th Edn., Cengage Learning, Noida, 2004.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles of quantum mechanics and apply them to explain the behaviour of particles at the atomic and molecular levels.	U, A	1
CO-2	Apply spectroscopic methods to investigate the electronic, vibrational, and rotational properties of molecules.	A	2, 5
CO-3	Interpret spectra to identify chemical compounds, determine molecular structures, and analyse chemical reactions.	U	5
CO-4	Apply statistical thermodynamics to predict thermodynamic properties of systems and understand chemical equilibria.	A	2

CO-5	Understand the mathematical principles of group theory and its applications in chemistry and apply it to predict molecular properties and interpret spectroscopic data.	U, A	2
CO-6	Apply instrumental methods to solve analytical problems in chemistry, biochemistry, environmental science, and related fields.	A	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL CHEMISTRY II

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the fundamental principles of quantum mechanics, and apply to explain the behaviour of particles at the atomic and molecular levels.	1	U, A	F, C	L	
CO-2	Apply spectroscopic methods to investigate the electronic, vibrational, and rotational properties of molecules.	2, 5	A	C	L	
CO-3	Interpret spectra to identify chemical compounds, determine molecular structures, and analyse chemical reactions.	5	U	P, M	L, T	
CO-4	Apply statistical thermodynamics to predict thermodynamic	2	A	P	L, T	

	properties of systems and understand chemical equilibria.					
CO-5	Understand the mathematical principles of group theory and its applications in chemistry and apply to predict molecular properties and interpret spectroscopic data.	2	U, A	P	L	
CO-6	Apply instrumental methods to solve analytical problems in chemistry, biochemistry, environmental science, and related fields.	5	A	P	L, T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PS O1	PS O2	PS O3	PS O4	PS O5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	1	1	1	2	1	3	1	1	2	1
CO 2	1	3	1	1	3	1	3	2	1	2	1	2
CO 3	1	1	2	1	3	1	3	1	3	1	1	1
CO 4	1	3	1	1	1	1	1	2	2	1	2	2
CO 5	1	3	2	1	1	1	2	1	2	1	2	1
CO 6	1	1	1	1	3	1	2	2	2	1	1	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

<table>
<tr><td>Discipline</td><td colspan="5">CHEMISTRY</td></tr>
<tr><td>Course Code</td><td colspan="5">MIUK5DSECHE300.1</td></tr>
<tr><td>Course Title</td><td colspan="5">ENVIRONMENTAL CHEMISTRY III</td></tr>
<tr><td>Type of Course</td><td colspan="5">DSE 5.1</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Academic Level</td><td colspan="5">300 - 399</td></tr>
<tr><td rowspan="2">Course Details</td><td>Credit</td><td>Lecture per week</td><td>Tutorial per week</td><td>Practical per week</td><td>Total Hours/Week</td></tr>
<tr><td>4</td><td>4 hours</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Pre-requisites</td><td colspan="5">1. Fundamental concept of Atmospheric chemistry
2. Basic chemistry of reactions</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course gives information regarding composition of earth atmosphere and various factors causing air pollution. This course also highlights mechanism of ozone layer depletion and the strategies adopted for improving the quality of air. This course enlightens the students with the analytical methods adopted for the determination of air quality parameters and policy framework for ensuring the quality of air.</td></tr>
</table>

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction and Importance of Atmospheric Chemistry**	**9**
	1.1	Introduction to Atmospheric Chemistry	1
	1.2	Composition of atmosphere	2
	1.3	Particles ions and radicals in the atmosphere	2

	1.4	Chemicals and Photochemical reactions in the atmosphere	2
	1.5	Human activities, Meteorology and air pollution	2
II	**Air pollution – Causes, Effects, Consequences and Types**		**18**
	2.1	Introduction to air pollution - Major sources of air pollution: Natural and man-made sources Classification of air pollutants, Nature and fate of air pollutants	4
	2.2	Major air pollutants – Oxides of Carbon, Nitrogen & Sulphur; Metallic pollutants, Radiation, Particulates Sources, composition and formation, industrial pollutants and air pollution	4
	2.3	Effects of gaseous pollutants - Effects of oxides of Carbon, Nitrogen & Sulphur, Hydrocarbons, Particulates and aerosols	3
	2.4	The ozone layer - importance, causes of Ozone layer depletion and its consequences Green House Effect, Global Warming	4
	2.5	Smog, Acid rain, Asbestos dust, Fly ash	3
III	**Methods for Monitoring Air Pollution**		**9**
	3.1	Air quality standards and air quality management	1
	3.2	Monitoring of air pollutants - CO, NO_2, SO_2, H_2S, Ozone, Hydrocarbons and particulates	2
	3.3	Spectroscopic methods for measuring air pollution - UV, IR, FT-IR and Emission spectroscopy	2
	3.4	Instrumental methods for measuring air pollution - Atomic absorption spectroscopy (AAS), X-ray fluorescence	2
	3.5	Chromatographic techniques for measuring air pollution - Gas chromatography, Ion chromatography, GC-MS, HPLC	2

IV	**Control Measures, Policies and Case Studies**		**9**
	4.1	Global and regional problems caused by air pollution; Case studies: Bhopal Gas tragedy, Chernobyl incident	2
	4.2	Methods to control particulates - Gravitational settling chambers and wet collection	2
	4.3	Methods to control gaseous pollutants - adsorption and condensation	2
	4.4	Government policies and legislation in India to control air pollution	1
	4.5	Recent research and advancements in air pollution control, The role of an individual in the protection of atmosphere	2
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc**		**15**
	1	Introduction to the composition of atmosphere and reactions (both chemical and photochemical) taking place in atmosphere	
	2	Sources, Types, effects and consequence of air pollution	
	3	Analytical methods adopted for the monitoring of air pollutants	
	4	Environmental Disaster caused by air pollution	
	5	Policies and laws enforced for the control of air pollution	

References:

1. Balram Pani, *Text Book of Environmental Chemistry*, I.K International Publishing House Pvt Ltd
2. A.K De, *Environmental Chemistry,* Seventh Edition, New Age International Publishers
3. Gray W. van Loon & Stephen J. Duffy, *Environmental Chemistry: A Global Perspective*, Oxford University Press

4. H. Kaur, *Environmental Chemistry*, Pragati Prakashan
5. V.K Ahluwalia, *Environmental Chemistry*, Second Edition, Ane Books Pvt. Ltd.
6. Ronald A. Bailey, Herbert M. Clark, James P. Ferris, Sonja Krause, Robert L. Strong, *Chemistry of the Environment*, Second Edition, Academic Press
7. Asim K. Das, *Environmental Chemistry with Green Chemistry*, Books and Allied (P) Ltd.
8. G S Sodhi, *Fundamentals Environmental Chemistry*, Second Edition, Narosa Publishing House

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Help to understand composition of Earth's atmosphere, including the major gases and aerosols present and the chemical reactions that occur in the atmosphere, including gas-phase reactions, photochemical reactions, and heterogeneous reactions on aerosol	U	1,2
CO-2	Enable the students to understand the sources, transport, and health effects of air pollutants, including pollutants like nitrogen oxides, sulfur dioxide, and particulate matter, as well as greenhouse gases and ozone-depleting substances	U	1,2
CO-3	Understand the principles regarding air quality management and be familiarized with strategies for reducing emissions of air pollutants and improving air quality	U,A	1,2
CO-4	Explore the analytical techniques for measuring and monitoring air pollutants	A	1,2
CO-5	Exploring the environmental laws and policy frameworks for protecting the air quality and case studies of disaster relating to air pollution	U	1,2
CO-6	Enable the students to understand the methods to control gaseous pollutants and particulates	U	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL CHEMISTRY III

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Help to understand composition of Earth's atmosphere, including the major gases and aerosols present and the chemical reactions that occur in the atmosphere, including gas-phase reactions, photochemical reactions, and heterogeneous reactions on aerosol	2,2	U	C	L	
CO-2	Enable the students to understand the sources, transport, and health effects of air pollutants, including pollutants like nitrogen oxides, sulfur dioxide, and particulate matter, as well as greenhouse gases and ozone-depleting substances.	2,2	U	F,C	L	
CO-3	Understand the principles regarding air quality management and be	2,2	U,A	C	L	

	familiarized with strategies for reducing emissions of air pollutants and improving air quality.					
CO-4	Explore the analytical techniques for measuring and monitoring air pollutants	2,2	A	F,C	L	
CO-5	Exploring the environmental laws and policy frameworks for protecting the air quality and case studies of disaster relating to air pollution	2,2	U	F,C	L	
CO-6	Enable the students to understand the methods to control gaseous pollutants and particulates	1,2, 2	U	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	1	3	1	3	1	1	1	2	1	1	1	1
CO 2	1	3	1	1	2	1	1	3	1	1	1	1
CO 3	1	3	1	2	1	1	1	2	1	1	1	1
CO 4	1	3	1	1	2	1	1	3	1	1	1	2

CO 5	1	2	1	2	1	1	1	3	1	1	2	3
CO 6	1	3	1	3	1	1	1	2	1	1	1	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK5DSECHE301.1**				
Course Title	**ENVIRONMENTAL CHEMISTRY IV**				
Type of Course	DSE 5.2				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	**5**
Pre-requisites	1. Basic Knowledge in soil chemistry 1. Fundamentals of analytical chemistry				
Course Summary	This course introduces the soil chemistry and environmental impact of soil chemistry. This course also gives information about the soil remediation techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Introduction and Importance of Soil Chemistry**	**9**
	1.1	Introduction to soil Chemistry – Soil formation, texture and soil profile	1
	1.2	Physical, Chemical and biological properties of soil	2
	1.3	Chemical process in soil – ion exchange reactions and soil pH; Redox reactions and nutrient cycling	2

	1.4	Soil colloids: Classification, Properties - charge, stability, zeta potential, flocculation and peptization; sorption properties of soil colloids	2
	1.5	Soil organic matter - fractionation of soil organic matter and different fractions	2
II	**Soil Pollution – Causes, Types, Effects and consequences**		**18**
	2.1	Introduction to soil pollution - Major sources of soil pollution: Natural and man-made sources	3
	2.2	Type of soil pollutants - Organic and inorganic contaminants, solid waste, nuclear waste, industrial pollutants, pollutants from agriculture, Mining and Municipal wastes	5
	2.3	Heavy metal pollution in soils, Chemistry of salt - affected soils	2
	2.4	Health hazards, Yield and quality depreciation in agricultural products, Desertification, Pollution of water and air resources due to soil pollution, emission of greenhouse gases and climate change	5
	2.5	Population displacement, Species extinction, Economic Impacts	3
III	**Analytical Methods for Monitoring Soil Quality**		**9**
	3.1	Soil sampling methods - Grid sampling and Zone sampling	3
	3.2	Determination of soil fertility and productivity	2
	3.3	Determination of pH, N, P, K and soil salinity	2
	3.4	Determination of moisture content, conductivity and organic carbon of soil	1
	3.5	Mechanical analysis of soil - methods of soil particle size analysis	1
IV	**Control Measures, Policies and Case Studies**		**9**
	4.1	Need to control soil pollution; Methods to prevent soil pollution - Biofertilizers, natural pesticides, Ecological farming	2

	4.2	Bioremediation of contaminated soil - mycoremediation and phytoremediation, use of biodegradable polymers	2
	4.3	Soil erosion - Forms, effects and factors affecting soil erosion; Conservation of soil	2
	4.4	Government policies and legislation in India to control soil pollution	1
	4.5	Case studies; Role of an individual in the conservation of soil	2
V	**Soil analysis Practicals II**		**30**
	1	Determination of Soil pH by pH meter - Minimum 5 Samples	
	2	Determination of Bulk density and moisture content by physical method - Minimum 5 Samples	
	3	Determination of organic matter and organic carbon content in soil by Titrimetric method - Minimum 5 samples	
	4	Determination of electrical conductivity of soil by conductivity method - Minimum 5 samples	
	5	Determination of specific gravity of soil samples - minimum 5 samples	

References:

1. I. Mirsal., Soil Pollution: Origin, Monitoring and Remediation, 2nd Edn,2008, Springer
2. T. Biswas, S. Mukherjee., Text Book of Soil Science, 2nd Edn, 2017, Mc Graw Hills Edn.
3. P.K. Behera., Soil and Solid Waste Analysis: A Laboratory Manual, 2012, Dominant Publishers
4. P.R. Hesse, A Text Book of Soil Chemical Analysis, 2013, S.R Health Science Pvt. Ltd. New Delhi
5. A.K De, *Environmental Chemistry,* Seventh Edition, New Age International Publishers

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles of soil chemistry, including soil composition, soil properties, mineralogy, and the role of organic matter	U	2,4
CO-2	Enable the students to understand laboratory techniques used for soil chemical analysis, such as pH measurement, nutrient extraction, and the influence of soil chemistry on crop productivity	U,A	2,4
CO-3	Explore the environmental impact of soil chemistry, including nutrient runoff, soil pollution, and the effects of soil management practices on water quality and ecosystem health.	A	2,4
CO-4	Provide an insight into soil remediation techniques for contaminated soils, including mycoremediation, phytoremediation, and soil erosion	U	2,4
CO-5	Provide information regarding the policy framework for soil conservation and case studies regarding disaster caused by soil pollution	U	2,4
CO-6	Acquire practical knowledge and hands-on experience in analytical techniques commonly used in soil analysis, such as pH measurement, soil texture analysis, nutrient analysis (e.g., nitrogen, phosphorus, potassium), soil organic matter determination by pH meters, spectrophotometers, atomic absorption spectrophotometers, flame photometers, and other specialized equipment.	A	2,4,5

R-Remember, U-Understand Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL CHEMISTRY IV

Credits: 3:0:1(Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the fundamental principles of soil chemistry, including soil composition, soil properties, mineralogy, and the role of organic matter	3,2	U	C	L	
CO-2	Enable the students to understand laboratory techniques used for soil chemical analysis, such as pH measurement, nutrient extraction, and the influence of soil chemistry on crop productivity.	3,4	U,A	F,C	L	
CO-3	Explore the environmental impact of soil chemistry, including nutrient runoff, soil pollution, and the effects of soil management practices on water quality and ecosystem health.	3,4	A	C	L	
CO-4	Provide an insight into soil remediation techniques for contaminated soils, including mycoremediation,	3,2,4	U	F,C	L	

	phytoremediation, and soil erosion					
CO-5	Provide information regarding the policy framework for soil conservation and case studies regarding disaster caused by soil pollution	3,3,4	U	F,C	L	
CO-6	Acquire practical knowledge and hands-on experience in analytical techniques commonly used in soil analysis, such as pH measurement, soil texture analysis, nutrient analysis (e.g., nitrogen, phosphorus, potassium), soil organic matter determination by pH meters, spectrophotometers, atomic absorption spectrophotometers, flame photometers, and other specialized equipment.	3,2,3,4	A	P		P

F-Factual, C-Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	3	1	1	1	1	1	1	1	1	1	1
CO 2	1	3	1	2	1	1	1	3	1	1	1	1
CO 3	1	3	2	1	1	1	1	3	1	1	1	1

CO 4	1	1	1	1	1	1	1	1	1	1	1	1
CO 5	1	2	1	1	1	1	1	3	1	1	1	3
CO 6	1	3	1	3	1	1	1	3	1	1	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK5DSECHE302.1**				
Course Title	**ANALYTICAL CHEMISTRY III**				
Type of Course	**DSE 5.3**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/ Week
	4	4 hours	-	-	4
Pre-requisites	1. Foundational understanding of chemistry principles, including chemical bonding, molecular structure, and chemical reactions 2. 2. Prior knowledge of basic analytical chemistry principles, such as the interaction of analytes with different separation techniques				
Course Summary	This course provides students with an in-depth understanding of various analytical chemistry techniques, including spectroscopic methods, thermal analysis and chromatographic techniques.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Thermal Methods of Analysis**		**9**
	1.1	Thermal Methods of Analysis: Introduction, Thermogravimetric Analysis & Differential Thermal Analysis: Principle, Instrumentation, Sources of Error in TGA, Interpretation of TG	4

		Curve, Factors Affecting TG Curve, Applications of TGA & DTA	
	1.2	Differential Scanning Calorimetry (DSC): Principle, Instrumentation and Applications of DSC	2
	1.3	Thermomechanical Analysis (TMA) and Dynamic Mechanical Analysis (DMA), Principle and Applications of TMA, DMA	3
II	**Spectroscopic Methods of Analysis I**		**9**
	2.1	Overview of Spectroscopy: EMR and its Interaction with Matter	1
	2.2	Basic Components of Spectroscopic Instrumentation: Sources of Energy, Wavelength Selection, Sample cells, Detectors, Slit width, Instrumental wavelength (for visible, UV, IR, fluorescence)	2
	2.3	Spectroscopy Based on Absorption: Absorbance and Transmittance, Beer-Lambert's Law, Its limitations	1
	2.4	Ultraviolet-visible Spectrophotometry: Principle, Instrumentation, molecular structure (transitions, absorption by isolated, conjugated & aromatic chromophores) Applications	3
	2.5	Infrared Spectrophotometry: Principle, Instrumentation, Absorption by functional groups, applications, introduction to NIR spectroscopy	2
III	**Chromatographic Techniques I**		**9**
	3.1	General description of chromatography, Principles of Chromatographic separations, Classification of chromatography: Adsorption, Partition, Ion exchange and Size exclusion chromatography	2
	3.2	General Theory of Column Chromatography, Theory of Column Efficiency, Chromatographic Resolution, Capacity Factor, Column Selectivity, Column Efficiency, Optimizing Chromatographic Separations	4
	3.3	Gas Chromatography: GC columns - packed, capillary, Stationary phases - polar to nonpolar, GC detectors, introduction to GC-MS, Applications	3
	Chromatographic Techniques II		**18**

IV	4.1	Liquid Chromatography: High-Performance Liquid Chromatography, Stationary Phases in HPLC, Chiral Stationary Phases	3
	4.2	Equipment for HPLC, Detectors (Universal detectors, refractive index detectors, Viscosity and light scattering detectors, UV-Visible detectors), introduction to Open Tubular Liquid Chromatography (OTLC)	3
	4.3	Ion chromatography: Ion exchange separation of amino acids and PCR	3
	4.4	Thin-layer chromatography (TLC), Rf values, TLC stationary and mobile phases, TLC sample application, HPTLC: development, gradient elution, spot visualization, quantitative measurements	3
	4.5	Paper chromatography: principle, solvent systems, mechanism of paper chromatography, different development methods: ascending, descending, horizontal, circular spreading	3
	4.6	Electrophoresis: Electrophoresis, CZE, Slab gel and Capillary gel electrophoresis	2
	4.7	Introduction to Micellar electrokinetic chromatography (MEKC), Capillary electrochromatography	1
V	**Open Ended Module: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc.**		15
	1.	Provide a detailed interpretation of the TG curve of Calcium oxalate monohydrate, and discuss the factors influencing the curve.	
	2.	Write a report on the applications of near-infrared (NIR) spectroscopy in non-destructive testing in a specific industry of your choice	
	3.	Measure the absorption spectra of known compounds and calculate the concentration using Beer-Lambert's Law	
	4.	Discuss the principles of NIR absorption and its advantages in quality control and product analysis.	
	5.	Compare and contrast gas chromatography (GC) and liquid chromatography (LC) in terms of their applications and	

		advantages/disadvantages. Provide examples of real-world scenarios where each technique would be most suitable	
	6.	Design an experiment to separate and analyse specific biomolecules using capillary gel electrophoresis	
	7.	Explore recent advancements in thermal analysis methods and their applications in materials science, pharmaceuticals and environmental analysis	
	8.	Present case studies on the use of chromatographic techniques in forensic science, food safety, and drug discovery, highlighting novel approaches and challenges faced in real-world scenarios.	

References:

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Text Book of Practical Organic Analysis,* Longman, 5th edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry,* Saunders College Publishing, 7th edition, 1996.
3. J. R. Dyer, *Applications of Absorption Spectroscopy of Organic Compounds*, Prentice 2, Hall, 1974.
4. D. H. Williams and I. Fleming, *Spectroscopic methods in organic chemistry*, 6th Edition, Tata McGraw Hill, 2011.
5. D. L. Pavia, G. M. Lampman, G. S. Kriz and J. A. Vyvyan, *Introduction to Spectroscopy*, 4th Edition, Brooks Cole, 2008.
6. Y. R. Sharma, *Elementary Organic Spectroscopy*, S. Chand Publishing, 2010.
7. D. J. Holme and H. Perk, *Analytical Biochemistry*, 3rd edition, Prentice Hall, 1998.
8. B. K. Sharma, Analytical Chemistry, Krishna Prakashan Media (P) Ltd., 2nd Edition, 2006
9. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry –*, Wiley, 7th edition, 2013.
10. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis,* Saunders College Publishing, 5th edition, 1998.
11. Gurdeep R. Chatwal, Sham K. Anand, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cogniti veLevel	PSO addresse d
CO-1	Understanding of various thermal analysis techniques and their instrumentation	U,Ap	**1**

CO-2	Proficiency in UV-visible and Infrared Spectrophotometry, including quantitative and qualitative applications	Ap,E	**1,2**
CO-3	Proficiency in the theory of column chromatography and gas chromatography techniques including instrumentation and quantitative measurements	U,Ap	**1,2**
CO-4	Familiarity with thin-layer chromatography, Paper Chromatography and electrophoresis techniques & competency in liquid chromatography	U	**1,2**
CO-5	**Applies the knowledge obtained from the course torelevant situations**	**Ap**	**1,2**

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY III

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understanding of various thermal analysis techniques and their instrumentation	1,1,2	U,Ap	F	L	
CO-2	Proficiency in UV-Visible and Infrared Spectrophotometry, including quantitative andqualitative applications	1,2	Ap,E	C	L	
CO-3	Proficiency in the theory of column chromatography and gas chromatography techniques including instrumentation and quantitative measurements	1,1	U,Ap	C	L	

CO-4	Familiarity with thin-layer chromatography Paper chromatography and electrophoresis techniques & competency in liquid chromatography	1,2	U	C	L	
CO-5	Applies the knowledge obtained from the course to relevant situations	1,1,2	Ap	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	1	1	1	3	1	1	1	1	1	1
CO 2	3	1	1	1	1	3	1	1	1	1	1	1
CO 3	3	1	1	1	1	3	1	1	1	1	1	1
CO 4	3	1	1	1	1	3	1	1	1	1	1	1
CO 5	3	2	1	1	1	2	1	1	1	1	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK5DSECHE303.1**				
Course Title	**ANALYTICAL CHEMISTRY IV**				
Type of Course	**DSE 5.4**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3hours	-	2	5
Pre-requisites	1. Prior knowledge of basic analytical chemistry principles, such as the interaction of analytes with different separation methods 2. Prior knowledge of electrochemical cells, electrode potentials, and the Nernst equation is necessary 3. Understanding voltaic cells, anodes, cathodes and cell voltages				
Course Summary	In-depth understanding of various analytical Separation techniques and electrochemical methods used in Analytical chemistry.				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I	**Electrochemical Methods of Analysis**		**9**
	1.1	Classification of Electrochemical Methods, Potentiometers & Potentiometric methods of analysis, Potentiometric Measurements: Potentiometric Electrochemical Cells,	3

		Potential and Concentration-The Nernst Equation, Liquid junction potential	
	1.2	Reference Electrodes: SHE, Saturated Calomel Electrode, Potentiometric Titrations: Principle, Detection of Endpoints, Derivative methods of locating end points.	2
	1.3	pH Meter, Standard Buffers Reference for pH Measurements, Accuracy of pH Measurements, Working of pH meter.	2
	1.4	pH Measurements in Nonaqueous Solvents, Ion Selective electrodes: Glass membrane electrodes	2
II	**Analytical Separation I**		**9**
	2.1	Classification of separation techniques (based on size, mass/density, complex formation, change of state, partitioning between phases)	3
	2.2	Separation of analyte by filtration, dialysis, masking, recrystallisation, precipitation, electrodeposition and volatilization	3
	2.3	Separation of analyte by Distillation: Different distillation Techniques: Simple, fractional, Vacuum, Steam distillation	3
III	**Analytical Separation II**		**9**
	3.1	Supercritical Fluid Extraction: Properties of Supercritical Fluids, Instrumentation and operating variable	2
	3.2	Solvent Extraction: Factors favouring solvent extraction, Quantitative treatment of solvent extraction equilibria, Synergistic extraction, Batch Extraction, Craig's Technique of Liquid-liquid extraction	3
	3.3	Solid Phase Extraction, SPE Cartridges, SPE Pipette Tips, SPE Disks, and other sorbents for SPE	2
	3.4	Centrifugation: Principle, Categories (isopycnic, density gradient, ultrafiltration, phase separation and pelleting), Types of centrifuges, Applications	2
	Electro Analytical Methods & Kinetic Methods of Analysis		**18**

IV	4.1	Electro gravimetry: Theory, Terms used in Electro-gravimetric analysis, Completeness of deposition, Electrolytic separation of metals	4
	4.2	Conductometry: Introduction, Applications of Conductometric measurements, The basics of Conductometric titrations, Apparatus and Applications of Conductometric titrations	4
	4.3	Coulometry: Introduction, Coulometry at controlled potential, Apparatus, Separation of nickel and cobalt by Coulometric analysis at controlled potential, Introduction to Flowing stream Coulometry	4
	4.4	Methods Based on Chemical Kinetics: Classifying chemical Kinetic Methods, Representative Methods: Determination of Creatinine in Urine, Instrumentation	3
	4.5	Radiochemical Methods of Analysis: Theory & Practise, Quantitative Applications: Direct Analysis of Radioactive Analytes, Neutron Activation Analysis, Characterization Applications	3
V	**Analytical Chemistry Practicals II**		**30**
		Section A **(All experiments in section A are compulsory)**	
	A	Separation of components from various Mixtures and check the purity of the components using TLC (a) Separation of components from a mixture of (i) aniline and toluene. (ii) O-cresol /β-naphthol and cinnamic acid/benzoic acid (iii) Cinnamic acid and aniline (iv) Benzoic acid and toluene (b) Paper chromatographic Separation of a mixture of inks or sugars	
		Section B & Section C **(Any 5 experiments from B and C need to be done)**	
	B	(i) Separation of metal ions by Solvent extraction using TOPO/TPPO/ crown ethers as the chelating agent and analyze the extraction efficiency using UV-Vis spectroscopy	

		(ii) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography (iii) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin-layer chromatography (TLC) (iv) Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)	
	C	Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Mixture of strong acid and weak acid vs. strong base iv. Strong acid vs. weak base Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Potassium dichromate vs. Mohr's salt	

References:

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Vogel's Text Book of Practical Organic Analysis*, Longman, 5th edition, 1989.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
3. D. J. Holme and H. Perk, *Analytical Biochemistry,* 3rd edition, Prentice Hall, 1998.
4. B. K. Sharma, *Analytical Chemistry*, Krishna Prakashan Media (P) Ltd., 2nd Edition, 2006
5. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
6. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.
7. Gurdeep R. Chatwal, Sham K. Anand, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House.
8. H. W. Nürnberg, *Electroanalytical Chemistry*, Wiley-Interscience, 1974.
9. H. H. Willard, L.L. Jr., J.A.Dean, F.A. Jr. Settle, *Instrumental Methods of Analysis*, CBS Publishers & Distributors, 7th Edition, 1986.
10. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Text book of Quantitative Inorganic Analysis,* Longman, Fifth Edition, 1989.
11. Gurdeep Raj, *Advanced Practical Inorganic chemistry*; GOEL publishing House
12. D. V. Jahagirdar, *Experiments in Chemistry*, Himalaya Publishing House.
13. B. D Khosla, V. C.Garg, Gulati, *A. Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Mastery of potentiometric electrodes and redox titrations.	Ap, An	1,2
CO-2	Understanding the principles of separation efficiency and various separation techniques.	U, Ap	1,2
CO-3	Mastery of solvent extraction and solid-phase extraction techniques.	Ap, An	1,2
CO-4	Understand the theory of electro-gravimetric analysis, the application of conductimetry and coulometry as an analytical tool & attain knowledge about Kinetic Methods of Analysis	U	1,2
CO-5	Proficiency in performing Separation of components from mixtures, Conductometric and Potentiometric Experiments	Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY IV

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Mastery of potentiometric electrodes and redox titrations	1,2,2	Ap,An	F, C	L	
CO-2	Understanding the principles of separation efficiency and various separation techniques	1,2,2	U,Ap	C	L	
CO-3	Mastery of solvent extraction and solid-phase extraction techniques	1,2	Ap,An	C	L	
CO-4	Understand the theory of electro-gravimetric analysis, the application					

	of conductimetry and coulometry as an analytical tool & attain knowledge about Kinetic Methods of Analysis	1,2,2	U	F,C	L	
CO-5	Proficiency in performing Separation of components from mixtures, Conductometric and Potentiometric Experiments	1,2,2	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	1	1	1	3	1	1	1	1	1	1
CO 2	3	2	1	1	1	2	1	1	1	1	1	1
CO 3	3	2	1	1	1	2	1	1	1	1	1	1
CO 4	3	2	1	1	1	3	1	1	1	1	1	1
CO 5	3	2	1	1	1	3	1	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK5SECCHE300.1**				
Course Title	**PHYTOCHEMICAL TECHNIQUES**				
Type of Course	**SEC 2**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-		3
Pre-requisites	Basic knowledge about organic chemistry and elementary spectroscopy				
Course Summary	The phytochemical techniques course covers a broad range of topics including introduction on phytochemicals, different extraction techniques, chromatographic separation techniques and herbal medicine. The course also gives students idea about different spectroscopic techniques used in this field for the identification of organic compounds.				

Detailed Syllabus:

MODULE	COURSE DESCRIPTION	Hrs	CO No.
1	**Phytochemicals: Introduction and Extraction methods**	**9**	
1.1	Pharmaceutical and therapeutic potential of various medicinal plants and its phytochemicals, Role of phytochemicals for the development of natural drugs, aromatherapy	3	1
1.2	Classification of phytochemicals and their biosynthesis. Tests for phytochemical screening.	3	1

	Structure and functions of major plant metabolites, Essential oils		
1.3	Extraction techniques in Phytochemistry: Maceration, Percolation, Digestion, Infusion, Decoction, Reflux, Tincture, Soxhlet extraction, Steam distillation, Hydro distillation, Cold pressing, Enfleurage, Super critical fluid extraction	3	1, 2
2	**Chromatographic techniques**	**9**	
2.1	Introduction of chromatographic methods, Theory of Chromatography, Column Chromatographic techniques	3	3
2.2	Thin Layer Chromatography (TLC), Paper Chromatography, Preparative Thin Layer Chromatography	3	3
2.3	High Performance Thin Layer Chromatography (HPTLC), High Performance Liquid Chromatography (HPLC), Gas Liquid Chromatography (GLC), Supercritical Fluid Chromatography	3	3
3	**Spectral Techniques**	**9**	
3.1	Principle of UV–Visible spectroscopy, Calculation of λ_{max} of dienes and α,β-unsaturated ketones. IR spectroscopy – Functional group determination	3	4
3.2	NMR spectroscopy – principle of proton NMR, Chemical shift in ^{13}C NMR, 2D NMR techniques: DEPT, COSY, HMBC, HSQC and NOESY	4	4
3.3	Theory of Mass spectrometry, determination of molecular mass	2	4
4	**Advanced Chromatographic techniques**	**9**	
4.1	Preparative high performance liquid chromatography, Liquid Chromatography-Mass spectrometry (LC-MS), Liquid Chromatography-Nuclear Magnetic Resonance (LC-NMR)	3	3, 5
4.2	Gas chromatography Fourier Transform Infrared Spectroscopy, Gas Chromatography-Mass	3	3, 5

	spectrometry (GC-MS), Super Critical Fluid Chromatography (SFC)		
4.3	Hyphenated chromatographic and spectroscopic techniques – LC-UV-MS, LC-UV-NMR, LC-UV-ES-MS	3	3, 5
5	**Phytochemicals and Herbal medicine**	**9**	
5.1	Biological activity assays of phytochemicals: antioxidant, antimicrobial and anticancer assays, Toxicological studies	3	1, 6
5.2	Safety concerns of phytochemicals, Phytochemicals as sources of antimicrobial and chemotherapeutic agents	3	1, 6
5.3	Herbal formulations: Standardisation and Evaluation procedures, Safety and efficacy of herbal medicine, Formulation and Development of Herbal drugs	3	6

References:

1. Phytochemical Methods, 3rd Edn 1998. J. B. Harborne., Chapman and Hall, London.
2. Phytochemical Techniques, 2006. N. Raaman., New India Publishing Agency, New Delhi.
3. Organic Chemistry of Natural Products. Vol. I & II Gurdeep R. Chatwal, Himalaya Publishing House, Mumbai.
4. Natural Products from Plants. 2nd Edn. L. J. Cseke., A. Kirakosyan., P. B. Kaufman., S. L. Warber., J. A. Duke and H. L. Brielmann., CRC Press, Boca Raton.
5. Chemistry of Natural Products. S.V. Bhat., B.A. Nagasampagi and N. Sivakumar., 2nd Edn. Narosa Publishing House, New Delhi.
6. Herbal Drug Formulation and Standardisation, 2021. A. N. Sahu, D. Mehapatra, Om Publications, New Delhi.

Course Outcomes

CO No.	COURSE OUTCOMES *Upon completion of this course, the students*	Cognitive Level	PSO addressed
1	Explore the basic idea of phytochemistry and its importance	**U**	**3**
2	Familiarize various extraction and isolation techniques of phytochemicals	**U, A**	**2, 3**
3	Understand the principles of chromatographic separation used in the field of phytochemistry	**U, A**	**2, 3**
4	Discuss different spectroscopic methods used for phytochemical analysis	**U, A**	**3**
5	Acquire good knowledge of advanced chromatographic techniques applied in phytochemistry	**U, A**	**5**
6	Familiarize with herbal medicines and its formulations	**A**	**5**

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Advanced Phytochemical techniques
Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Explore the basic idea of phytochemistry and its importance	U	3	F, C	L	
CO-2	Familiarize various extraction and isolation techniques of phytochemicals	U, A	2, 3	F, C	L	
CO-3	Understand the principles of chromatographic separation used in the field of phytochemistry	U, A	2, 3	F, C	L	

CO-4	Discuss different spectroscopic methods used for phytochemical analysis	U, A	3	F, C	L	
CO-5	Acquire good knowledge of advanced chromatographic techniques applied in phytochemistry	U, A	5	F	L	
CO-6	Familiarize with herbal medicines and its formulations	A	5	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO 7
CO 1	-	-	1	-	-	1	1	1	1	1	1	1
CO 2	-	2	2	-	-	2	1	1	1	1	2	1
CO 3	-	3	2	-	-	2	1	1	1	1	1	1
CO 4	-	-	2	-	-	2	2	1	1	1	1	1
CO 5	-	-	-	-	2	1	2	1	1	2	1	2
CO 6	-	-	-	-	2	1	2	1	1	2	1	2

Correlation Levels:

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

SEMESTER VI

Mar Ivanios College (Autonomous)					
Discipline	CHEMISTRY				
Course Code	**MIUK6DSCCHE350.1**				
Course Title	**ORGANIC CHEMISTRY IV**				
Type of Course	**DSC A6-I**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Foundational understanding of chemistry principles, including chemical bonding, molecular structure				
Course Summary	This course enables the student to understand the chemistry of naturally occurring compounds such as amino acids, proteins, heterocyclic compounds, terpenes, vitamins etc. This course also provide a comprehensive understanding on different organic spectroscopy methods including UV-Vis, IR, NMR, Mass spectrometry.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Amino acids, Proteins and Nucleic acids**	**12**
	1	Amino acids – classification, structure and stereochemistry of amino acids.	3
	2	Essential and nonessential amino acids – zwitterion, isoelectric point.	2
	3	Synthesis of amino acids – Strecker synthesis, Gabriel phthalimide synthesis, Erlenmeyer azlactone synthesis. Peptides: Structure and synthesis (Carbobenzoxy, Sheehan and solid phase synthesis)	3

	4	Proteins – classification of proteins – structure of proteins – denaturation and colour reactions.	2
	5	Nucleic acids: Classification, structure of DNA and RNA. Replication of DNA. Transcription and Translation - Genetic code.	2
II		**Heterocyclic compounds**	**12**
	6	Heterocyclic compounds- classification, nomenclature, aromaticity. Basicity of pyridine and pyrrole.	3
	7	Preparation - Paal-Knor synthesis and Hantzsch synthesis. Properties of furan, pyrrole, thiophene and pyridine.	3
	8	Synthesis and reactions of quinoline, isoquinoline and indole with special reference to Skraup, Bischler-Napieralski and Fischer-Indole synthesis.	3
	9	Dyes: Theory of colour and constitution , classification according to structure and method of application.Preparation and uses of 1) Azo dye - methyl orange,) 2) Phthalein dye - phenolphthalein, 4) Xanthen dye - fluorescein, Optical brighteners – Introduction and important characteristics	3
III		**Natural Products**	**12**
	10	Terpenes – Classification - Isoprene rule - Essential oil – Source	2
	11	Structure (no structural elucidation) and uses of citral, geraniol, limonene and menthol. Structure of natural rubber – vulcanization and its advantages.	2
	12	Alkaloids – Extraction. Structure and importance of nicotine, quinine, morphine and codeine.	2
	13	Structural elucidation of Nicotine and Conine.	2
	14	Vitamins : Classification, structure, functions and deficiency diseases (structure of vitamin A, B1 and C only - no structural elucidation).	2
	15	Lipids – biological functions – oils and fats - Common fatty acids	1
	16	Hydrogenation, rancidity, saponification value, iodine value and acid value.	1
IV		**Organic Spectroscopy I**	**12**
	17	UV–Visible spectroscopy – Beer-Lambert's law, types of electronic transitions.	2
	18	Bathochromic, hypsochromic shifts, hyperchromic and hypochromic effects	1
	19	UV-Visible spectra of enes, effect of conjugation – solvent effect - Calculation of λmax of dienes and α,β-unsaturated ketones	2

	20	IR spectroscopy – Molecular vibrations, Functional group and finger print region. Effect of hydrogen bonding on –OH stretching frequency.	2
	21	Factors influencing carbonyl stretching frequency. Comparison of carbonyl stretching frequency in compounds containing carbonyl group.	2
	22	Interpretation of IR spectra of simple organic molecules such as salicylaldehyde, benzamide, acetophenone, nitro benzoic acid and phenyl acetate.	3
V	**Organic Spectroscopy II**		**12**
	23	NMR spectroscopy – principle of proton NMR, shielding and deshielding effect.	3
	24	Chemical shift, factors influencing chemical shift spin-spin splitting, coupling constant.	2
	25	Interpretation of PMR spectrum of simple molecules like CHBr2CH2Br, ethylbromide, pure ethanol and impure ethanol (acidic impurities) acetaldehyde and toluene.	2
	26	Introduction to 13C NMR Structural elucidation of simple organic molecules using IR and NMR spectroscopic techniques.	2
	27	Theory of Mass spectrometry – mass spectrum, base peak and molecular ion peak, types of fragmentation, McLafferty rearrangement, isotopic effect.	3

References

For Theory

Text books

1. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, S.Chand& Company, New Delhi.

2. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, Vikas Publishing House (Pvt) Ltd., New Delhi..

3. S.C.Sharma and M.K.Jain, Modern Organic Chemistry, Vishal Publishing Company,New Delhi..

4. I L Finar, "Organic Chemistry" Vol – 1&2, 5th Edition, Pearson Education, New Delhi.

5. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, Polymer Science,Wiley Eastern Ltd, New Delhi.

6. O.P.Agarwal, Chemistry of Natural Products, Goel Publications.

7. T.L.Gilchrist, Heterocyclic Chemistry, Pearson Education, New Delhi.

8. Y.R.Sharma, Elementary Organic Spectroscopy, Pearson Education, New Delhi.

9. William Kemp, Organic Spectroscopy, Macmillan, New York.

10. AshuthoshKar, Medicinal Chemistry, New Age International Publishers.

For Further Reading:

1. R.T.Morrison, R.N.Boyd. Organic Chemistry, Pearson Education, New Delhi.

2. P.Y.Bruice, Essential Organic Chemisty, Pearson Education, New Delhi.

3. J.Clayden, N.Greeves and S.Warren, Organic Chemistry, Oxford University Press, New York.

4. Billmeyer F.W., Text book of Polymer Science, John Wiley and Sons.

5. S.P.Bhutani, Chemistry of Biomolecules, Ane Book Pvt Ltd.

6. R.M.Silverstein and F.X.Webster, Spectrometric Identification of Organic Compounds, John Wiely and Sons, New York.

7. P.S.Kalsi, Application of Spectroscopic Techniques in OrganicChemistry, NewAge International, New Delhi.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Classify amino acids, proteins, heterocyclics, nucleic acids, terpenes and vitamins	U	1,2
CO-2	Discuss the synthesis of amino acids and proteins	U	2
CO-3	Outline the chemistry of simple heterocyclic compounds	R, U	2

CO-4	Describe the isolation and structure of terpenes and alkaloids.	R	1
CO-5	Use the simple organic reactions to elucidate the structure of quinoline, piperine and conine.	A	3
CO-6	Discuss the principle of UV, IR, NMR and Mass spectroscopy.	U	4
CO-7	Interpret spectroscopic data to elucidate the structure of simple organic compounds.	A	1,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ORGANIC CHEMISTRY IV

Credits: 4:0:0 (Lecture:Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Classify amino acids, proteins, heterocyclics, nucleic acids, terpenes and vitamins	1,2	U	F	L	
2	Discuss the synthesis of amino acids and proteins	2	U	C, F	L	
3	Outline the chemistry of simple heterocyclic compounds	2	R, U	C	L	
4	Describe the isolation and structure of terpenes and alkaloids.	1	R	P	L	
5	Use the simple organic reactions to elucidate the	3	A	C	L	

	structure of quinoline, piperine and conine.					
6	Discuss the principle of UV, IR, NMR and Mass spectroscopy.	4	U	P, M	L	
7	Interpret spectroscopic data to elucidate the structure of simple organic compounds.	1,5	A	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	3	1	1	1	1	1	2	2	2	2	2
CO 2	1	3	1	1	1	1	2	1	1	1	1	1
CO 3	1	3	2	1	1	1	1	2	1	1	1	2
CO 4	3	1	1	3	1	3	1	2	2	2	1	2
CO 5	1	1	3	1	1	1	1	2	1	2	2	2
CO 6	2	1	1	3	1	1	2	1	1	1	1	1
CO 7	2	1	1	1	5	1	2	2	2	2	2	2

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK6DSCCHE351.1**				
Course Title	**PHYSICAL CHEMISTRY III**				
Type of Course	**DSC** A6-II				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Basic knowledge of General chemistry 2. Mathematical knowledge of calculus and algebra				
Course Summary	This physical chemistry course aims to familiarize students with important fundamental areas such as electrolytic conductance, electromotive force and thermodynamics. Additionally, it covers topics such as adsorption phenomena, binary liquid systems, and practical applications in physical chemistry experiments, providing students with a comprehensive understanding of the discipline's theoretical and practical aspects.				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs**
I	**ELECTROLYTIC CONDUCTANCE**		**9**
	1	Equivalent Conductance, Molar conductance and its variation with dilution, Kohlraush's law and its applications.	2
	2	Applications of conductivity measurements: -Determination of degree of dissociation of weak electrolytes, degree of hydrolysis, solubility of sparingly soluble salts, conductometric titrations	3

		involving strong acid strong base, strong acid-weak base, weak acid-strong base, weak acid-weak base and precipitation.	
	3	Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation, Debye-Falkenhagen effect, Wien effect.	2
	4	Activity and activity coefficient of electrolytes, Ionic strength.	2
II	**ELECTROMOTIVE FORCE**		**9**
	5	Origin of electrode potential, half-cell reaction and cell reactions, Types of electrodes-Metallic electrodes, anion reversible electrodes and redox electrodes. Reference electrodes: standard hydrogen electrode, calomel electrode.	3
	6	Effect of concentration of electrolytes on electrode potential: Nernst equation for electrode and cell (Derivation).	2
	7	Relation between electrical energy, free energy, enthalpy and entropy- Gibb's Helmholtz equation and EMF of a cell - calculation of ΔG, ΔH and ΔS from EMF data.	2
	8	Fuel Cells – H_2-O_2, hydrocarbon-O_2. Applications of EMF measurements- Determination of pH using hydrogen electrode and potentiometric titrations of redox systems with Fe/Cr system.	2
III	**THERMODYNAMICS**		**18**
	9	Definition of internal energy and enthalpy, First law of thermodynamics, mathematical form.	1
	10	Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition.	2
	11	The Joule-Thomson effect – isenthalpic process, Joule-Thomson coefficient, derivation of the expression for Joule-Thomson coefficient.	1
	12	Thermochemistry – Standard state. Standard enthalpies of reactions: Enthalpies of formation, combustion and neutralization. Hess's law and its applications. Kirchoff's equations.	2
	13	Limitations of First Law, Need for Second law of thermodynamics. Spontaneous process. Carnot cycle:-net work done and efficiency of Carnot engine, Carnot theorem. Different statements of Second law.	3

	14	Concept of entropy- Definition and physical significance. Entropy as a function of volume and temperature, pressure and temperature, as a criterion of spontaneity and equilibrium. Entropy changes in reversible and irreversible processes. Entropy changes accompanying change of phase	2
	15	Free energy: Gibbs and Helmholtz free energies and their significances - criteria of thermodynamic equilibrium and spontaneity. Gibbs-Helmholtz equation, dependence of Gibbs free energy changes on temperature, volume and pressure.	2
	16	Partial molar quantities. Chemical potential-Gibbs-Duhem equation, Clausius Clapeyron equation. Concept of fugacity, determination of fugacity by graphical method.	2
	17	Nernst heat theorem, proof and its consequences. Statement of Third law-Plank's statement, Lewis Randall statement. Concept of perfect crystal, evaluation of absolute entropies of solid, liquid and gas.	3
IV	**BINARY LIQUID SYSTEMS & ADSORPTION**		**9**
	18	Liquid-Liquid system: ideal and non-ideal mixtures, Raoult's law, vapour pressure - composition, temperature-composition curves, fractional distillation	2
	19	Azeotropic mixtures, partially miscible liquid system, critical solution temperature, examples for upper, lower and upper cum lower CST	2
	20	Distribution law, its thermodynamic derivation, Application of distribution law to the study of association and dissociation of molecules	2
	21	Adsorption: Physical and chemical adsorption, Freundlich adsorption isotherm, Derivation of Langmuir adsorption isotherm.	1
	22	Statement and explanation of BET isotherm Determination of surface area of adsorbents by BET equation. Applications of adsorption	2
V	**PRACTICALS: PHYSICAL CHEMISTRY EXPERIMENTS**		**30**
		A minimum of 5 practical experiments out of which at least one each from sections I, II and III must be performed and reported.	
	23	**A. Conductometry**	5

		11. Determination of cell constant 12. Conductometric titration of NaOH using HCl	
	24	**B. Potentiometry**	6
		13. Potentiometric titration of Fe^{2+} versus $Cr_2O_7^{2-}$ 14. Potentiometric titration of KMnO4 versus KI	
	25	**C. Experiments with Partially miscible liquid pairs**	3
		15. Critical solution temperature of phenol –water system 16. Influence of KCl (impurity) on the miscibility temperature of Phenol-water system. Determination of concentration of given KCl solution	
		17.	
	26	**D. Adosrption Experiments**	6
		18. Freundlich and Langmuir isotherms for adsorption of oxalic acid on active charcoal. 19. Determination of unknown concentration of oxalic acid using isotherm.	
	27	**E. Calorimetry**	5
		20. Determination of water equivalent of Calorimeter and heat of neutralization of strong acid and strong base	
	28	**F. Partition experiments**	5
		21. Partition coefficient of iodine between CCl_4 and H_2O or Partition coefficient of ammonia between $CHCl_3$ and H_2O	

References:

Textbooks

8. P W Atkins, "*Physical Chemistry*", Oxford University Press
9. R L Madan, *Physical Chemistry*, Mc Graw Hill
10. *Elements of Physical Chemistry*, Glasstone and Lewis, Macmillan
11. Puri, Sharma & Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co
12. P. C. Rakhit, *Physical Chemistry*, Sarat Book House, Calcutta
13. J. B. Yadav *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd

For Further Reading

6. R J Selby and RA Alberty, *Physical Chemistry*, John Wiley &sons
7. Levin, *Physical Chemistry*, 5th edn, TMH.
8. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house
9. S Glasstone, *"Thermodynamics for Chemists*", Affiliated East West Publishers
10. G W Castellan, "*Physical Chemistry*", Narosa Publishing House
11. S Glasstone, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd.
12. B. Viswanathan, P. S. Raghavan, *A Practical Physical Chemistry*, Viva Books

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recall the basic physical concepts in electrochemistry, thermodynamics, adsorption and binary liquid systems	R	1,2
CO-2	Understand the basic concepts involved electrochemistry, thermodynamics, adsorption and binary liquid systems	U	1,2
CO-3	Apply laws of thermodynamics in physical and chemical processes and real system	A	1,2
CO-4	Discuss the second law of thermodynamics and assess thermodynamic applications using second law of thermodynamics.	E, A	1,2
CO-5	Develop Scientific outlook and approach in applying principles of physical chemistry in chemical systems/reactions	U	3,4
CO-6	Acquire Instrumentation skill in using conductometer, potentiometer, calorimeter	U	4,5
CO-7	Compare theory with experimental findings	A	3,4
CO-8	Practice Punctuality and regularity in doing experiments and submitting Lab records	A	3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL CHEMISTRY III

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Recall the basic physical concepts in electrochemistry, thermodynamics, adsorption and binary liquid systems	1,2	R	F, C	L	
CO-2	Understand the basic concepts involved electrochemistry, thermodynamics, adsorption and binary liquid systems	1,2	U	F, C	L	
CO-3	Apply laws of thermodynamics in physical and chemical processes and real system	1,2	A	M	L	
CO-4	Discuss the second law of thermodynamics and assess thermodynamic applications using second law of thermodynamics.	1,2	E, A	P	L	
CO-5	Develop Scientific outlook and	3,4	U	P	L	

	approach in applying principles of physical chemistry in chemical systems/reactions					
CO-6	Acquire Instrumentation skill in using conductometer, potentiometer, calorimeter	4,5	U	P		P
CO 7	Compare theory with experimental findings	3,4	A			P
CO 8	Practice Punctuality and regularity in doing experiments and submitting Lab records	3,4	A			P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	1	1	1	1	1	1	2	1	1	1
CO 2	1	2	1	2	1	2	2	2	1	1	1
CO 3	1	1	1	1	1	2	3	2	1	1	1
CO 4	2	1	1	1	1	1	1	2	1	1	1
CO 5	1	1	3	3	1	1	2	3	1	1	1
CO 6	1	1	1	2	3	1	3	1	1	1	1
CO 7	1	2	2	2	2	1	1	2	2	1	1

CO 8	2	1	1	2	1	1	2	2	3	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK6DSCCHE352.1**				
Course Title	**CHEMICAL DYNAMICS AND EQUILIBRIA**				
Type of Course	**DSC A6-III**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Basic knowledge of General chemistry 2. Mathematical knowledge of calculus and algebra				
Course Summary	The course covers a range of topics in chemical kinetics, catalysis, chemical and ionic equilibria. Students will gain theoretical knowledge in understanding and applying fundamental principles in these areas, preparing them for careers in higher studies, research, or industry in the field of chemistry. It includes an open-ended module focusing on problem-solving, seminars, discussions, and other interactive learning methods to enhance students' critical thinking and analytical abilities.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**PHASE EQUILIBRIA**		**15**
	1	Phase Equilibria: Terminology, the phase rule, thermodynamic derivation of phase rule	2
	2	Phase diagram and understanding of one component system. Water and sulphur phase diagram	3
	3	Phase Diagram of two component System. Reduced Phase rule. Phase diagram of three component System.	2
	4	Solid-liquid equilibria involving simple eutectic system such as Salt and water system. Applications: KI-Water System, Freezing Mixtures, any application to Metallurgy - Pattinson Process-Desilversization from Lead.	3
	5	Solid-liquid equilibria involving compound formation with congruent and incongruent melting points: $FeCl_3$- H_2O system and Na_2SO_4-H_2O system, solid–gas system- decomposition of $CaCO_3$, dehydration of $CuSO_4.5H_2O$, deliquescence and efflorescence.	5
II	**CHEMICAL KINETICS & CATALYSIS**		**15**
	6	Order of reaction, Derivation of integrated rate equation of zero, first, second and nth order reaction	2
	7	Determination of order of reactions: Graphical and analytical methods using integrated rate equations, Fractional life- method, Differential rate equation method, Isolation method.	3
	8	Qualitative idea of Complex reactions: (a) opposing reactions (b) first order consecutive reactions (c) parallel reactions. Qualitative idea of chain reactions. (no derivations, graphs and examples are to be included)	3
	9	Influence of temperature on rate of reaction: Arrhenius equation, Determination of Arrhenius parameter, Energy of activation and its significance.	2
	10	Collision theory. unimolecular reactions- Lindemann mechanism, steady state approximation.	2

	11	Catalysis: Types and Theories of catalysis, Intermediate compound formation theory, Adsorption theory, steady state method, Enzyme catalysis, Michaelis-Menten law.	3
III	**CHEMICAL AND IONIC EQUILIBRIA**		**15**
	12	Equilibrium constant and free energy. Thermodynamic derivation of law of mass action, relation between Kp, Kc and Kx	3
	13	Le-Chatelier's Principle – Application in Haber process and dissociation of PCl_5	2
	14	Reaction isotherm, Temperature dependence of equilibrium constant, Pressure dependence of equilibrium constant. Application of Clausius-Clapeyron equation in physical equilibria.	3
	15	Ionic equilibrium: Ionic product of water, Effects of solvents on ionic strength, levelling effect, pKa and pKb values, solubility product and common ion effect and their applications, pH and its determination by indicator methods, buffer solution, buffer action, Henderson's equation, buffer capacity	4
	16	Hydrolysis of salts of all types, degree of hydrolysis and hydrolytic constant, determination of degree of hydrolysis, relation between hydrolytic constant and ionic product of water	3
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc**		**15**
	17	Open discussions on 1. Real life examples involving phase equilibria 2. Wide range of applications of phase equilibria in industries 3. Presentations of phase diagrams of other systems by students 4. Problems solving sessions 5. Kinetics of Hydrolysis of ester or any other reaction. 6. Reaction Rate Determination using Spectrophotometry 7. Any similar learning methods suggested by the faculty based on I-IV modules.	

References:

Textbooks

1. Puri, Sharma & Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co
2. *Elements of Physical Chemistry*, Glasstone and Lewis, Macmillan
3. P. C. Rakhit, *Physical Chemistry*, Sarat Book House, Calcutta
4. R L Madan, *Physical Chemistry*, Mc Graw Hill

For Further Reading

1. R J Selby and RA Alberty, *Physical Chemistry*, John Wiley &sons
2. Levin, *Physical Chemistry*, 5th edn, TMH.
3. Bahl, Arun Bahl and G D Tuli, *Essentials of Physical Chemistry*, S Chand Ltd
4. S. C. Anand, *A text book of Physical Chemistry*, New Age International publishers.
5. Gurdeep Raj, *Advanced Physical Chemistry*, Goel publishing house

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Provide an understanding of phase equilibria principles, enabling to analyze and predict equilibrium conditions in complex chemical systems, useful for industrial processes and research in materials science.	U, Ap	1,2
CO-2	Equips with a reflective knowledge on reaction kinetics, and catalysis, to analyze and predict reaction rates in various chemical systems.	Ap, An	1,2
CO-3	Covers the principles of chemical and ionic equilibrium, essential for understanding and optimizing chemical processes.	R. U	1,2,
CO-4	Analyse and understand the equilibrium chemistry dynamics and apply this knowledge to solve numerical problems in related subjects	U, Ap	4, 5
CO-5	Learn the analytical skills and practical knowledge needed to handle challenging problems in chemical processes and industrial applications through problem-solving sessions, student presentations, industry applications, and other comparable approaches.	U, Ap, An	4, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: CHEMICAL DYNAMICS AND EQUILIBRIA

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Provide an understanding of phase equilibria	1,2	U, Ap	F, C	L	

	principles, enabling to analyze and predict equilibrium conditions in complex chemical systems, useful for industrial processes and research in materials science.					
CO-2	Equips with a reflective knowledge on reaction kinetics, and catalysis, to analyze and predict reaction rates in various chemical systems.	1,2	Ap, An	F,C	L	
CO-3	Covers the principles of chemical and ionic equilibrium, essential for understanding and optimizing chemical processes.	1,2,	R. U	C, P	L	
CO-4	Analyse and understand the equilibrium chemistry dynamics and apply this knowledge to solve numerical problems in related subjects	4, 5	U, Ap	P	L	
CO-5	Learn the analytical skills and practical knowledge needed to handle challenging problems in chemical processes and industrial applications through	4, 5	U, Ap, An	P	L, T	

	problem-solving sessions, student presentations, industry applications, and other comparable approaches.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	2	1	1	1	1	2	1	1	2	1	2
CO 2	2	1	1	1	1	1	1	2	2	1	1	1
CO 3	1	1	2	1	1	1	1	2	1	1	1	1
CO 4	1	2	1	3	2	1	1	1	1	2	1	2
CO 5	2	1	1	1	2	1	1	1	1	2	1	2

Correlation Levels:

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

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Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	**MIUK6DSECHE350.1**				
Course Title	**ENVIRONMENTAL CHEMISTRY V**				
Type of Course	DSE 6.1				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4	-	-	4
Pre-requisites	1. Prior Knowledge of classification of waste 2. Basic knowledge of Disaster				
Course Summary	This course covers waste generation, treatment and disposal methods. This course also gives information regarding the case studies of national disaster and disaster management.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Solid Waste and Environmental Impacts**		**9**
	1.1	Introduction; solid waste & its characteristics	1
	1.2	Solid waste. Source, Composition and Classification- Domestic waste, Municipal Solid Waste (MSW),	3

		Industrial Solid Waste (ISW) and Biomedical Solid Waste (BSW), Agricultural, nuclear and e -waste.	
	1.3	Environmental impact on human and plant health, water quality and aquatic life	2
	1.4	Environmental effect of mining waste and land degradation.	1
	1.5	Effect of land leachate on soil characteristics and ground water pollution	2
II	**Solid Waste Management**		**9**
	2.1	Objectives of solid waste management, Methods of collection of solid waste	2
	2.2	Disposal Methods - conservancy system, water carriage system and dilution method	2
	2.3	Management of Solid Waste - MSW: Vermi composting, sanitary landfill, incineration. BSW- incineration and plasma pyrolysis. ISW - high temperature incineration, pyrolysis and vitrification.	3
	2.4	Solid Waste Management by Biotechnology, Drawbacks in Waste Management Techniques	2
III	**Recycling, Recovery and Reuse of Waste**		**9**
	3.1	Recycling, Recovery and Reuse of Paper, glass, plastic, rubber and waste oil	2
	3.2	Recovery of heavy metal ions from agricultural waste	1
	3.3	Concept of energy recovery from solid waste - refuse derived fuel (RDF)	1
	3.4	Different waste to energy processes - combustion, pyrolysis, landfill gas recovery (LFG), anaerobic digestion, gasification	2
	3.5	Waste management policies - MSW (management and handling) rules 2000, Hazardous waste management and handling rules 1989, BSW (Management and Handling) rules 1998.	2

	3.6	Ecofriendly or green products	1
IV	**Disasters and Disaster Management**		**18**
	4.1	Basic Concept of Disaster - Definition of hazard, vulnerability risk, disaster. Causative factors of disaster	2
	4.2	Classification of disaster – natural, flood, drought, landslide, tsunami, cyclone - causes, mitigation and management	3
	4.3	Manmade disaster - fire, industrial pollution, biological disaster, structural failure (Building and bridges), accidents (road, rail and water), dams	4
	4.4	Disaster Management - definition, components of disaster management cycle - crisis management and risk management	2
	4.5	Crisis management - Quick relief, recovery and rehabilitation	2
	4.6	Risk management - risk identification and assessment, risk reduction in vulnerable areas. Risk transfer	2
	4.7	Disaster management related policies and Acts in India	2
	4.8	Environmental management and audit - Basic concept only	1
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc**		15
	1	Introduction to Solid waste - classification, storage and disposal	
	2	3 R's concept of solid waste management	
	3	Waste Management policies	
	4	Classification of disaster	
	5	Concept of Disaster Management	

References:

1. John P., Waste Management Practices, 2014, Boca Raton, CRC Press
2. George T., Frank K., Handbook of Solid Waste Management, 2nd Edition, 2002, The McGraw-Hill Companies, Inc
3. Lawrence K.W., Handbook of Industrial and Hazardous Wate Treatment, 2004, Mercel Dekker Inc
4. S.M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi
5. S.S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Comprehend the fundamentals of waste generation, collection, transportation, treatment, and disposal. This includes knowledge of various waste types, their characteristics, and the environmental and health implications of improper waste management	R,U	2,4
CO-2	Develop skills in waste reduction strategies, such as source reduction, recycling, composting, and waste-to-energy technologies	A	2,4
CO-3	Students will gain insight into waste management systems at local, national, and global levels, including regulations, policies, and best practices	U	2,4
CO-4	Develop comprehensive knowledge on various types of disasters, including natural disasters (e.g., earthquakes, hurricanes, floods) and man-made disasters (e.g., industrial accidents, terrorist attacks)	U	2,4
CO-5	Understanding about the characteristics, causes, and impacts of each type of disaster	U	2,4

CO-6	Gives an idea about ethical and legal aspects of disaster management, including issues related to human rights, audits, equity and accountability	A	2,4,5

Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ENVIRONMENTAL CHEMISTRY V

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Comprehend the fundamentals of waste generation, collection, transportation, treatment, and disposal. This includes knowledge of various waste types, their characteristics, and the environmental and health implications of improper waste management	1,3,2	R,U	F,C	L	
CO-2	Develop skills in waste reduction strategies, such as source reduction, recycling, composting, and waste-to-energy technologies	1,3,2	A	F,C	L	

CO-3	Students will gain insight into waste management systems at local, national, and global levels, including regulations, policies, and best practices	1,2	U	F,C	L	
CO-4	Develop comprehensive knowledge on various types of disasters, including natural disasters (e.g., earthquakes, hurricanes, floods) and man-made disasters (e.g., industrial accidents, terrorist attacks)	1,3	U	F,C	L	
CO-5	Understanding about the characteristics, causes, and impacts of each type of disaster	1,2,3	U	F,C	L	
CO-6	Gives an idea about ethical and legal aspects of disaster management, including issues related to human rights, audits, equity and accountability	1,2,3	A	F,C	L	

F-Factual, C-Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	3	1	3	2	1	1	1	1	1	1	2
CO 2	1	3	1	3	1	1	1	3	1	2	1	1
CO 3	1	3	1	1	3	1	1	3	1	3	1	2
CO 4	1	1	1	1	1	1	1	1	1	1	1	2
CO 5	1	1	1	1	1	1	1	1	1	1	1	3
CO 6	1	3	1	3	2	1	3	3	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)					
Discipline	CHEMISTRY				
Course Code	**MIUK6DSECHE351.1**				
Course Title	**ENVIRONMENT CHEMISTRY VI**				
Type of Course	DSE 6.2				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	1. Foundational understanding of green chemistry 2. Fundamentals of green synthesis				
Course Summary	This course provides students with an in-depth understanding toxicology of substances and give an insight into green technology adopted for clean environment				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**Introduction to Toxicology**		**9**
	1.1	Introduction- concept of Toxicology, chronic and acute effects, toxic chemicals in environment- Air, Water & Soil,	3

	1.2	Dose response concept - LD 50, LC 50	2
	1.3	Carcinogens-general aspects. Hazards from food additives.	2
	1.4	Toxicology of pesticides, insecticides and organometallic compounds	2
II	**Toxicological Effects**		**9**
	2.1	Toxicological effects- General characteristics, biochemical, physiological, reversible and irreversible effects. Effect on the immune system. Detoxification. Impact of toxic chemicals on enzymes	4
	2.2	Biochemical effects of As, Pb, Cd, Hg, CO, oxides nitrogen & Sulphur, ozone and PAN	3
	2.3	Solutions to environmental problems- Prevention of pollution and design for eco-friendly environment	2
III	**Green Technology and Green Chemistry- Introduction**		**18**
	3.1	Introduction Definition and concepts, Green technology, green energy, green infrastructure, green economy and green chemistry. Green technologies in historical and contemporary perspectives. Successful green technologies: Wind Turbines, solar panel, 3 R's of green technology	5
	3.2	Applications of green technology: Pollution reduction and removal, Flue gas desulfurization method, catalytic or thermal destruction of nitrogen oxides. energy efficient fume hoods, carbon capture and storage technologies	4
	3.3	Need and goal of green chemistry, Twelve principles of green chemistry - Concept of atom economy and its calculations	4
	3.4	Tools of Green Chemistry - Green starting materials, green reagents, green reactions, green methodology and green chemical products - obstacles and progress of Green Chemistry	5

IV	**Applications of Green Chemistry**		**9**
	4.1	Green reagents - dimethyl carbonate, polymer supported reagents. Green catalyst- acid catalyst, base catalyst, oxidation catalyst, photocatalyst, polymer supported catalyst, phase transfer catalyst and bio catalyst. Green solvents - super critical fluid system, aqueous solvent systems and ionic liquids	4
	4.2	Green chemistry in action - real world cases - CO_2 as a blowing agent, super critical CO_2 as a cleaning agent, poly lactic acid as a biodegradable polymer, closed loop recycling of PET, use of H_2O_2 as a bleaching agent	3
	4.3	Importance of green chemistry in day to day life, green chemistry in sustainable development	2
V	**Soil and water analysis Practicals III**		**30**
	1	Determination of Acidity and Total Alkalinity of Water- Titration Method - Minimum 3 Samples	
	2	Hardness of Water - Temporary, Permanent and Total Hardness - Complexometric Titration Method - Minimum 4 Samples	
	3	Determination of Nitrogen content in soil by titrimetric method - Minimum 5 samples	
	4	Determination of Phosphorus content in soil by colorimetric method - Minimum 5 samples	
	5	Determination of potassium content in soil by colorimetric method - Minimum 5 samples	

References:

1. Balram Pani, *Text Book of Environmental Chemistry*, I.K International Publishing House Pvt Ltd
2. A.K De, *Environmental Chemistry,* Seventh Edition, New Age International Publishers
3. H. Kaur, *Environmental Chemistry*, Pragati Prakashan
4. V.K Ahluwalia, *Environmental Chemistry*, Second Edition, Ane Books Pvt. Ltd.

5. Asim K. Das, *Environmental Chemistry with Green Chemistry*, Books and Allied (P) Ltd.
6. Paul T. Anastas, John C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press.
7. V. Kumar, *An Introduction to Green Chemistry*, Vishal Publishing Co.
8. Arceivala S.L, *Green Technologies: For a Better Future*, Mc-Graw Hill Publication

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Enable to understand of the basic principles of toxicology, including the mechanisms of toxicity, dose-response relationships, and factors influencing toxicity such as route of exposure and duration of exposure. General introduction to carcinogens	U	2,4
CO-2	Relate the information about the fate and transport of chemicals in the environment, including processes such as degradation, bioaccumulation, and persistence, and their implications for environmental and human health	U, A	2,4
CO-3	Comprehensive understanding of the principles of green chemistry, including the design of safer chemicals, the use of renewable feedstocks, and the reduction or elimination of hazardous substances and waste	U.Ap	2,3,4
CO-4	Students should be able to apply green chemistry concepts and principles to the design and synthesis of chemical products and processes, with a focus on minimizing environmental impact and promoting sustainability	Ap	2,4
CO-5	Students should learn how to evaluate and compare alternative chemicals and technologies based on their environmental and health	A	2,4

	impacts, energy efficiency and economic feasibility		
CO-6	Give an idea about analytical methods to assess various parameters determining soil and water quality	Ap	2,3,4

Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

<u>Name of the Course: ENVIRONMENTAL CHEMISTRY VI</u>

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Enable to understand of the basic principles of toxicology, including the mechanisms of toxicity, dose-response relationships, and factors influencing toxicity such as route of exposure and duration of exposure. General introduction to carcinogens	3,4	U	F,C	L	
CO-2	Relate the information about the fate and transport of chemicals in the environment, including processes such as degradation, bioaccumulation, and persistence, and their implications for environmental and human health	3,4	U,A	F,C	L	

CO-3	Comprehensive understanding of the principles of green chemistry, including the design of safer chemicals, the use of renewable feedstocks, and the reduction or elimination of hazardous substances and waste	1,3,4	U,Ap	F,C	L	
CO-4	Students should be able to apply green chemistry concepts and principles to the design and synthesis of chemical products and processes, with a focus on minimizing environmental impact and promoting sustainability	1,3,4	Ap	C,M	L	
CO-5	Students should learn how to evaluate and compare alternative chemicals and technologies based on their environmental and health impacts, energy efficiency, and economic feasibility	3,4	A	F,C	L	
CO-6	Give an idea about analytical methods to assess various parameters determining soil and water quality	3,4	Ap	F,C		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	1	3	1	1	1	3	1	1	1	2
CO 2	1	2	1	3	3	1	1	3	1	1	1	2
CO 3	1	1	1	1	3	1	1	3	1	1	1	1
CO 4	1	3	1	3	1	1	1	1	1	1	1	1
CO 5	1	2	1	1	1	1	1	1	1	1	1	2
CO 6	1	3	1	3	1	1	1	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)					
Discipline	CHEMISTRY				
Course Code	**MIUK6DSECHE352.1**				
Course Title	**ANALYTICAL CHEMISTRY V**				
Type of Course	**DSE 6.3**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Prior knowledge of analytical chemistry principles, such as spectroscopy, interaction of Electromagnetic radiation with Molecules and materials, and titration techniques 2. Familiarity with blood fluids 3. Understanding of electromagnetic radiation and microscopy principles				
Course Summary	The course delves into various advanced topics in analytical chemistry, covering both traditional and modern techniques. Students explore, spectroscopic analysis, material characterization techniques and the topic Green Analytical Chemistry				

Detailed Syllabus:

Module	Unit	Content	Hrs
	Selected topics in Analytical Chemistry		**9**
I	1.1	Food Chemistry: Analysis of milk and milk products: Composition of milk, analysis of milk with respect to pH, acidity, fates, casein content, lactose content, mineral content, adulteration of milk	2
	1.2	Food Additives - General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes	2

	1.3	Clinical Chemistry: Blood - Composition, Collection and Preservation of Blood Samples, Clinical Analysis - Common Determinations	2
	1.4	Immunoassay: Introduction, Principles, Specificity, Incubation Period for The Assay, Separation of the bound and free antigen, Fluorescence Immunoassay, Enzyme Immunoassay	3
II	**Material Characterization Techniques**		**9**
	2.1	Electromagnetic Radiation, Scanning Electron Microscopy (SEM) - principles, Imaging Modes, Energy Dispersive X-ray Spectroscopy (EDAX) - SEM: Applications, Limitations	3
	2.2	Transmission Electron Microscopy (TEM) - principles, Imaging Modes, Applications, Limitations	2
	2.3	Scanning Probe Microscopy (SPM) - Principles, Atomic Force Microscopy (AFM) - basic principles, instrumentation, operational modes, Applications, Limitations	2
	2.4	X-Ray Diffraction Technique: Principle, Instrumentation, Basics of Data interpretation, Introduction to Single crystal X Ray Diffraction.	2
III	**Green Analytical Chemistry**		**9**
	3.1	Green Analytical Chemistry an Introduction, The Basics of Green Chemistry	2
	3.2	Green Metrics Commonly Applied throughout the Industry: Eco Footprint, E-factor, NEMI Labelling and Greener Analytical Methods, Greenness Profiles of Greener Analytical Methods	2
	3.3	Concept of green analytical Process: Basic concept of green sampling techniques, direct analysis of samples, green analytical approaches in sample preparation. Green strategies	5
IV	**Spectroscopic Methods of Analysis II**		**18**
	4.1	Fluorometry: Principle of fluorometry, Chemical structure & fluorescence, Quenching, Relationship between concentration and fluorescence intensity, Instrumentation, fluorescence lifetime and gated fluorescence/phosphorescence measurement, fluorescence vs absorbance, chemiluminescence	4
	4.2	Atomic spectrometric methods: Distribution of atoms as a function of temperature, Flame emission spectrometry, Atomic absorption spectrometry, Flame AAS, Electrothermal AAS, Interferences in	4

		AAS, Sample Preparation, Internal standard and standard addition calibration	
	4.3	Atomic emission spectrometry the induction-coupled plasma (ICP), Laser ablation ICP-optical emission spectrometry/mass spectrometry (ICP-MS), Atomic fluorescence spectrometry	4
	4.4	Spectroscopy Based on Scattering: Origin of Scattering, Turbidimetry and Nephelometry, Instruments for nephelometry and turbidimetry	6
V	**Open Ended Module: Learning through problem-solving, seminars, open discussions, assignment discussions, Quizzes, Open book exams etc.**		**15**
	1	Research and write a report on clinical chemistry focusing on blood composition and analysis	
	2	Discuss the importance of proper collection and preservation of blood samples and common determinations in clinical analysis	
	3	Explore the principles and applications of immunoassays, including fluorescence and enzyme immunoassay techniques	
	4	Discuss the feasibility and practicality of implementing green analytical strategies in the industry	
	5	Discuss the concepts of eco footprint, E-factor, and NEMI labelling in evaluating the environmental impact of analytical methods	
	6	Interpret imaging and XRD data	
	7	Explore the applications of immunoassays in clinical diagnostics and biomedical research	
	8	Explore case studies and examples of green analytical approaches in various industries	
	9	Explore the advantages and limitations of different spectroscopic methods for chemical analysis	
	1	Discuss the challenges of pH measurement in nonaqueous solvents and propose strategies to overcome these challenges	
	1	Propose greener alternatives or modifications to the method to reduce waste generation, energy consumption, and chemical usage	

References:

1. D. J. Homes and H. Peck, *Analytical Biochemistry*, Longman 1983.
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
3. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry*, Wiley, 7th edition, 2013.
4. T. Pradeep, *NANO: The Essentials: Understanding Nanoscience and Nanotechnology*, Tata McGraw-Hill Publishing Company Limited, 1st Edition, 2007.
5. Miguel de la Guardia, Salvador Garrigues (E), *Handbook of Green Analytical Chemistry,* John Wiley & Sons, Ltd, 2012.
6. Lawrence H. Keith, Liz U. Gron, and Jennifer L. Young, *Green Analytical Methodologies,* Chem. Rev. 2007, 107, 2695−2708.
7. Marek Tobiszewski, Mariusz Marć, Agnieszka Gałuszka and Jacek Namieśnik, *Green Chemistry Metrics with Special Reference to Green Analytical Chemistry*, Molecules 2015, 20, 10928-10946; doi:10.3390/molecules200610928.
8. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.
9. Gurdeep R. Chatwal, Sham K. Anand, *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House.
10. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr., *Instrumental Methods of Analysis*, CBS Publishers & Distributors, 7th Edition, 1986.
11. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, *Vogel's Text book of Quantitative Inorganic Analysis*, Longman, Fifth Edition, 1989.

Course Outcomes:

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the composition and collection of blood samples, clinical analysis techniques to common determinations	U,Ap	1.2
CO-2	Understand the principles and applications of scanning electron microscopy (SEM), transmission electron microscopy (TEM), Scanning probe microscopy (SPM), including atomic force microscopy (AFM)	U	1,2
CO-3	Acquires knowledge about green analytical chemistry including tools and techniques for assessing the greenness of methods	U	1.2

CO-4	Understands the principles of fluorometry at an advanced level, acquires knowledge about various atomic spectrometric methods and spectroscopy based on scattering	U, Ap	1.2
CO-5	Applies and analyze the knowledge acquired through this course in practical situations	Ap, An	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY V

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the composition and collection of blood samples, clinical analysis techniques to common determinations	1,2	U,Ap	F	L	
CO-2	Understand the principles and applications of scanning electron microscopy (SEM), transmission electron microscopy (TEM), Scanning probe microscopy (SPM), including atomic force microscopy (AFM)	1,2	U	C	L	
CO-3	Acquires knowledge about green analytical chemistry including tools and techniques for assessing the	1,2,2	U	F,C	L	

	greenness of methods					
CO-4	Understands the principles of fluorometry at an advanced level, acquires knowledge about various atomic spectrometric methods and spectroscopy based on scattering	1,2,2	U,Ap	C	L	
CO-5	Applies and analyze the knowledge acquired through this course in practical situations	1,2,2	Ap,An	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	1	1	1	2	1	1	1	1	1	1
CO 2	1	2	1	1	1	2	1	1	1	1	1	1
CO 3	1	1	1	1	1	1	1	1	1	1	1	1
CO 4	1	1	1	1	1	2	1	1	1	1	1	1
CO 5	2	2	1	1	3	1	1	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)					
Discipline	CHEMISTRY				
Course Code	**MIUK6DSECHE353.1**				
Course Title	**ANALYTICAL CHEMISTRY VI**				
Type of Course	**DSE 6.4**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	1. Basic knowledge of chemistry, including chemical reactions and analytical techniques 2. Understanding of laboratory safety protocols and hazardous chemical handling 3. Familiarity with environmental science concepts, including pollution sources and regulations				
Course Summary	This course provides a comprehensive overview of analytical chemistry techniques, and safety protocols essential for laboratory work and environmental analysis.				

Detailed Syllabus:

Module	Unit	Content	Hrs
	Environmental Sampling		**9**
I	1.1	Getting a meaningful sample, Collecting air samples - General considerations, the sample train, sampling devices, Air sample analysis	3
	1.2	Collecting water samples - surface, groundwater	3
	1.3	Soil & Sediment Sampling, Sampling preparation for Trace organics	3

II	**Material Characterization Techniques**		**9**
	2.1	Principles of Automation, Process Control: Continuous and Discrete Analyzers, Instruments used in automated process control, Automatic Instruments: Discrete sampling instruments & Continuous - flow sampling instruments, Flow Injection Analysis, Sequential Injection Analysis, Laboratory Information Management System	5
	2.2	Objective of Quality Assurance, Quality Control, Quality Assessment: Internal & External Methods, Evaluating Quality Assurance Data: Prescriptive Approach, Performance - Based Approach, Using Control Charts for Quality Assurance	4
III	**Chemical Safety & Ethical Handling of Chemicals**		**9**
	3.1	Being Safe in the Laboratory, Safety culture and Your role in it, Medical Emergencies, Fire, Proper Conduct/Behaviour in lab	1
	3.2	Personal Protective Equipment: Hair & Apparel for Laboratory, Eye protection, Gloves, Laboratory Protocols: Safe Handling of Chemicals & Equipment, Proper House Keeping, Proper Hygiene, Disposal of Chemicals, Electrical Safety, Fire Safety	2
	3.3	Emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure	3
	3.4	Safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	3
IV	**Environmental Analysis & Management**		**18**
	4.1	Air Pollution, Sources, classification, pollutants and permissible limits. Sampling methods for air, flew gas, Industrial Exhaust, stag samples etc. Importance of automobile exhaust control and its limits, Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapours.	3
	4.2	Soil Analysis: sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility	4

		of soil and effect of pollution on it, synthetic fertilizers and their long-term effect on soil quality	
	4.3	Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification	2
	4.4	Water Quality Fundamentals, Physical and chemical properties, Important water Quality parameters and methods for their determination - Hardness testing, turbidity, colour, taste, pH, acidity, alkalinity, chemical constituents, hardness, dissolved oxygen, EC, DTC etc., water sampling, the standard for drinking water as per BIS specifications, household water treatment and safe storage	5
	4.5	Analysis of Water: Metals in water by AAS & ICPMS (Zn, Mg, Ca, Pb, Hg), Toxic Substances-Pesticides- Polychlorinated Biphenyls, Microbiological Parameters: Aerobic Microbial count, Detection of E. Coli and Coliform, Enterococci	4
V	**Analytical Chemistry Practicals III**		**30**
	A	**7 Experiments from Section A are compulsory** Water Analysis (chemical constituents, hardness, dissolved oxygen, EC, DTC) Physical & Chemical Parameters 1. To determine total alkalinity of water 2. To determine the total hardness of the water sample 3. To determine pH and conductance of waste water 4. To determine dissolved oxygen of waste water 5. To determine Biological and Chemical oxygen demand 6. To determine Acidity of Water 7. To determine TS, TSS, TDS of water 8. To determine salinity of the given water sample 9. Analysis of metals and ions 10. Microbiological analysis.	
	B	**Open ended: Any 3 experiments are to be conducted (May be selected from the list or the teacher can add related experiments)** Soil Analysis Sampling 1. Analysis of Physical Parameters 2. Determination of Moisture Content	

		3. Water Holding Capacity 4. Analysis of Chemical Parameters 5. Analysis of Carbonate 6. Organic carbon and organic matter 7. Total nitrogen, ammonia and nitrates 8. Total determination of major soil constituents by fusion analysis 9. Determination Ca, Mg, Na, K, phosphate Exchangeable cations, Cation exchange capacity	
	C	**Analysis of Selected Food Materials** **Milk Analysis:** 1. Detection of Added Water in Milk 2. Detection of Added Starch and Cereal Flours 3. Detection of Cellulose in Milk 4. Detection of Added Cane Sugar (Sucrose) 5. Detection of Added Glucose 6. Detection of Added Urea Detection of Preservatives added to Milk: 1. Formalin 2. Boric Acid and Borate 3. Benzoic and Sodium benzoate 4. Salicylic Acid	

References:

1. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders College Publishing, 7th edition, 1996.
2. Gary D. Christian, Purnendu K. Dasgupta, Kevin A. Schug, *Analytical Chemistry* –, Wiley, 7th edition, 2013.
3. D. A. Skoog and D. M. West, *Principles of Instrumental Analysis*, Saunders College Publishing, 5th edition, 1998.
4. Gurdeep R. Chatwal, Sham K. Anand, *Instrumental Methods of Chemical Analysis,* Himalaya Publishing House.
5. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; *Settle, F.A. Jr.*, *Instrumental Methods of Analysis,* CBS Publishers & Distributors, 7th Edition, 1986.
6. A. K. De, *Environmental Chemistry*, Wiley, 2nd edition, 1989.
7. S. M. Khopkar, *Environmental Pollution Analysis*, John Wiely, 1993
8. Sharad Gokhale, *Air Pollution Sampling and Analysis,* IIT Guwahati, May 2009.
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10. S. M. Khopkar, *Environmental Pollution Analysis*, New Age International publication, 2011.
11. *FSSAI Manual of methods of Analysis of Water*, Food Safety And Standards Authority of India, Ministry of Health And Family Welfare, Government of India, 2016
12. W. Horwitz (Editor), Official Method of Analysis of AOAC International, 18th Edn., AOAC, 2010
13. *FSSAI Manual of Simple methods for testing of common adulterants in food*, Food Safety And Standards Authority of India, Ministry of Health And Family Welfare, Government of India.
14. *Chemical Safety matters – IUPAC-IPCS*, (1992) Cambridge University Press.

Course Outcomes:

No:	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the sampling methods	U	1
CO-2	Understands quality control methods and assessment techniques and applies the knowledge of quality assurance data evaluation methods using control charts.	U, Ap	1,2
CO-3	Acquires knowledge about safety protocols, procedures in the laboratory emergency procedures and first aid measures and understand safe storage and disposal of hazardous chemicals and waste.	R, U	1,2
CO-4	Understand air pollution sources, classification, and permissible limits, the importance of controlling automobile exhaust emissions.	U	1,2
CO-5	Understands soil & water analysis techniques including sampling,	U	1,2
CO-6	Applies the knowledge of Water and soil analysis techniques	Ap	1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ANALYTICAL CHEMISTRY VI

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the sampling methods	2,1	U	**C**	L	

CO-2	Understands quality control methods and assessment techniques and applies the knowledge of quality assurance data evaluation methods using control charts	2,2	U, Ap	P	L	
CO-3	Acquires knowledge about safety protocols, procedures in the laboratory emergency procedures and first aid measures and understand safe storage and disposal of hazardous chemicals and waste	2,2	R, U	C	L	
CO-4	Understand air pollution sources, classification, and permissible limits, the importance of controlling automobile exhaust emissions	2,2	U	C	L	
CO-5	Understands soil & water analysis techniques including sampling	2,2	U	P	L	
CO-6	Applies the knowledge of Water and soil analysis techniques	2,2	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

NO:	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	1	2	1	1	1	2	2	1	1	1	3	1
CO 2	1	2	1	2	1	1	2	1	1	1	2	1
CO 3	1	2	1	3	1	2	1	1	1	1	1	2
CO 4	1	3	1	3	1	1	1	1	1	1	1	1
CO 5	2	3	1	3	1	1	1	1	1	1	1	2
CO 6	2	2	1	2	2	1	2	1	1	1	1	1

Correlation Levels:

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

Mar Ivanios College (Autonomous)					
Discipline	CHEMISTRY				
Course Code	**MIUK6SECCHE350.1**				
Course Title	**ELECTROANALYTICAL TECHNIQUES**				
Type of Course	**SEC 3**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	1. Students should have a basic understanding of the Faraday's Law of Electrolysis, Current-Voltage relationship and Electrolytic Cell 2. Students must know the applications of using electroanalytical methods for qualitative and quantitative determination				
Course Summary	Students know the applications of using electroanalytical methods for qualitative and quantitative determination as an alternative for conventional methods.				

Detailed Syllabus:

Module	Unit	Content	Hrs
	Introduction to Electrochemistry and Electroanalytical Methods		**9**

I	1.1	Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.	4
	1.2	Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.	3
	1.3	Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations.	2
II	**Conductometry**		**9**
	2.1	Definition and basic principles of conductometry. Definition of electrolytes and conductivity. Specific conductance, molar conductance, and equivalent conductance.	3
	2.2	Relationship between conductivity and concentration. Construction and operation principles of conductometric cells.	3
	2.3	Principles and applications of conductometric titrations. Types of conductometric titrations; acid-base titrations, precipitation titrations, complexometric titrations.	3
III	**Potentiometry**		**9**
	3.1	Potentiometric methods; Reference electrodes and indicator electrodes. The hydrogen, Calomel, Ag-AgCl electrode,	4
	3.2	Carbon electrode. The glass electrode- its structure, performance and limitations.	3
	3.3	Measurement of pH. Potentiometric titrations- acid-base, redox and precipitation titrations.	2
IV	**Voltammetry and Polarographic Techniques**		**9**
	4.1	Principles of voltammetry; Cyclic voltammetry; Differential pulse voltammetry, Stripping voltammetry techniques; anodic and cathodic stripping voltammetry and Square wave voltammetry.	3
	4.2	Basic principles of polarography; Construction and components of a polarographic cell, Types of electrodes used in polarography.	3

	4.3	Polarographic curves and their interpretation, Determination of diffusion coefficient and rate constant, Quantitative analysis using polarography, Applications of polarography.	3
V	**Amperometry, Coulometry and Electrogravimetric methods**		**9**
	5.1	Principles of amperometry; Amperometric titrations; Applications in quantitative analysis.	3
	5.2	Principles of coulometry; Coulometric titrations; Applications in quantitative analysis.	3
	5.3	Electrogravimetry- Principle and method. Determination of Copper. Separation of metals.	3

References:

1. "Electroanalytical Chemistry: A Series of Advances" by Allen J. Bard
2. "Electrochemical Methods: Fundamentals and Applications" by Allen J. Bard and Larry R. Faulkner
3. "Modern Electrochemistry" by John O'M. Bockris, Amulya K.N. Reddy, and Maria E. Gamboa-Aldeco
4. Journal articles and research papers in electroanalytical chemistry

Course outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Provides an introduction to various electroanalytical techniques used in chemical analysis.	**U**	1
CO-2	Students learn how to apply Electro Analytical methods such as conductometry, potentiometry, voltammetry, polarography, amperometry, coulometry and electrogravimetry in qualitative and quantitative analysis.	**U, Ap**	1,2
CO-3	Students learn skills in using the various electroanalytical techniques	**Ap**	2

Name of the Course: ELECTROANALYTICAL TECHNIQUES

Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Provides an introduction to various electroanalytical techniques used in chemical analysis.	1	U	F, C	L	
CO-2	Students learn how to apply Electro Analytical methods such as conductometry, potentiometry, voltammetry, polarography, amperometry, coulometry and electrogravimetry in qualitative and quantitative analysis.	1,2	U, Ap	F, C	L	
CO-3	Students learn skills in using the various electroanalytical techniques	2	Ap	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

SEMESTER VII

MAR IVANIOS COLLEGE (AUTONOMOUS)

Discipline	CHEMISTRY				
Course Code	**MIUK7DSCCHE400.1**				
Course Title	**ADVANCED INORGANIC CHEMISTRY**				
Type of Course	**DSC A7-I**				
Semester	7				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Strong foundation in core inorganic chemistry concepts and proficiency in advanced topics from organic and physical chemistry. 2. Familiarity with analytical techniques commonly used in inorganic chemistry research.				
Course Summary	The course delivers solid electrolytes, molecular materials, advanced coordination chemistry, electronic and magnetic spectra of metal complexes, and practical experiments in inorganic estimations and preparations. Students will gain a deep understanding of the interdisciplinary nature of inorganic chemistry, explore emerging research directions, and a deep knowledge of coordination complexes, and develop practical skills through hands-on laboratory work, preparing them for the challenges and opportunities in the field.				

Detailed Syllabus:

Module	Unit	Contents	Hrs
I	**FRONTIERS IN INORGANIC CHEMISTRY**		**9**
	1	Introduction to Frontiers in Inorganic Chemistry: Overview of the interdisciplinary nature of inorganic chemistry, Importance of inorganic chemistry in addressing global challenges and advancing technology, Discussion on emerging trends and research directions in the field.	1
	2	Solid Electrolytes: Mixed oxides, cationic, anionic solidelectrolytes, mixed ionic-electronic conductors.	2
	3	Solid oxide fuel cells, Rechargeable battery materials.	1
	4	Solid state chemistry of metal nitrides and fluorides, chalcogenides, intercalation chemistry and metal-richphases.	2

	5	Inorganic pigments, Inorganic phosphors.	1
	6	Molecular materials and fullerides, Basic idea of molecular materials chemistry like One dimensional metals, Molecular magnets and Inorganic liquid crystals.	2
II	**ADVANCED COORDINATION CHEMISTRY**		**12**
	7	Crystal Field Theory: Splitting of d-orbitals in octahedral, tetragonal, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields.	4
	8	Jahn-Teller theorem, evidence for JT effect, static and dynamic JT effect.	1
	9	Crystal Field Stabilization Energy: Octahedral site stabilization energy. Factors affecting the splitting parameter.	2
	10	Spectrochemical series. Evidence of covalency in Metal-Ligand bond - Ligand field theory.	2
	11	Molecular Orbital Theory: Sigma and pi-bonds in complexes. MO diagrams of octahedral and tetrahedral complexes with and without pi bonds.	2
	12	Experimental evidence of pi-bond on the stability of sigma bond. Nephelauxetic effect.	1
III.	**ELECTRONIC SPECTRA OF METAL COMPLEXES**		**12**
	13	Electronic Spectra of Metal Complexes: Term symbols of d^n system, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields.	3
	14	Correlation diagrams for d^n and d^{10-n} ions in octahedral and tetrahedral fields (qualitative approach only), d-d transition, selection rules for electronic transition, effect of spin orbit coupling and vibronic coupling.	3
	15	Interpretation of electronic spectra of complexes: Orgel diagrams, Tanabe-Sugano diagrams, calculation of Dq, B and β (Nephelauxetic ratio) values, charge transfer spectra.	3
	16	Spectral properties of lanthanides and actinides: Lanthanide complexes as shift reagents.	2
	17	Applications of electronic spectra in the structural studies of complexes	1
V	**MAGENTOCHEMISTRY**		**9**
	18	Terminology used in Magnetochemistry	1
	19	Classification of Magnetic Substances	2
	20	Energy of a magnet in a magnetic field	1
	21	Origin of magnetic properties of substances	1
	22	Larmor precession and diamagnetism	1
	23	Magnetic moment for multielectron systems	1
	24	Curie equation	1
	25	Langevin`s theory of diamagnetism	1

IV	MAGNETIC SPECTRA OF METAL COMPLEXES		9
	26	Temperature dependence of magnetism. Temperature-independent paramagnetism. Spin state crossover, Antiferromagnetism - Inter and intra molecular interaction.	2
	27	Thermal populations of different energy levels-Large and small multiplet widths	1
	28	Spin-only magnetic moment, Orbital contribution to magnetic moment, Anti-ferromagnetism	2
	29	Magnetic properties of lanthanides and actinides. Lanthanide complexes as shift reagents.	2
	30	Application of magnetic measurements in the determination of structure of transition metal complexes.	2

References:

1. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, John Wiley and Sons, 6th edition, 1999.
2. J. E. Huheey, *Inorganic Chemistry-Principles of Structure and Reactivity*, Harper Collins College Publishing, 4th edition, 2011.
3. S. F. A. Kettle, *Physical Inorganic Chemistry*, Oxford University Press, 1st edition, 1998.
4. S. Cotton, *Lanthanides and Actinides*, Macmillan, 1991.
5. B. N. Figgins and M. A. Hitchman, *Ligand Field Theory and its Applications*, Wiley-VCH, 2000.
6. A. Syamal and R. L. Datta, *Elements of Magnetochemistry*, Affiliated East-West Press, 1980.
7. N. N. Greenwood and A. Earnshaw, *Chemistry of Elements*, REPP Ltd, 2nd edition, 2005.
8. A. Earnshaw, *Introduction to Magnetochemistry*, Academic Press, 1968.
9. K. F. Purcell and J. C. Kotz, *Inorganic Chemistry*, Saunders, 1977.
10. S. F. A. Kettle, *Physical Inorganic Chemistry*, Oxford University Press, 1st edition, 1998.
11. Shriver and Atkins, *Inorganic Chemistry*, Oxford University Press, 2010.
12. Douglas, D. H. Mc Daniel, J. J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd Edn. John Wiley & Sons, 2006.
13. J. D. Lee, Concise *Inorganic Chemistry*, 5th Edn. Chapman & Hall, 1996.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Emphasizing the interdisciplinary nature of inorganic chemistry and its significance in addressing global challenges and technological advancements.	U, An	1,2

CO-2	Equip with the knowledge and skills to explore emerging research directions and contribute to innovative solutions in the field of inorganic chemistry.	U	1,2
CO-3	Apply the theories of coordination chemistry, predict the splitting patterns of d orbitals, and analyze the factors influencing the stability and reactivity of metal-ligand bonds.	Ap, E	1,3
CO-4	Predict and interpret the electronic spectra of lanthanide and actinide complexes, and understand the applications of electronic spectra in their structural studies.	An, E	1,4
CO-5	Gain knowledge of spin states, to apply magnetic measurements in determining the structure of transition metal complexes.	R, U	5
CO-6	Develop skills in experimental and apply effectively in quantitative and qualitative chemical analysis	C, Ap	1,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ADVANCED INORGANIC CHEMISTRY
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Emphasizing the interdisciplinary nature of inorganic chemistry and its significance in addressing global challenges and technological advancements.	1,2	U, An	F	L	
CO-2	Equip with the knowledge and skills to explore emerging research directions and contribute to innovative solutions in the field of inorganic chemistry.	1,2	U	C, P	L	
CO-3	Apply the theories of coordination chemistry, predict the splitting patterns of d orbitals, and analyze the factors influencing the stability and reactivity of metal-	1,3	Ap, E	P	L	

	ligand bonds.					
CO-4	Predict and interpret the electronic spectra of lanthanide and actinide complexes, and understand the applications of electronic spectra in their structural studies.	1,4	An, E	M	L	
CO-5	Gain knowledge of spin states, to apply magnetic measurements in determining the structure of transition metal complexes.	5	R, U	C	L	
CO-6	Develop skills in experimental and apply effectively in quantitative and qualitative chemical analysis	1,4	C, Ap	M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	CHEMISTRY				
Course Code	MIUK7DSCCHE401.1				
Course Title	**ADVANCED ORGANIC CHEMISTRY**				
Type of Course	**DSC A7-II**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Cr4edit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Basic idea about organic chemistry reactions and reaction mechanisms				
Course Summary	The course delivers the concepts of molecular recognition, supramolecular Chemistry, organic photochemistry, and pericyclic reactions in organic chemistry. It gives the student a deep understanding of the different methods used in organic synthesis reaction and the importance of green chemistry. Student will also gain deep knowledge and develop practical skills on different organic separation methods and identification of organic compounds through hands-on laboratory work preparing them for the challenges and opportunities in the field.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I		**Molecular recognition and Supramolecular chemistry**	**12**
	1	Concept of molecular recognition. Hydrogen bonding, ionic bonding, π-stacking, van der Waals and hydrophobic interactions.	4
	2	Introduction to molecular receptors, tweezers, cryptands and carcerands, cyclophanes, cyclodextrins and calixarenes - typical examples.	4
	3	Importance of molecular recognition in DNA and protein structure, their function and protein biosynthesis – basic aspects only.	4
II		**Organic Photochemistry and Pericyclic reactions**	**12**
	4	Introduction – photochemical Vs thermal reactions. Single and Triplet states. Jablonski diagram, Energy transfer, Photosensitization.	4

	5	Photochemical reactions of olefins: Cis-trans isomerisation, Photodimerisation, Photochemistry of carbonyl compounds: Norrish I (Acetone), Norrish II cleavages.	4
	6	Introduction to pericyclic reaction: Electrocyclic, cycloaddition and sigmatropic reactions (Elementary idea only)	4
III		**Methods in Organic synthesis**	**12**
	7	Retrosynthetic analysis and disconnection approach synthons, synthetic strategy, reliable reaction, disconnect after heteroatom, chemoselectivity, two group disconnections (use of epoxide), creation of cis and trans double bonds, retro synthesis of amines.	4
	8	Protecting group strategy: Tetrahydropyranyl, silyl, t-butyl, trichloro ethyl, acetal and thioacetal as hydroxyl, thiol, carboxyl and carbonyl protecting groups in synthesis.	4
	9	Introduction to combinatorial synthesis - split and pool method only.	4
IV		**Green chemistry**	**9**
	10	Twelve principles of green chemistry in detail. Green chemical strategies for sustainable development - Reaction mass balance, atom economy evaluation for chemical reaction efficiency, green solvents, reaction media - Synthesis under water, solventless, fluorous and ionic liquid media.	3
	11	Green processes- microwave synthesis - fundamentals of microwave synthesis - Two principal mechanisms for Interaction with matter - The Microwave Effect with examples - Single-Mode and Multimode Microwave cavities.	3
	12	Sonochemical synthesis. Applications of sonication in the synthesis of organic compounds.	3
V		**Organic Practicals - Separation and identification of Organic compounds**	**30**
	13	Quantitative wet chemistry separation of a mixture of two components by solvent extraction. TLC of the purified samples along with the mixture in same TLC plates (component 1 with mixture and component 2 with mixture on separate TLC plate) and calculation of Rf values- Reporting and recording TLC in standard formats- preparation of sample solution, adsorbent, dimensions of the plate, saturation time, developing time, visualization and detection, Rf Value, Drawing - in the form of a table.	15
	14	Open ended practical	15

References

For Theory

Text books

1. Helena Dodzuik, Introduction to supramolecular chemistry, Springer.

2. L.M. Lehn, Supramolecular Chemistry, VCH.

3.Von J. Kagan, Organic Photochemistry, Principles and Applications,Academic Press, 1993.

4.J.D. Coyle. Wiley, Introduction to Organic Photochemistry, 1998.

5. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, S.Chand& Company, New Delhi.

6. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, Vikas Publishing House (Pvt) Ltd., New Delhi..

7. S.C.Sharma and M.K.Jain, Modern Organic Chemistry, Vishal Publishing Company,New Delhi..

8. I L Finar, "Organic Chemistry" Vol – 1&2, 5th Edition, Pearson Education, New Delhi.

9. V.K.Ahluwalia, Green Chemistry, Enviornmentally Benign reaction, Ane Book.

For Further Reading:

1. R.P. Wayne, Principles and Applications of Photochemistry, Oxford University Press, New York, 1988.

2. R.T.Morrison, R.N.Boyd. Organic Chemistry, Pearson Education, New Delhi.

3. J.Clayden, N.Greeves and S.Warren, Organic Chemistry, Oxford University Press, New York.

4. M.M.Sreevastava and Rashmi Sanghi, Green Chemistry for environment, Narosa Publishing House.

5. Phytochemical Methods, 3rd Edn 1998. J. B. Harborne., Chapman and Hall, London.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	List the forces involved in molecular recognition and recognize molecular receptors	U	1
CO-2	Quote molecular recognition events in biological systems	R, U	1
CO-3	Differentiate photochemical and thermal reactions	R, U	1
CO-4	Understand mechanism involved in photoinduced reaction	U, Ap	1
CO-5	Propose the retro synthetic pathways to a variety of molecules	U, Ap, C	2
CO-6	Propose mechanisms for chemical reactions, given starting materials, reagents, conditions, and/or products.	U, Ap, C	2
CO-7	Compare the reactions and mechanism and determine the products of a selected set of reactions; identify protecting group strategies	Ap, E	2
CO-8	Appreciate and apply the principles of green chemistry	U, An	5
CO-9	Illustrate reactions in which green chemistry principles are applied and calculate atom economy	Ap, An	5
CO-10	Determine the correct method for separation of a binary mixture and make the separated compounds in pure form	An	3
CO-11	Develop thin layer chromatogram of a compound and determine its purity	An	3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ADVANCED ORGANIC CHEMISTRY
Credits: 3:0:1 (Lecture:Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	List the forces involved in molecular recognition and recognize molecular receptors	1	U	F	L	
2	Quote molecular recognition	1	R, U	C, F	L	

	events in biological systems					
3	Differentiate photochemical and thermal reactions	1	R, U	C	L	
4	Understand mechanism involved in photoinduced reaction	1	U, Ap	P	L	
5	Propose the retro synthetic pathways to a variety of molecules	2	U, Ap, C	C	T, L	
6	Propose mechanisms for chemical reactions, given starting materials, reagents, conditions, and/or products.	2	U, Ap, C	P, M	L	
7	Compare the reactions and mechanism and determine the products of a selected set of reactions; identify protecting group strategies	2	Ap, E	M	T, L	
8	Appreciate and apply the principles of green chemistry	5	U, An	C	L	
9	Illustrate reactions in which green chemistry principles are applied and calculate atom economy	5	Ap, An	C, P	L	

10	Determine the correct method for separation of a binary mixture and make the separated compounds in pure form	3	An	F		P
11	Develop thin layer chromatogram of a compound and determine its purity	3	An	M, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PS O1	PS O2	PS O3	PS O4	PS O5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	
CO 1	2	-	-	-	-	1	-	2	-	-	-	-	
CO 2	2	-	-	-	-	-	2	1	-	-	-	-	
CO 3	-	-	2	-	-	1	-	-	-	-	-	-	
CO 4	-	-	-	3	-	-	-	-	2	-	-	-	
CO 5	1	-	2	-	-	1	1	-	-	-	-	-	
CO 6	2	-	-	-	-	1	-	1	-	-	-	-	
CO 7	2	-	-	-	2	1	-	-	-	2	-	-	
CO8	-	-	-	-	3	1	-	2	-	-	-	-	
CO 9	-	-	1	-	3	-	2	1	-	-	-	-	
CO 10	-	-	3	2	-	1	-	-	-	-	-	-	
CO 11	-	-	3	-	1		1	1	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

MAR IVANIOS COLLEGE (AUTONOMOUS)

Discipline	CHEMISTRY				
Course Code	**MIUK7DSCCHE301.1**				
Course Title	**COORDINATION AND BIOINORGANIC CHEMISTRY**				
Type of Course	**DSC B7**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	1. Plus two 2. Basic idea in general chemistry				
Course Summary	This course deals with the electronic configuration, general characteristics, stability of oxidation states, and the formation of complexes by transition and inner transition elements, their color, magnetic, and catalytic properties, along with the preparation, properties, and uses of their specific compounds. Furthermore, the course covers coordination chemistry, organometallic and bioinorganic chemistry, metallurgy, and practical experiments in gravimetric analysis, providing students with a holistic understanding of the chemistry of transition and inner transition elements.				

Detailed Syllabus:

Module	Unit	Content	Hrs 75
I	**TRANSITION AND INNER TRANSITION ELEMENTS**		**9**
	1	Electronic Configuration and General Characteristics - Overview of transition elements and inner transition elements - Electronic configuration	2

		- General characteristics including oxidation states, ionization enthalpy, and enthalpy of atomization - Variation of ionization enthalpy across the 3d series - Introduction to standard electrode potentials (E° M^{2+}/M & E° M^{3+}/M^{2+}).	
	2	Stability of Higher Oxidation States and Formation of Complexes - Factors affecting stability of higher oxidation states - Formation of complexes and ligand interactions - Importance of coordination chemistry in transition metal complexes	1
	3	Colour, Magnetic Property, and Catalytic Property - Explanation of colour in transition metal complexes (d-d transitions) - Magnetic properties including paramagnetism and diamagnetism - Catalytic properties and their industrial applications - Explanation of relativistic effects in heavier transition elements	2
	4	Preparation, Properties, and Uses of Specific Compounds - Detailed study of $K_2Cr_2O_7$, $KMnO_4$, and $TiCl_4$ - Preparation methods, physical and chemical properties - Industrial and laboratory uses of these compounds - Important applications of transition metals in various fields	2
	5	Electronic Configuration, General Properties, and Reactions of Lanthanides and Actinides - Introduction to lanthanides and actinides - Electronic configurations and general properties - Reactions and similarities with transition elements - Overview of unique properties, applications of lanthanides and actinides	2
	COORDINATION CHEMISTRY		**18**
	6	Ligands and Their Classifications - Introduction to ligands in coordination chemistry - Classification of ligands based on donor atoms: monodentate, bidentate, polydentate - Classification based on charge: anionic, cationic, neutral - Discussion on coordination number and coordination geometry	1
	7	Nomenclature of Complexes - Guidelines for naming coordination compounds - Nomenclature of complexes with simple and complex ligands - Examples illustrating the naming process	1
	8	EAN Rule, Chelates, and Stability of Complexes - Explanation of the EAN (Effective Atomic Number) rule - Concept of chelation and chelating ligands - Factors affecting the stability of complexes: size and charge of metal ion, nature of ligands, and coordination number	2
	9	Isomerism in Complexes	2

II		- Overview of structural isomerism and stereoisomerism in coordination compounds - Types of structural isomerism: linkage isomerism, coordination isomerism, and ionization isomerism - Types of stereoisomerism: geometrical isomerism and optical isomerism	
	10	Bonding in Complexes - V.B. Theory - Introduction to Valence Bond Theory (V.B. Theory) for coordination compounds - Explanation of bonding between metal ion and ligands - Hybridization and overlap of atomic orbitals - Limitations and applications of V.B. Theory	2
	11	Crystal Field Theory (CFT) Applied to Various Complex Geometries - Overview of CFT - Application of CFT to octahedral, tetrahedral, and square pyramidal complexes - Explanation of splitting of d orbitals in the presence of ligands - Factors affecting crystal field splitting: nature of metal ion, ligand strength, and geometry of complex	2
	12	Factors Affecting Crystal Field - Detailed discussion on factors influencing crystal field splitting energy - Ligand field stabilization energy (LFSE) - Effects of coordination number, ligand field strength, and nature of ligands on crystal field splitting - Applications of crystal field theory in predicting magnetic properties and colours of coordination compounds.	1
	13	Spectrochemical Series and Crystal Field Stabilization Energy (CFSE) - Introduction to the spectrochemical series - Explanation of ligands' ability to cause d-orbital splitting - Relationship between ligand strength and splitting energy - Calculation and significance of CFSE - Examples illustrating the spectrochemical series and CFSE values	1
	14	Magnetic Properties and Colour of Metal Complexes - Explanation of magnetic properties: paramagnetism, diamagnetism, and ferromagnetism - Factors influencing magnetic behaviour in metal complexes - Relationship between electronic configuration, CFSE, and magnetic properties - Relationship between ligand field strength, d-d transitions, and colour in metal complexes	1
	15	Effects of Crystal Field Splitting - Overview of crystal field splitting in octahedral complexes - Explanation of the effects of crystal field splitting on electronic configuration and stability	1

		- Relationship between ligand field strength and the magnitude of splitting - spectrochemical series	
	16	Jahn-Teller Effect and Tetragonal Distortion - Introduction to the Jahn-Teller effect in transition metal complexes - Explanation of distortion in coordination geometries caused by Jahn-Teller effect - Focus on tetragonal distortion of octahedral complexes - Examples illustrating the Jahn-Teller effect in coordination chemistry	1
	17	Application of Coordination Compounds in Metallurgy and Analysis - Overview of the role of coordination compounds in metallurgical processes - Application of coordination compounds in qualitative and quantitative analysis - Use of EDTA (Ethylenediaminetetraacetic acid) as a complexometric titrant - Examples of complexometric titrations and their significance in analytical chemistry	1
	18	Reactions of Metal Complexes - Labile and Inert Complexes - Explanation of labile and inert metal complexes - Ligand substitution reactions: S_N1 and S_N2 mechanisms - Factors influencing the rate of ligand substitution reactions - Examples illustrating labile and inert complexes and their reactions - Ligand substitution reactions and their applications - Review of key concepts including spectrochemical series, CFSE, magnetic properties, crystal field splitting, Jahn-Teller effect, and application in metallurgy and analysis - Summary of the importance of coordination compounds in various fields.	2
III	**ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY**		**9**
	19	Definition and Nomenclature of Organometallic Compounds - Introduction to organometallic compounds - Definition and significance in chemistry - Nomenclature guidelines for organometallic compounds.	1
	20	Classification and 18-Electron Rule - Classification of organometallic complexes as sigma, pi, and mixed complexes - Explanation of the 18-electron rule in organometallic chemistry - Examples illustrating the application of the 18-electron rule	1
	21	Metal Carbonyls - Overview of metal carbonyls - Classification into mononuclear and polynuclear complexes - Detailed study of metal carbonyls with examples using Fe, Co, and Ni - Preparation methods and key properties of metal carbonyls	1
	22	Bonding in Organometallic Compounds	2

		- Explanation of bonding in organometallic compounds without using Molecular Orbital Theory (MOT) - Detailed analysis of bonding in specific compounds like ferrocene, dibenzene chromium, and Ziese's salt - Introduction to dinitrogen complexes and their bonding characteristics	
	23	Applications of Organometallic Compounds - Overview of the diverse applications of organometallic compounds - Industrial applications in catalysis, synthesis, and materials science - Environmental and pharmaceutical applications	2
	24	Bioinorganic Chemistry - Introduction to bioinorganic chemistry and the role of metal ions in biological systems - Detailed study of the biochemistry of iron in hemoglobin and myoglobin - Elementary understanding of the structure and mechanism of action of hemoglobin and myoglobin	2
IV	**METALLURGY**		**9**
	25	Methods of Concentration of Ore - Overview of ore concentration techniques - Gravity separation: principles and applications - Froth flotation: process and its significance in mineral processing - Magnetic separation: principles and applications in separating magnetic ores - Leaching: introduction to different leaching methods such as acid leaching and cyanide leaching - Electrostatic separation: principles and applications in separating non-conductive minerals - Automated ore sorting: modern techniques for ore sorting based on optical properties or sensors - Dewatering: methods to remove water from concentrated ore slurry	1
	26	Preliminary Processes - Calcination and Roasting - Definition and importance of calcination and roasting in metallurgy - Explanation of calcination and roasting processes - Differences between calcination and roasting - Examples illustrating the application of calcination and roasting in ore treatment	1
	27	Methods of Extracting Metal from Concentrated Ore - Overview of electrometallurgy as a method for extracting metals from ores - Metallurgy of Aluminium: Bayer's process, Hall-Héroult process - Sodium-pyrometallurgy: extraction of sodium by Downs process - Pyrometallurgy: principles and applications in extracting metals from ores using heat	2

		- Discussion on specific examples of pyrometallurgical processes	
	28	Metallurgy of Iron and Zinc - Detailed study of the metallurgy of iron, including blast furnace process and refining methods - Metallurgy of zinc: overview of the extraction process from zinc blende (sphalerite)	1
	29	Aluminothermy, Auto-reduction, and Hydrometallurgy - Explanation of aluminothermy and its applications in extracting metals - Auto-reduction: self-reduction processes in metallurgy - Hydrometallurgy: principles and applications of extracting metals using aqueous solutions.	1
	30	Metallurgy of Silver and Gold - Overview of the metallurgy of silver and gold -Methods of extraction including cyanidation, amalgamation, and smelting - Importance of purification steps in obtaining high-purity silver and gold	1
	31	Purification of Crude Metal - Explanation of purification techniques such as distillation, liquation, and zone refining - Electrorefining: principles and applications in refining metals like copper - Chromatographic techniques: separation methods based on differential migration - Introduction to vapor phase refining processes like Mond's process and Van Arkel process	2
V	**PRACTICALS: GRAVIMETRIC ANALYSIS**		**30**
		A minimum of 5 practical experiments from any sections must be performed and reported.	
	32	**D. Estimations using silica crucible**	
		Estimation of water of crystallization in hydrated Barium chloride	
		Estimation of Barium as Barium sulphate	
		Estimation of sulphate as Barium sulphate	
		Estimation Iron as Fe_2O_3	
		Estimation Calcium as $CaCO_3$	
		Estimation Aluminium as Al_2O_3	
		Estimation Magnesium as $Mg_2P_2O_7$	
	33	**E. Estimations using sintered crucible**	
		Magnesium as oxinate	
		Nickel as nickel dimethyl glyoximate	
		Copper as copper thiocyanate	
		Silver as silver chloride	
	34	**F. Colorimetry**	
		Determination of Fe^{3+} using thiocyanate	

		Determination of ammonia using Nessler's reagent.	

References:

1. B.R. Puri L.R. Sharma, K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2010.
2. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Wiley India Pvt. Ltd., 2008.
3. R. Gopalan, V.Ramalingam, *Concise Coordination Chemistry*, 1st Edn.,Vikas Publishing House, New Delhi, 2001.
4. S. Prakash, G. D. Tuli, S. K. Basu, R. D. Madan, *Advanced Inorganic Chemistry*, 5th Edn., Vol. I, S Chand, 2012.
5. G. S. Manku, *Theoretical Principles of Inorganic Chemistry*. McGraw-Hill Education; New edition (1 August 1982)
6. M.C. Day, J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
7. J. E. Huheey, E.A. Keitler, R. L. Keitler, *Inorganic Chemistry-Principles of Structure and Reactivity*, 4th Edn., Pearson Education, New Delhi,2013.
8. B.K. Sharma, *Industrial chemistry*, 11th Edn., Goel publishing House, Meerut, 2000.
9. M.N. Greenwood, A. Earnshaw, *Chemistry of elements*, 2nd Edn., Butterworth,1997.
10. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn., Pearson Education, Noida, 2013.
11. D. A. Skoog, D. M. West, F. J. Holler, S. R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.

Further Reading

12. James E. House, Inorganic Chemistry, academic press, 2008.
13. W.U. Malik, G.D.Tuli, R.D. Madan, selected Topics in Inorganic Chemistry, S. Chand and Co., New Delhi, 2010.
14. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn., Wiley India Pvt. Ltd., New Delhi,2009.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the electronic configuration, general properties, and reactions of lanthanides and actinides, including their unique properties and applications	R, U	1,2
CO-2	Understand the principles and theories in coordination chemistry, including ligand classification, nomenclature of complexes, and factors influencing the stability of complexes.	R, U	1,2
CO-3	Gain proficiency in applying various theoretical models to analyze and predict the properties of coordination	Ap	1,3

	compounds, including their magnetic behaviour, colour, and stability.		
CO-4	Gain insights into the applications of organometallic compounds in various fields such as catalysis, materials science, and bioinorganic chemistry.	Ap, U	1,3
CO-5	Gain insight into the metallurgy of specific metals, enabling to comprehend the practical aspects of metallurgical processes and their applications in industry.	E, Ap	4,5
CO-6	Develop skills in quantitative analysis, data interpretation, and laboratory techniques, enabling them to apply these methods effectively in practical scenarios and contribute to advancements in analytical chemistry.	C, Ap	1,3,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: COORDINATION AND BIOINORGANIC CHEMISTRY

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practica l (P)
CO-1	Understand the electronic configuration, general properties, and reactions of lanthanides and actinides, including their unique properties and applications	R, U	1,2	F, C	L	
CO-2	Understand the principles and theories in coordination chemistry, including ligand classification, nomenclature of complexes, and factors influencing the stability of complexes.	R, U	1,2	C	L	
CO-3	Gain proficiency in applying various theoretical models to analyze and predict the properties of coordination compounds, including their magnetic	Ap	1,3	C, P	L, T	

	behaviour, colour, and stability.					
CO-4	Gain insights into the applications of organometallic compounds in various fields such as catalysis, materials science, and bioinorganic chemistry.	Ap, U	1,3	C	L, T	
CO-5	Gain insight into the metallurgy of specific metals, enabling to comprehend the practical aspects of metallurgical processes and their applications in industry.	E, Ap	4,5	C	L, T	
CO-6	Develop skills in quantitative analysis, data interpretation, and laboratory techniques, enabling them to apply these methods effectively in practical scenarios and contribute to advancements in analytical chemistry.	C, Ap	1,3,4	C, M		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

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

Correlation Levels:

Level	Correlation

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

MAR IVANIOS COLLEGE (AUTONOMOUS)

Discipline	CHEMISTRY				
Course Code	**MIUK7DSCCHE302.1**				
Course Title	**ORGANIC CHEMISTRY AND BIOMOLECULES**				
Type of Course	**DSC C7**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	3. Plus Two 4. Basic idea about stereochemistry, reaction mechanism				
Course Summary	The Course deals with preparation, properties and uses of different alchols, carbonyl compounds, carboxylic acids, sulphonic acid and its derivatives. The course also covers topics on different organic nitrogen compounds- its classification, preparation, reactions and its separation. Classification, reactions and properties of carbohydrates, organometallics compounds and properties of different active methylene compounds are also discussed in the course.				

Detailed Syllabus:

Module	Unit	Content	60 Hrs
I		**Aldehydes and Ketones**	**12**
	1	Preparation: Oxidation of primary and secondary alcohols using PCC, reduction of esters using DIBAL-H, Rosenmund reduction, Gattermann-Koch formylation and Friedel-Craft's acylation Chemical properties: Nucleophilic addition (HCN, NaHSO3, RMgX and ROH)	3
	2	Addition-elimination reaction (with ammonia and ammonia derivatives). Addition reactions of unsaturated carbonyl compounds:	3

		Michael addition. MPV reduction, Clemmenson and Wolff-Kishner reduction	
	3	Oxidation: with KMnO4, Tollen's reagent, Fehling solution, Br2 water, Oppenaur oxidation	2
	4	Acidity of α-hydrogen: Aldol, Claisen-Schmidt, Benzoin, Perkin and Knovenagel condensations (mechanism not expected).	2
	5	Haloform reaction – Iodoform test – Cannizaro reaction (mechanism not expected) and Beckmann rearrangement (mechanism not expected).	2
II	**Carboxylic acids and Sulphonic acids**		**12**
	6	Preparation: Hydrolysis of nitrile, carboxylation of Grignard reagent and oxidation of alkyl benzenes.	3
	7	Chemical properties: HVZ reaction, Decarboxylation – Kolbe electrolysis (Mechanism expected), Curtis reaction. Ascent and descent series in aliphatic carboxylic acids	3
	8	Preparation, properties and uses of anthranilic acid, cinnamic acid, citric acid, lactic acid, oxalic acid, adipic acid and phthalic acid.	2
	9	Formation of acid derivatives – acid chlorides, amides, acid anhydrides and esters – comparison of reactivity of acid derivatives. Preparation of coumarin – Fries rearrangement (Mechanism expected)	2
	10	Preparation and reactions of benzene sulphonic acid, toluene sulphonic acid and benzene sulphonyl chloride	2
III	**Organic Nitrogen compounds**		**12**
	11	Nitrocompounds: Nitro-acitautomerism, Nef's reaction. Reduction of nitrobenzene in various media. Preparation of nitro toluenes, nitro compounds as explosives.	2
	12	Amines: Classification – Preparation: From alkyl halides, nitro compounds, nitriles, isonitriles and amides – Hoffmann's bromamide reaction, Schmidt reaction, Gabriel phthalimide synthesis.	2
	13	Chemical properties: Carbyl amine reaction, conversion of amines to alkene (Hoffmann elimination with mechanism), acylation, reaction with nitrous acid and Mannich reaction.	2
	14	Electrophilic substitution reactions of aniline: halogenation, sulphonation and nitration by amino protection (acetylation). Benzidine rearrangement (mechanism expected).	2
	15	Separation of mixture of amines – methods to distinguish primary, secondary and tertiary amines.	2
	16	Preparation and synthetic applications of diazonium chloride and diazomethane	2
IV	**Carbohydrates**		**12**
	17	Classification and nomenclature of monosaccharides, configuration of monosaccharides.	3
	18	Reactions of glucose and fructose – Determination of open chain structure of D-glucose and D-fructose.	3

	19	Anomers and mutarotation in glucose - cyclic structure – pyranose and furanose forms – Haworth projection formula – chair conformations. Epimers and epimerization – Interconversion of aldoses and ketoses – chain lengthening and shortening of aldoses.	4
	20	Disaccharides – reactions and structure of sucrose -– Industrial applications of cellulose-Paper Industry, Textile Industry, Rayon.	2
V		**Organometallics and Active Methylene compounds**	**12**
	21	Organomagnesium compounds: Grignard reagent: Preparation – Reaction with compounds containing acidic hydrogen, carbonyl compounds, cyanides and CO2.	3
	22	Organo lithium compounds: Preparation – Reaction with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO2.	3
	23	Organo zinc compounds: Preparation of dialkyl zinc – Reaction with active hydrogen compounds, acid halides and alkyl halides,	2
	24	Li dialkylcuprates – Preparation and reaction with aliphatic/aromatic/vinyl halides.	2
	25	Active methylene compounds – examples. Preparation of ethyl acetoacetate by Claisen condensation (mechanism expected), tautomerism.	2

References

For Theory

Text books

1. A.Bahl and B.S.Bahl, Advanced Organic Chemistry, S.Chand& Company, New Delhi.

2. L.G.Wade Jr, Organic Chemistry, Pearson Education, New Delhi.

3. K.S.Tewari, N.K.Vishnoi and S.N.Mehrotra, A textbook of Organic Chemisty, Vikas Publishing House (Pvt) Ltd., New Delhi..

4. S.C.Sharma and M.K.Jain, Modern Organic Chemistry, Vishal Publishing Company, New Delhi.

5. I L Finar, “Organic Chemistry” Vol – 1, 5th Edition, Pearson Education, New Delhi.

6. J. Clayden, N.Greeves and S.Warren, Organic Chemistry, Oxford University Press, New York.

7. Helena Dodzuik, Introduction to supramolecular chemistry, Springer.

		For further reading: 1. L.M. Lehn, Supramolecular Chemistry, VCH. 2. M.M.Sreevastava and Rashmi Sanghi, Green Chemistry for environment, Narosa Publishing House. 3. R.T.Morrison, R.N.Boyd. Organic Chemistry, Pearson Education, New Delhi. 4. P.Y.Bruice, Essential Organic Chemisty, Pearson Education, New Delhi. 5. G.M. Louden, Organic Chemistry, Oxford University Press, New York. 6. V.K.Ahluwaliya, Organic Reaction Mechanisms, Narosa Publishing House, New Delhi.	

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Describe the preparation and reactions of carbonyl compounds, carboxylic acids, sulphonic acids, amino and nitro compounds, carbohydrates	R, A, U	1,2
CO-2	Plan synthesis of derivatives of carbonyl compounds, carboxylic acids and sulphonic acids	A	1
CO-3	Distinguish primary, secondary & tertiary amines.	U	3
CO-4	Write reaction steps in ascending & descending of interconversion of aldose and ketose, chain lengthening and shortening of aldoses.	Ap	4
CO-5	Explain the structure of glucose, fructose, sucrose, starch and cellulose.	A	1,3
CO-6	Describe the preparation and reactions of organo Mg, Li, Zn and Cu compounds	U, Ap	1
CO-7	Classify reaction mechanism with suitable examples	A	1,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: ORGANIC CHEMISTRY III

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Describe the preparation and reactions of carbonyl compounds, carboxylic acids, sulphonic acids, amino and nitro compounds, carbohydrates	1,2	R, A, U	F	L	
2	Plan synthesis of derivatives of carbonyl compounds, carboxylic acids and sulphonic acids	1	A	P	L	
3	Distinguish primary, secondary & tertiary amines.	3	U	C	L	
4	Distinguish primary, secondary & tertiary amines.	4	Ap	C	L	
5	Explain the structure of glucose, fructose, sucrose, starch and cellulose.	1,3	A	M	L	
6	Describe the preparation and reactions of organo Mg, Li, Zn and Cu compounds	1	U, Ap	C, P	L, T	
7	Classify reaction mechanism with suitable examples	1,5	A	P	L, T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	3	1	1	1	1	2	2	1	2	1	2
CO 2	3	1	1	1	1	2	2	1	1	3	1	3
CO 3	1	1	3	1	1	1	2	2	1	1	1	1
CO 4	1	1	1	3	1	2	2	2	3	1	3	1
CO 5	3	1	2	1	1	1	1	1	1	1	1	1
CO 6	3	1	1	1	1	1	2	1	2	1	2	1
CO 7	3	1	1	1	2	1	2	1	1	1	1	1

Correlation Levels:

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

MAR IVANIOS COLLEGE (AUTONOMOUS)

Discipline	**CHEMISTRY**				
Course Code	**MIUK7DSCCHE303.1**				
Course Title	**PHYSICAL SPECTROSCOPY AND QUANTUM MECHANICS**				
Type of Course	**DSC D7**				
Semester	VII				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	1. Essential conditions for understanding quantum mechanics, spectroscopy, statistical thermodynamics, group theory, non-spectroscopic methods, and instrumental methods of analysis include a strong grasp of fundamental principles such as wave-particle duality, electromagnetic radiation interactions, statistical ensembles, symmetry operations, and analytical techniques. 2. Proficiency in mathematical techniques including algebra and calculus, experimental methodologies, data interpretation, and their applications in various scientific disciplines is crucial for mastering these subjects.				
Course Summary	This course provides a comprehensive understanding of Quantum Mechanics, delving into wave-particle duality, Schrödinger's equation, and energy quantization. Spectroscopy techniques, including rotational spectroscopy, vibrational spectroscopy,				

	electronic spectroscopy, Raman, NMR and ESR, are explored for molecular analysis and structural elucidation. Additionally, students study Statistical Thermodynamics and Group Theory for molecular symmetry analysis. The Instrumental Methods of Analysis provides an in-depth understanding of modern analytical techniques and their applications.

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**QUANTUM MECHANICS**		**12**
	1	Quantum mechanical operators, Postulates of quantum mechanics, Schrödinger equation and its application to particle in one-dimensional box (complete solution) - quantization of energy levels, zero-point energy, normalization of wave functions, probability distribution functions, nodal properties.	4
	2	Extension to three-dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.	4
	3	Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables (Preliminary treatment).	4
II	**SPECTROSCOPY I**		**12**
	4	Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.	4
	5	Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes	4

		of vibration. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches	
	6	Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	4
III	**SPECTROSCOPY II**		**12**
	7	Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.	3
	8	NMR spectroscopy: Principle of NMR, nuclear spin. HNMR, Interaction of nuclear spin with external magnet. Energy level splitting, Precession.	2
	9	Chemical shift. Delta and tau scales. Presentation of NMR spectra, Low resolution spectra and high-resolution spectra, -Spin-spin coupling	2
	10	Electron spin resonance spectroscopy: Principle, Types of substances with unpaired electrons, interaction of electron magnet with external magnet.	2
	11	Energy level splitting. Lande splitting factor, presentation of ESR spectrum, the normal and derivative spectra. Hyperfine splitting. Simple examples of methyl and benzene radicals	3
IV	**STATISTICAL THERMODYNAMICS & GROUP THEORY**		**12**
	12	Statistical thermodynamics: introduction, types of statistics-MB, BE and FD. Fermions and bosons, Phase space, system, assembly and ensemble-types of ensembles and uses. Thermodynamic probability, Boltzmann distribution law and Partition function (no derivation).	3
	13	Thermodynamic functions in terms of partition functions -internal energy, enthalpy, pressure, work function and free energy function	2
	14	Symmetry element and operation, definition of mathematical group, sub group, Point group. Identification of symmetry elements and point groups for different molecules. H_2O, NH_3, BF_3, C_2H_2, C_6H_6, CH_4, SF_6.	5
	15	Construction of Group multiplication table of C_2V. The great orthogonality theorem (without proof) and its importance.	2
V	**OPEN ENDED MODULE: Learning through problem solving, seminars, open discussions on real life applications, assignment discussions, Quizzes, Open book exams, etc.**		**12**

References:

12. Ira N. Levine, *Quantum Chemistry*, Delhi: PHI Learning, 2014.
13. R L Madan, *Quantum Mechanics and Analytical Techniques*, NEP 2020 Uttar Pradesh Latest Edition 2023 By S. Chand's.
14. *A Text book of Quantum Mechanics*, PM Mathews & K Venkatesan, 2nded, Tata McGraw Hill, (2011).
15. *Introduction to Quantum Mechanics*, David Griffiths, 2^{nd}ed., Pearson, (2015).
16. C.N. Banwell, *Fundamentals of Molecular Spectroscopy*, Tata McGraw-Hill Education.
17. Manas Chanda, "*Atomic structure and Chemical bonding in Molecular Spectroscopy*", Tata McGraw Hill.
18. A. Salahuddin Kunju and G. Krishnan, *Group Theory and its Applications in Chemistry*, PHI Learning Pvt. Ltd.
19. B. R Puri, L. R Sharma,M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Company.
20. Ramakrishnan and M S Gopinathan, *Group Theory in Chemistry*, Vishal Publishing Co.
21. J. E. Huheey,E. A. Keiter, R. L. Keiter, O. K. Medhi. *Inorganic Chemistry*, 4th Edn. Pearson, 2006.
22. D. A. Skoog, F. James Holler. S.R. Crouch. *Principles of Instrumental analysis*, 6th Edn., Cengage Learning, Noida, 2004.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles of quantum mechanics and apply them to explain the behaviour of particles at the atomic and molecular levels.	U, A	1
CO-2	Apply spectroscopic methods to investigate the electronic, vibrational, and rotational properties of molecules.	A	2, 5
CO-3	Interpret spectra to identify chemical compounds, determine molecular structures, and analyse chemical reactions.	U	5
CO-4	Apply statistical thermodynamics to predict thermodynamic properties of systems and understand chemical equilibria.	A	2
CO-5	Understand the mathematical principles of group theory and its applications in chemistry and apply it to predict molecular properties and interpret spectroscopic data.	U, A	2
CO-6	Apply instrumental methods to solve analytical problems in chemistry, biochemistry, environmental science, and related fields.	A	5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL SPECTROSCOPY AND QUANTUM MECHANICS

Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand the fundamental principles of quantum mechanics, and apply to explain the behaviour of particles at the atomic and molecular levels.	1	U, A	F, C	L	
CO-2	Apply spectroscopic methods to investigate the electronic, vibrational, and rotational properties of molecules.	2, 5	A	C	L	
CO-3	Interpret spectra to identify chemical compounds, determine molecular structures, and analyse chemical reactions.	5	U	P, M	L, T	
CO-4	Apply statistical thermodynamics to predict thermodynamic properties of systems and understand chemical equilibria.	2	A	P	L, T	
CO-5	Understand the mathematical principles of group theory and its applications in chemistry and apply to predict molecular properties and interpret spectroscopic data.	2	U, A	P	L	
CO-6	Apply instrumental methods to solve analytical problems in chemistry, biochemistry,	5	A	P	L, T	

	environmental science, and related fields.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	1	1	1	2	1	1	1	2	1	1
CO 2	1	3	1	1	3	1	3	2	1	2	1	2
CO 3	1	1	1	1	3	1	3	2	1	2	1	3
CO 4	1	2	1	1	1	1	1	2	2	1	3	1
CO 5	1	3	1	1	1	1	2	1	2	1	2	2
CO 6	1	1	1	1	3	2	2	2	2	1	1	3

Correlation Levels:

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

Mar Ivanios College (Autonomous)

Discipline	**CHEMISTRY**				
Course Code	**MIUK7DSECHE400.1**				
Course Title	**RESEARCH METHODOLOGY AND ETHICS**				
Type of Course	**DSE 7.1**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Plus Two				
Course Summary	This will be an elective course for students who are in their seventh semester. This course is useful to understand the scientific methodology adopted for research in chemistry and allied subjects.				

Detailed Syllabus:

Module	Unit	Content	Hrs
I	**INTRODUCTION TO SCIENTIFIC RESEARCH**		**15**
	1	Understanding the Scientific Method- - Overview of the scientific method: observation, hypothesis, experimentation, analysis, and conclusion.- Role of experimentation in testing hypotheses and theories. - Examples of famous scientific experiments and discoveries.	3

	2	Formulating Research Questions and Hypotheses- Importance of formulating clear and concise research questions.- Strategies for developing testable hypotheses.- Different types of hypotheses (null, alternative, directional, non-directional).	4
	3	Literature Review and Background Research- Purpose and significance of literature review in research. Techniques for conducting literature searches and reviews. Evaluation of scientific literature: credibility, relevance, and reliability.- Introduction to online databases, journals, and other scientific resources.	3
	4	Research Ethics and Responsible Conduct of Research - Overview of research ethics principles: honesty, integrity, objectivity, and accountability. Ethical considerations in chemistry research: human and animal subjects, environmental impact, conflicts of interest. - Responsible conduct of research: data integrity, authorship, peer review, and collaboration. Case studies and ethical dilemmas in chemistry research.	5
II	**EXPERIMENTAL DESIGN AND TECHNIQUES**		**15**
	5	Variables and Controls in Experimental Design - Definition and types of variables: independent, dependent, and controlled variables. - Importance of controlling variables to ensure validity and reliability of experiments. - Designing controlled experiments: identifying and manipulating variables.	4
	6	Sample Selection, Preparation, and Handling - Principles of sample selection: representativeness, randomization, and sample size. - Techniques for sample preparation: weighing, dilution, dissolution, and extraction.	5

		- Proper handling and storage of samples to prevent contamination and degradation.	
	7	Statistical Considerations in Experimental Design - Introduction to basic statistical concepts: mean, median, mode, standard deviation, and variance. - Importance of statistical analysis in interpreting experimental results. - Selection of appropriate statistical tests based on experimental design and data characteristics.	4
	8	Safety Protocols in the Laboratory and Chemical Handling** - Overview of laboratory safety regulations and guidelines. - Hazard identification and risk assessment in chemical laboratories. - Proper use of personal protective equipment (PPE) and emergency response procedures. - Handling, storage, and disposal of hazardous chemicals and waste materials	2
III	**DATA COLLECTION AND ANALYSIS**		**15**
	9	Methods for Data Recording and Organization - Importance of systematic data recording and organization in scientific research. - Techniques for maintaining accurate and detailed laboratory notebooks. - Electronic data recording and management systems.	3
	10	Quantitative and Qualitative Data Analysis Techniques - Introduction to quantitative data analysis methods: descriptive statistics, inferential statistics, and hypothesis testing. - Application of statistical tests such as t-tests, ANOVA, regression analysis, and correlation analysis. - Techniques for qualitative data analysis: coding, thematic analysis, and content analysis.	3
	11	Error Analysis and Uncertainty Estimation	3

		- Understanding sources of error in experimental measurements: systematic errors, random errors, and instrumental errors. - Methods for error propagation and uncertainty estimation. - Introduction to error bars, confidence intervals, and uncertainty budgets.	
	12	Interpretation of Experimental Results - Strategies for interpreting and evaluating experimental results. - Differentiating between correlation and causation. - Drawing conclusions and implications from experimental findings. - Communicating uncertainties and limitations of research outcomes.	2
	13	Practical Exercises and Activities - Data collection and analysis exercises using real or simulated experimental data sets. - Statistical software tutorials and hands-on practice sessions. - Error analysis exercises and uncertainty estimation calculations. - Interpretation of experimental results and discussion in small groups.	4
IV	**SCIENTIFIC COMMUNICATION AND RESEARCH ETHICS**		**15**
	14	Writing Research Proposals and Reports - Structure and components of research proposals and reports. - Guidelines for writing clear, concise, and well-organized research documents. - Incorporating background literature, research questions, methods, results, and conclusions. - Formatting and citation styles commonly used in scientific writing (e.g., APA, ACS).	2
	15	Creating Effective Scientific Presentations - Principles of effective scientific presentations: clarity, organization, and engagement. - Designing visual aids (e.g., slides, posters) to enhance communication of research findings.	3

		- Techniques for delivering presentations confidently and engagingly. - Handling questions and feedback during presentations.	
	16	Peer Review Process and Manuscript Submission - Overview of the peer review process in scientific publishing. - Understanding the roles of authors, reviewers, and editors. - Ethical considerations in peer review: confidentiality, conflicts of interest, and fairness. - Strategies for responding to peer review comments and revising manuscripts.	3
	17	Ethical Considerations in Chemistry Research - Ethical principles guiding chemistry research: honesty, integrity, objectivity, and accountability. - Ethical issues specific to chemistry research, including safety, environmental impact, and human subjects. - Case studies and ethical dilemmas related to data fabrication, plagiarism, and authorship disputes.	2
	18	Plagiarism Awareness and Academic Integrity - Understanding plagiarism and its consequences in academic and professional settings. - Techniques for properly citing sources and avoiding plagiarism. - Importance of academic integrity in research and scholarship. - Strategies for fostering a culture of academic honesty and integrity.	1
	19	Practical Exercises and Activities - Writing research proposals, reports, and abstracts based on provided prompts or student-generated research ideas. - Designing and delivering scientific presentations on research findings. - Participating in mock peer review exercises and providing constructive feedback.	4

		- Ethical case studies and discussions on responsible conduct of research. Participation in peer review exercises and response to reviewer comments. - Ethical reflection papers or assignments demonstrating understanding of research ethics principles. - Adherence to citation and referencing conventions in written assignments.	

References

Text Books:

1. C.R. Kothari and Gaurav Garg (2019), Research Methodology: Methods and Techniques, New Age Publications.

2. Ledwani, L., & Chakraborty, T. (2021). *Research Methodology in Chemical Sciences: Experimental and Theoretical Approach*. CRC Press.

Other references:

1. Booth, W. C., Colomb, G. G., & Williams, J. M. (2008). The Craft of Research. University of Chicago Press.

2. Ruxton, G., & Colegrave, N. (2006). Experimental Design for the Life Sciences. Oxford University Press.

3. Miller, J. N., & Miller, J. C. (2005). Statistical Methods for Chemistry. Wiley.

4. Whitlock, M. C., & Schluter, D. (2020). The Analysis of Biological Data. Roberts and Company Publishers.

5. Coghill, A. M., & Garson, L. R. (2006). The ACS Style Guide: Effective Communication of Scientific Information. American Chemical Society.

6. Committee on Science, Engineering, and Public Policy. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research (3rd ed.). The National Academies Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Demonstrate Proficiency in Scientific Research Skills.	U	1, 2
CO-2	Develop Practical Laboratory Technique adhering to safety protocols and ethical guidelines.	Ap, U	1, 2
CO-3	Apply Quantitative and Qualitative Data Analysis Methods.	Ap, U	1, 2
CO-4	Communicate Scientific Findings Effectively.	Ap, An	1, 2, 4
CO-5	Understand Research Ethics and Responsible Conduct.	U	1, 2, 4
CO-6	Promote Academic Integrity and Professionalism	U	1, 2, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: RESEARCH METHODOLOGY AND ETHICS
Credits: 4:0:0 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Demonstrate Proficiency in Scientific Research Skills.	1, 2	U	F, C	L	
2.	Develop Practical Laboratory Technique adhering to safety protocols and ethical guidelines.	1, 2	Ap, U	F, C,	L, T	
3.	Apply Quantitative and Qualitative Data Analysis Methods.	1, 2	Ap, U	F, C, P	L	
4.	Communicate Scientific	1, 2, 4	Ap, An	F, C, P	L, T	

	Findings Effectively.					
5.	Understand Research Ethics and Responsible Conduct.	1, 2, 4	U	F, C	L, T	
6.	Promote Academic Integrity and Professionalism	1, 2, 5	U	F, C, P	L, T	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

SEMESTER VIII

Discipline	CHEMISTRY				
Course	DSC A8-I				
Type of Course	Online Course				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Course Summary	Students can select an online course from a list of courses approved by the Board of studies. MOOC / Appropriate courses will be provided by the department.				

Discipline	CHEMISTRY				
Course	DSC A8-II				
Type of Course	Online Course				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Course Summary	Students can select an online course from a list of courses approved by the Board of studies. MOOC / Appropriate courses will be provided by the department.				

Discipline	CHEMISTRY				
Course Code	MIUK8RPHCHE450				
Course Title	Research Project				
Type of Course	RPH				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	12	-	-	-	-
Course Summary	Students has to do a research project				

MAR IVANIOS COLLEGE (AUTONOMOUS),
THIRUVANANTHAPURAM
BOARD OF STUDIES IN CHEMISTRY, 2023 – 2026

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18.	Prof. V. M. Biju	Professor & Head Department of Chemistry National Institute of Technology Trichy-620 015, Tamil Nadu