RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M. S. Ramaiah University of Applied Sciences

Programme structure and Course details of M.Sc. (Industrial Chemistry)

Postgraduate Degree Programme

Programme Code: 083

2022 onwards

Registrar
M.S.Ramaiah University of Applied Sciences
Bangalore

Department of Chemistry
Faculty of Mathematical and Physical Sciences
M. S. Ramaiah University of Applied Sciences
University House, New BEL Road, MSR Nagar, Bengaluru – 560 054
www.msruas.ac.in

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Bangalore - 560 058.

Dean - Academics
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Approved by Academic Council at its 26th meeting held on 14th July 2022

University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society
2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society
3. To promote health, human well-being and provide holistic healthcare
4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences
5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business
6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in
7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes

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Programme Specifications: M. Sc. (Industrial Chemistry)

Faculty	Mathematical & Physical Sciences
Department	Chemistry
Programme Code	083
Programme Name	M.Sc. (Industrial Chemistry)
Dean of the Faculty	Prof. Dilip Kumar Mahanty
Head of the Department	Dr. T. Niranjana Prabhu

1. **Title of the Award:** M.Sc. (Industrial Chemistry)
2. **Mode of Study:** Full-Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Mathematical & Physical Sciences, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications: 14 July 2022**
7. **Date of Programme Approval by the Academic Council of MSRUAS: 14 July 2022**
8. **Next Review Date:** June 2024
9. **Programme Approving Regulating Body and Date of Approval: University Grants Commission, New Delhi, 21st July 2016**
10. **Programme Accredited Body and Date of Accreditation: NA**
11. **Grade Awarded by the Accreditation Body: NA**
12. **Programme Accreditation Validity: NA**
13. **Programme Benchmark:** NA
14. **Rationale for the Programme:**

Industrial Chemistry is the branch of chemistry, which applies physical and chemical processes towards the transformation of natural materials and their derivatives to products which have utilitarian value. Over 90% of all the manufactured goods are touched by the business of chemistry. Chemical industries are an essential part of any nation's economy. Chemical industry contributes around 7 % of the Indian GDP. The industry presently produces around 80,000 commercial products, which range from toiletries and cosmetics, to plastics and pesticides. The industry is integral to the development of agricultural and industrial development in India and has key linkages with other industries dealing with fertilizers, automobiles, consumer goods, pharmaceuticals and food products. Globalization poses many challenges to the industry, which had predominantly developed in a protected environment. With World Trade Organization assuming an increasing role in global economics, there is an inevitable move towards an inter-linked international economy. In India, pharmaceuticals and biotechnology have performed exceedingly well even at the world level. The share of Gross Value Added (GVA) in the Manufacturing Sector during 2019-20 is about 8.97% at current prices. GVA of Chemical Sector has grown with CAGR of 12.57% during the period 2014-15 to 2019-20. Growing at this CSGR, the Indian

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chemical industry offers a wide spectrum of job opportunities for chemists. There is a great demand for chemists who are capable of translating chemical knowledge and skills into industrial development.

The Department of Chemistry at Faculty of Mathematical and Physical Sciences of MSRUAS offers the M.Sc. (Industrial Chemistry) programme with an outcome based curriculum emphasizing the Critical, Analytical and Problem Solving skills to equip the students to pursue their scientific and research career with better preparedness and a mature professional outlook. The presence of other allied Faculties of the University provides for a multi-disciplinary approach which is emerging as a key differentiator in the success of modern scientific and engineering endeavors.

In the coming years, the government intends to boost up funds for basic sciences. There is an acute shortage of qualified teaching staff. The job prospects for candidates with M.Sc. (Industrial Chemistry) look good in academia, R&D and industry.

15. Programme Mission

The purpose of the programme is to create innovative problem solvers in multi-disciplinary settings, entrepreneurs and leaders that apply their knowledge, understanding, cognitive abilities, practical skills and transferable skills gained through systematic, flexible and rigorous learning in the chosen academic domain.

16. Gradate Attributes (GAs)

GA-1. Ability to apply fundamental knowledge of Mathematical and Physical Sciences to solve real life problems in their chosen domain

GA-2. Ability to teach in schools, colleges and universities with relevant training and perform administrative duties in government, semi-government, private and public sector organizations

GA-3. Ability to understand and solve scientific problems by conducting experimental investigations

GA-4. Ability to apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories

GA-5. Ability to conduct scientific research and disseminate the knowledge in the chosen domain

GA-6. Ability to understand the effect of scientific solutions on legal, cultural, social, public health and safety aspects, and apply ethical principles to scientific practices and professional responsibilities

GA-7. Ability to develop sustainable solutions and understand their effect on society and environment

GA-8. Ability to Ability to work as a member of a team, to plan and to integrate knowledge of various disciplines and to lead teams in multidisciplinary settings

GA-9. Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

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GA-10. Ability to adapt to the changes and advancements in science and engage in independent and life-long learning

17. Programme Outcomes (POs)

M.Sc. graduates will be able to:

PO-1. Scientific Knowledge: Apply fundamental knowledge of chemical Sciences to solve real life problems in their chosen domain

PO-2. Knowledge, Dissemination and Administration: Teach in schools, colleges and universities with relevant training and perform administrative duties in government, semi-government, private and public sector organizations

PO-3. Problem Solving: Understand and solve scientific problems by conducting experimental investigations

PO-4. Modern Tool Usage: Apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories

PO-5. Research: Conduct scientific research and disseminate the knowledge in the chosen domain

PO-6. The Science, Society and Ethics: Understand the effect of scientific solutions on legal, cultural, social, public health and safety aspects, and apply ethical principles to scientific practices and professional responsibilities

PO-7. Environment and sustainability: Develop sustainable solutions and understand their effect on society and environment

PO-8. Individual and teamwork: Work as a member of a team, to plan and to integrate knowledge of various disciplines and to lead teams in multidisciplinary settings

PO-9. Communication: Make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

PO-10. Life-long learning: Adapt to the changes and advancements in science and engage in independent and life-long learning

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18.Programme Goal

The programme goal is to train students with advanced knowledge and understanding of Industrial Chemistry with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of academia and research with sufficient transferrable skills, and to pursue a career in academia with further relevant training, business and industry.

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19. Program Educational Objectives (PEOs)

The objectives of the M.Sc. (Industrial Chemistry) Programme are to:

PEO-1. To provide students the fundamental knowledge of chemistry to enable them to deliver efficient solutions for complex scientific problems using analytical and cognitive skills in their chosen domain.

PEO-2. To enable students to apply appropriate tools, techniques and understand utilization of resources in laboratories and computational skills in conducting research in their chosen domains and work as an individual as well as lead team in multidisciplinary settings.

PEO-3. To inculcate ethics, environmental sustainability, communication, soft, managerial and entrepreneurial skills for a successful career in industries and to engage in lifelong learning and also work towards developing sustainable society.

20. Programme Specific Outcomes (PSOs)

At the end of the M.Sc. (Industrial Chemistry) programme, the graduate will be able to:

PSO-1. Apply the knowledge of Chemistry to identify and explain basic laws and principles governing physical and chemical systems, use mathematical, statistical and computational methods to manufacture industrially important materials, explain their properties, adopt suitable methods to obtain the required products out of these materials.

PSO-2. Model and explore alternative materials and processes in an industry, develop strategies for commercial viability of a processes and products, solve and interpret results obtained through experimentation, design ways to recycle industrial wastes adopting safe handling practices and perform duties as per scientific protocols, demonstrate to work as an individual, and as a leader.

PSO-3. Demonstrate ethics, leadership qualities, communication, managerial, entrepreneurial skills and involvement in lifelong learning for the betterment of organization, environment and society.

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21. Programme Structure:

Semester 1

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	CYC511A	Physical Chemistry 1	4			100	4
2	CYC512A	Inorganic Chemistry 1	4			100	4
3	CYC513A	Organic Chemistry 1	4			100	4
4	CYC514A	Instrumental Methods of Analysis	4			100	4
5	CYL515A	Physical Chemistry Laboratory			4	50	2
6	CYL516A	Qualitative & Quantitative Analysis of Inorganic Compounds			4	50	2
7	CYS517A	Seminar 1			2	50	1
Total			**16**		**10**	**550**	**21**

Semester 2

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	CYC521A	Physical Chemistry 2	4			100	4
2	CYC522A	Inorganic Chemistry 2	4			100	4
3	CYC523A	Organic Chemistry 2	4			100	4
4	CYC524A	Computational Chemistry	4			100	4
5	CYL525A	Computational Techniques in Chemistry			4	50	2
6	CYL526A	Qualitative & Quantitative Analysis of Organic Compounds			4	50	2
7	CYS527A	Seminar 2			2	50	1
Total			**16**		**10**	**550**	**21**

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Semester 3

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	CYC611A	Chemistry of Agrochemicals, Textiles and Polymers	3			100	3
2	CYC612A	Chemistry of Industrial Minerals	3			100	3
3	CYC613A	Petroleum Chemistry	3			100	3
4	CYC614A	Chemistry of Oils, Fats, Surfactants and Coatings	3			100	3
5	MPF615A	Research Methodology	2			50	2
6	CYL616A	Industrial Chemistry Laboratory 1			4	50	2
7	CYL617A	Industrial Chemistry Laboratory 2			4	50	2
8	CYS618A	Seminar 3			2	50	1
Total			**14**		**10**	**600**	**19**

Semester 4

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	CYI621A	Internship*			8	100	4
	CYS621A	Seminar**					
2	CYP622A	Dissertation Work ***			30	300	15
Total					**38**	**400**	**19**

* Internship can be done during the vacation period for a maximum period of 8 weeks, where the student needs to submit a report along with the presentation.

**A student can opt for seminar instead of internship, where a student in consultation with his/her project supervisor is expected to conduct review of literature related to their project work, write a review article and submit along with a presentation on the same topic.

*** A student in consultation with allotted supervisor is required to conduct research on a topic, submit a dissertation report along with an article in a prescribed journal format. Dissertation can be conducted within the department or in the other department within the university in consultation with Head of the Department. A student can also conduct dissertation work in any of the reputed R & D institute / organization or in an Industry in consultation with Head of the Department. In such cases, an internal supervisor from the department will facilitate and monitor the work along with the external supervisor.

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22. Course Delivery: As per the Timetable

23. Teaching and Learning Methods

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations

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3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. Project Work
10. Project
11. Exhibitions
12. Technical Festivals

24. Assessment and Grading

24.1. Components of Grading

There shall be **two components** of grading in the assessment of each course:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (LSC1, LSC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have equal weightage (CE: 50% and SEE: 50%) in determining the final marks obtained by a student in a Course.

The complete details of Grading are given in the Academic Regulations.

24.2. Continuous Evaluation and Semester-End Examination Policies

Continuous evaluation and Semester-End Examination depends on the type of the course as discussed below:

24.2.1 Theory Courses

Theory Course			
CE (Weightage: 50 %)			SEE (Weightage: 50 %)
TSC1 Midterm exam / Term Test	TSC2 Assignment	TSC3 Innovative	SEE Written exam
50 Marks	25 Marks	25 Marks	100 Marks

There shall be three subcomponents, first one is midterm exam carrying 50 marks and others carrying 25 marks each.

The innovative TSC3 can be of any of the following types:

a) Online Test
b) Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio

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f) Reports
g) Case Study
h) Group Task
i) Quiz
j) Any other

After the three subcomponents are evaluated, the CE component marks are determined as:
CE Component Marks = (Total of the marks obtained in all the three subcomponents) ÷ 2

24.2.2 Laboratory Course

For a laboratory course, the scheme for determining the CE marks is as under:

Laboratory Course		
CE (Weightage: 50 %)		SEE (Weightage: 50 %)
LSC1	LSC2	Lab SEE
25 Marks	25 Marks	50 Marks

The subcomponents can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission
e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

After the subcomponents of CE are evaluated, the CE component Marks are determined as:
CE Component Marks = (Total of the best two subcomponent marks out of the three) ÷ 2

25. Student Support for Learning

1. Course Notes
2. Reference Books in the Library
3. Magazines and Journals
4. Internet Facility
5. Computing Facility
6. Laboratory Facility
7. Workshop Facility
8. Staff Support
9. Lounges for Discussions
10. Any other support that enhances their learning

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26. Quality Control Measures

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1. Review of Course Notes
2. Review of Question Papers and Assignment Questions
3. Student Feedback
4. Moderation of Assessed Work
5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports
7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

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27. Programme Map (Course-PO-PSO Map)

Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
1	Physical Chemistry 1	3		2								3	2	
1	Inorganic Chemistry 1	3		2								3	2	
1	Organic Chemistry 1	3		3								3	3	
1	Instrumental Methods of Analysis	3		2								3	3	
1	Chemistry Laboratory 1				3					3		3	3	3
1	Chemistry Laboratory 2				3					3		3	3	3
1	Seminar 1		2							3				3
2	Physical Chemistry 2	3		3								3	2	
2	Inorganic Chemistry 2	3		2								3	2	
2	Organic Chemistry 2	3		3							2	3	3	
2	Computational Chemistry	3		3	3							3	3	
2	Chemistry Laboratory 3				3					3		3	3	
2	Chemistry Laboratory 4				3					3		3	3	3
2	Seminar 2		2							3				3
3	Chemistry of Agrochemicals, Textiles and Polymers	3		3								3	2	
3	Chemistry of Industrial Minerals	3						1			2	3	2	
3	Petroleum Chemistry	3		3				2				3	2	2
3	Chemistry of Oils, Fats, Surfactants and Coatings	3		3								3	2	
3	Research Methodology	3		3	3	3				3	3	3	3	3
3	Industrial Chemistry Laboratory 1				3					3			3	3
3	Industrial Chemistry Laboratory 2				3					3			3	3
3	Seminar 3		2							3				3
4	Internship									3				3
4	Seminar		2							3			3	3
4	Dissertation Work	3		3	3	3	3		3	3	2	3	3	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution														

28. Co-curricular Activities

Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

29. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

30. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.

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Detailed Course Curriculum

Semester 1

Course Specifications: Physical Chemistry 1

Course Title	Physical Chemistry 1
Course Code	CYC511A
Course Type	Core Theory
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

The aim of this Course is to introduce students to fundamentals and applications of certain aspects of Physical Chemistry.

In this Course the students are taught the laws of thermodynamics and their application to phase transformations, principles of photochemistry, electrochemistry and kinetics. They are also taught about phase equilibria, colloids, micelles and colligative properties. Emphasis is given on quantum mechanics and the occurrence of various types of molecular energy levels.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

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- **CO-1.** Explain the laws of thermodynamics, concepts in photochemistry, JT effect, Raoult's law, and Henry's law to the physical transformation of substances
- **CO-2.** Discuss the theories of kinetics, concepts in quantum mechanics, phase diagram construction and electrochemistry
- **CO-3.** Illustrate quantum mechanical systems such as particle in a box, hydrogen atom, orbitals, electron systems, kinetics of complex & fast reactions
- **CO-4.** Apply the principles of chemical & enzyme kinetics to determine the energetics of chemical reactions and assess the effect of catalyst on the outcome of reaction kinetics, laws of electrochemistry to estimate chemical compounds, applications of Schrodinger wave equation and thermodynamic processes
- **CO-5.** Solve problems based on quantum mechanics and chemical/enzyme kinetics, electrochemistry, colloids, colligative properties, Phase equilibria and thermodynamics

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4. Course Contents

Quantum Chemistry I:

Postulates of quantum mechanics, Schrödinger equation (time dependent & independent); Eigen values and Eigen functions, Numerical. Physical interpretation of wave function. Concepts of operators (Laplacian, Hamiltonian, Linear and Hermition). Commutation of operators, normalization, orthogonality and orthonormality of wave functions, Numerical. Solution of Schrödinger equation for a free particle, particle in a ring, particle in a 1D and 3D boxes, Numerical. Hamiltonian equation for hydrogen and hydrogen like atoms. Application of Schrödinger equation to harmonic oscillator, rigid rotator. Eigen functions and eigenvalues of angular momentum.

Thermodynamics I:

First law of thermodynamics: State function, Internal energy, enthalpy and heat capacity. Joule – Thomson effect, Numerical. Second law of thermodynamics: Spontaneous and reversible processes, Carnot theorem, concept of entropy, Maxwell relations, Gibb's -Helmholtz equation, Chemical potential, Clapeyron-Clausius equation, concept of activity and activity coefficient, Numerical. Third law of thermodynamics: Determination of absolute entropies, Boltzmann entropy equation, entropies of real gases.

Concepts of partial molar properties – partial molar free energy, chemical potential, partial molar volume and its significance. Gibbs-Duhem equation, Gibbs-Duhem-Margulus equation. Determination of partial molar volume: Graphical method, intercept method and Apparent molar volume method. Activity and activity coefficient: Determination of activity coefficient by EMF and solubility method, Numerical.

Chemical Kinetics:

Rate of reaction, rate law, rate constant, molecularity, order & numerical problems based on kinetic data. Rate expression of first, second and third order reactions. Methods of determining order of a reaction, half-life time of a reaction, effect of temperature and catalyst on reaction rates, mechanisms of complex reactions, collision theory of bimolecular reaction, Arrhenius equation, ACT theory, Lindeman theory, kinetics of complex reactions, chain reactions and branched chain reactions.

Kinetics of fast reactions- flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

Photochemistry:

Jablonski diagram, Fluorescence, phosphorescence, Photosensitization, and quenching and luminescence. Laws of photochemistry (Beer-Lambert's law, Grotthus-Draper law, Stark-Einstein law) and numerical. Quantum yield and numerical, photochemical processes with examples. Quantum yield of photochemical combination of (i) H2 and Cl2 (ii) H2 and Br2 (iii) dissociation of HI (iv) dimerization of anthracene.

Electrochemistry 1:

Nernst equation, redox systems, electrochemical cells; electrolytic conductance – Kohlrausch's law and its applications; transport number, ionic mobility, ionic equilibria; conductometric and potentiometric titrations, Oswald's dilution law.

Electrochemistry of solutions: Ionic atmosphere, Debye-Huckel theory for the problem of activity coefficient, Debye-Huckel limiting Law, Debye-Huckel equation for appreciable concentration, Debye-Huckel Onsager conductance equation and its extension to ion solvent interations, Debye-Huckel Bjerrum mode, Ion association, triple ions, triple ions and conductance minima. Thermodynamics of electrified interface, derivation of electro capillary Lipmann's equation, surface excess, thermodynamic aspects of surface excess.

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Phase Equilibrium:
Derivation of phase rule from the concept of chemical potential. Calculation of Phases, components and degree of freedom. Reduced phase rule. Application of Phase Rule to one (water and Sulphur), two (Pb-Ag and KI-water) and three component (CH3COOH-CHCl3-Water and (Salt A- Salt B-Water) system. High pressure systems (water and carbon). Reduced phase rule. Principle of triangular diagram, plots for a mixture of three liquids consisting of one, two and three pairs of partially miscible liquids.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		2								3		
CO-2	3										3		
CO-3	3										3		
CO-4	3		2								3	2	
CO-5	3		2								3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		02
1.Demonstration using Videos	02	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		08
1. Solving Numerical Problems	08	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

1. Class Notes
2. P. Atkins, P. J. De (2006), Atkin's Physical chemistry, 6th Edn. Oxford University Press, Noida-UP.
3. Ira Levine (2011), Physical Chemistry, 6th Edn. McGraw Hill Education (India) Pvt. Ltd., Bangalore.
4. Puri, Sharma and Pathania (2012), Principles of Physical Chemistry, 46th Edition, Vishal Publishing & Co. Jalandhar
5. Keith J. Laidler, John H. Meiser and Bryan C. Sanctuary (2002), Physical Chemistry, 4th Revised edition, Houghton Mifflin.
6. Samuel Glastone, Text book of physical chemistry, 2nd edition, Mac Millan India Ltd (1991).

b. Recommended Reading

1. K. J. Laidler, Chemical Kinetics, McGraw Hill. Inc. New York (1988).
2. McQuarie and Simon, Physical Chemistry: A Molecular Approach, Viva, New Delhi, (2001).
3. R. K. Prasad, Quantum Chemistry, New Age International, 2nd edition, (2000).
4. J. J. Bikerman, Surface Chemistry: Theory and Applications, Academic Press. New York (1972).
5. D. R. Crow, Principles and applications of Electrochemistry- 3rd edition Chapmanhall London (1988).
6. S. Glasstone, Thermodynamics for Chemists, , East-West Press, New Delhi, (1960).

c. Magazines and Journals

1. Chemistry for everyone Letters; Springer ISSN: 1610-3653 Jo. No. 10311
2. Journal of Chemical Sciences; Springer ISSN:0973-7103

d. Websites

1. http://nptel.ac.in/

e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

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10. Course Organization

Course Code	CYC511A		
Course Title	Physical Chemistry 1		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date		14th July 2022	
Next Course Specifications Review Date		July 2024	

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Course Specifications: Inorganic Chemistry 1

Course Title	Inorganic Chemistry 1
Course Code	CYC512A
Course Type	Core Theory
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to introduce students to the basic and advanced concepts of Inorganic Chemistry.

The student will be introduced to the concept of atomic structure and chemical bonding. The basic chemistry of main group elements and d and f block elements would be focused on magnetic, electronic and spectral properties. Acid-Base chemistry and non-aqueous system will be elaborated. The solid state chemistry and structure of inorganic ionic compounds such as NaCl, ZnS, CsCl, CaF_2 and $CaCl_2$ will be emphasized.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Outline the principles of electron filling in the atomic orbitals, VSEPR theory, molecular orbital theory, wades rule, polymorphism, magnetic property d and f-block elements and acid-base concepts and non-aqueous solutions.

CO 2. Differentiate between VSEPR and MO theory/CFT, closo/nido/arachno boranes, structure of silicates and phosphates, electronic configuration in d and f-block elements and its consequences

CO 3. Explain with examples the industrially important compounds, inorganic molecules by VSEPR theory, structure of ionic crystals, defects in crystals, acid- base concepts, closo/nido/ arachno boranes, structure of silicates and phosphates, super heavy elements

CO 4. Discuss the structure and bonding in solids, borazines, metallocarboranes, oxyacids of nitrogen, phosphorous sulfur halogens, intercalated compounds, silicates, concepts of non-aqueous solvents, polarizability and partial covalent character

CO 5. Illustrate the potential applications of main group compounds, d and f block elements, boranes carboranes silicates phosphates, metallo carboranes and non aqueous solvents

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4. Course Contents

Atomic Structure and Chemical Bonding:
Aufbau energy diagram, Pauli's exclusion principle and Hund's rule of maximum multiplicity, Valence bond theory, Hybridization and Valence shell electron pair repulsion theory (VSEPR): crystal field theory, shapes of molecules; Molecular orbital theory: bond order, stability and magnetic properties of diatomic molecules.
Ionic Bond: Lattice energy: Born Lande equation, Born-Haber cycle, uses of Born-Haber type of calculations.
Kapustinskii equation; polarizability and partial covalent character.

Industrial important compounds of alkali and alkaline earth metals:
Hydroxides, plastaer of paris, bicarbonates, bicarbonates and metals oxides, halides, boranes, carboranes- application of Wades rule, metallocarboranes borazines; Compounds of phosphorus, sulphur and nitrogen - oxyacids of nitrogen, phosphorus, sulfur and halogens (including the ligation properties of their anions); noble gas compounds; carbon and sulphur. Silicates: classification and structures of ortho, pyro, chain, cyclic, sheet and three dimensional silicates, silica gel, alumino-silicates. Graphitic compounds – intercalation compounds with heavier alkali metals, halides, oxides, oxygen and fluorine.

d and f – Block elements - Transition elements:
Basic concepts of d-block elements electronic configuration, oxidation state, color, magnetic, catalytic properties. 3d , 4d and 5d series.
Lanthanides: Elements and their electronic configurations; oxidation states; lanthanide contraction and its consequences; magnetic properties; electronic spectral properties and colour; complex formation; isolation of lanthanides from monazite sand; separation of lanthanides using ion-exchange method.

Actinides: Elements and their electronic configuration, comparison of actinides with lanthanides – with respect to the oxidation states, electronic spectral properties and complex formation. Comparative study of f-block elements with d-block elements – with respect to oxidation states; magnetic properties and electronic spectral properties. Trans-uranium elements, further extension of periodic table, super heavy elements (SHE).

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Acids, Bases and Solvents:
Review of acid- base concepts– Bronsted, Lewis and solvent system definitions of acids and bases, Strengths of hydracids, oxoacids and Lewis acids, Drago -Wayland equation for Lewis acid- Lewis base interactions, HSAB concept, Bronsted acid-base strength verses hardness and softness, symbiosis, applications of HSAB concept. Non-aqueous media – Classification of solvents, leveling effect, reactions in HF, BrF_3, N_2O_4 and molten salts, super acids. Liquid ammonia, chemical reactions of ammonia, anhydrous H2SO4, liquid dinitrogen tetroxide and Sulphur dioxide.

Solid-State Chemistry:
Basic concepts of symmetry in crystals, Bravais Lattices, miller indices, radius ratio rule Structure of ionic crystals, NaCl, ZnS, CsCl, CaF_2, $CdCl_2$.Defects and ion transport, schottky defect, Frenkel Defects, metal excess defects, metal deficiency defects, thermal defects, semiconductor chemistry.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3										3		
CO-3	3										3		
CO-4	3										3		
CO-5	3		2								3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		56
Demonstrations		02
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		02
1. Solving Numerical Problems	02	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme

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Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks ▶	50	25	25	
CO-1	×	×	×	×
CO-2	×		×	×
CO-3	×	×	×	×
CO-4			×	×
CO-5		×	×	×
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

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1. Class Notes
2. HUHEEY, J.E. (2008) Inorganic Chemistry: Principles of Structure and Reactivity. Dorling Kindersley Pvt Ltd., Noida
3. J.D. Lee (2008) Concise Inorganic Chemistry, 5th Edn, Oxford University Press, New Delhi.
4. Shriver and Atkins, (2006) Inorganic Chemistry, WH Freeman and Company, New York.

b. Recommended Reading

1. F.A. Cotton, G. Wilkinson and P. L. Gaus, (1995) Basic Inorganic Chemistry III edition, John-Wiley and Sons, USA.
2. N.N. Greenwood and A.E. Earnshaw, (1997) Chemistry of Elements, Butterworth Heinemann, UK.
3. Jack Barrett and Mounir A. Malati, Harwood, Fundamentals of Inorganic Chemistry, (1998).
4. Catherine E. Housecroft and Alan G. Sharpe, (2001) Inorganic Chemistry, IV edition, Pearson Education Asia Pvt. Ltd. Bengaluru.

c. Websites

1. http://www-jmg.ch.cam.ac.uk/data/c2k/cj/inorganic.html
2. https://www.nature.com/subjects/inorganic-chemistry

d. Other Electronic Resources

1. http://www.freebookcentre.net/chemistry-books-download/Inorganic-Chemistry-(PDF-194p).html
2. https://ocw.mit.edu/index.htm (MIT free open Course materials)

e. http://nptel.ac.in/

10. Course Organization

Course Code	CYC512A	
Course Title	Inorganic Chemistry 1	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Organic Chemistry 1

Course Title	Organic Chemistry 1
Course Code	CYC513A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to introduce students to various concepts of organic chemistry. Students will be able to discuss and select starting material, reactive intermediates, stereochemistry required in synthesis of organic molecules. Course focuses on carbohydrates, vitamins and heterocyclic chemistry. Emphasis is given on organic reaction mechanisms and reactive intermediates.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Discuss the principles of structure and bonding, acid base concepts, reactive intermediates, stereochemistry, vitamins and carbohydrates

CO 2. Illustrate the reaction mechanism and stereochemistry of the molecules and structural elucidation of natural products

CO 3. Identify the reagents, reactive intermediates, reaction mechanism, stereochemistry of heterocyclic compounds, carbohydrates and other molecules

CO 4. Apply the basic concepts of synthesis of heterocyclic molecules, carbohydrates, reactive intermediates for the synthesis of new molecules

CO 5. Recommend reagents, reactive intermediates, reaction mechanism, stereochemistry for synthesis of small organic molecules

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4. Course Contents

Structure and Bonding in Organic Molecules:

Review of basic principles of structure and bonding, application of acid base concepts, Aromaticity and antiaromaticity, Hückel's rule, n-annulenes, heteroannulene, fullerenes, C-60, cryptates, Bonds weaker than covalent; addition compounds, inclusion compounds, crown ethers, cyclodextrins, catenanes and rotaxanes

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Reactive intermediates:

Reactive intermediates: Generation, stability , structure, and reactivity of (1) Carbocations (2) Carbanions- (3) Carbenes (4) Free radicals and (5) Nitrene, Types of mechanism reactions, Classification of reactions.

Reactions:

Addition, Elimination and Condensation reactions: Electrophilic, Nucleophilic and Free-radical reactions of aliphatic, alkenes, alkynes, aromatics, carbonyl compounds; Various mechanisms involved; Reactivity control

Classification of reactions and mechanisms. Thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates.

Methods of determining mechanisms: Based on the structure of products, determination of the presence of intermediates, isotopic labeling, isotope effects, from stereochemical evidence.

Acids and bases: Hard and soft acids and bases. Effect of structure on the strengths of acids and bases

Stereochemistry:

Fischer, Newman, Sawhorse and flying wedge projections and their interconversions. Optical isomerism: Elements of symmetry and chirality. D-L conventions. CIP rules, R-S and M-P conventions. Cram's and Prelog's rules.

Conformational analysis: Conformational analysis of cycloalkanes: cyclobutane, cyclopentane, cychexanes (monosubstituted e.g., methyl, iso-propyl, tert-butyl and di-substituted cyclohexanes e.g., dialkyl, dihalo, diols), and cycloheptane. Nomenclature and conformations of fused rings and bridged ring systems.

Carbohydrates – I:

Introduction to carbohydrates. Classification of monosaccharides: aldoses and ketoses. Structural formulae of sugars- aldotetroses, aldopentoses and aldohexoses. Mutarotation, Configuration of aldoses and ketoses: d- and l-sugars. Cyclic structures of monosaccharides. Cyclization of hydroxyaldehydes, pyranose and furanose forms of monosaccharides. 12 Reactions of monosaccharides: esters and ether formations, formation of cyclic ketals, and acetals. Glycoside formation, enolisation, tautomerisation, epimerization and reduction. Reaction of monosaccharides with phenyl hydrazine: formation of osazones. Oxidation of monosaacharides. Reducing and non-reducing sugars. Reaction with bromine water, nitric acid and periodate. Synthesis of aldonic, uronic, aldaric acids and alditols.

Heterocyclic compounds:

Nomenclature of heterocyclic compounds. Synthesis and reactivity of five-, six- and seven-membered heterocycles containing one or more hetero atoms of nitrogen, oxygen and sulfur; Fused-ring heterocycles

Vitamins:

Biological importance and synthesis of Vitamins A, Vitamin B1 (thiamine), Vitamin B6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α-tocopherol), Vitamin H (biotin), Vitamins K1 and K2

General biogenetic studies: classification, structural elucidation, chemistry and applications of Alkaloids, and Terpenes

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2			2								3		
CO-3			3								3		
CO-4			3								3		
CO-5	3											3	

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		55
Demonstrations		05
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

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7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks ▶	50	25	25	
CO-1	×		×	×
CO-2	×		×	×
CO-3	×	×	×	×
CO-4	×	×	×	×
CO-5		×	×	×
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

f. Essential Reading

1. Course and class notes
2. Carey and Sundberg (1990), Advanced Organic Chemistry – Part A & B, 3rd Edition, Plenum Press, New York.
3. Jerry March (2008) Advanced Organic Chemistry – Reactions, Mechanism and Structure, USA, John Wiley
4. Advanced Organic Chemistry (1990), F A Carey and R J Sundberg, New York, Plenum Press.
5. A Guide Book to Mechanism in Organic Chemistry (2000) Peter Sykes, USA, Longman.

b. Recommended Reading

1. Smith, M. B. (2013), March Advanced Organic Chemistry: Reactions, Mechanism, and Structure. 7th Edn. Wiley, New Jersey, USA.
2. R O C Norman and J M Coxon (1996) Principles of Organic Synthesis, London, Blackie Academic and Professional.
3. D Nasipuri (1999), Stereochemistry of Organic Compounds, New Delhi, New-Age International

c. Other Electronic Resources

http://nptel.ac.in/

10. Course Organization

Course Code	CYC513A		
Course Title	Organic Chemistry 1		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date		14th July 2022	
Next Course Specifications Review Date		July 2024	

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Course Specifications: Instrumental Methods of Analysis

Course Title	Instrumental Methods of Analysis
Course Code	CYC514A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to introduce students to modern instrumental methods of analysis in the field of chemistry. Students are taught the overview of modern instrumental methods for determining the structure, composition and properties of materials. Techniques which are included in the module are spectroscopic techniques such as optical, mass, electron and x-ray photoelectron spectroscopic methods, separation techniques such as chromatography including the detection techniques, microscopic techniques such as optical spectroscopy, electron spectroscopy and probe based microscopy. This module also deals with thermal characterization techniques, voltammetry techniques, radio analytical techniques and x-ray diffraction technique.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Outline the working principle and instrumentation of mass, optical, electron and X-ray and NMR spectroscopic techniques, chromatography, microscopy, thermal, X-ray diffraction, electrochemical and radio analytical techniques

CO 2. Analyze the morphology of materials using optical, electron and probe type microscopy techniques

CO 3. Interpret thermal properties of materials using TGA, DTA and DSC techniques

CO 4. Identify and analyze the appropriate chromatographic techniques for separation and analysis of chemical compounds

CO 5. Interpret the structure and/or determine concentration of chemical compounds using UV-Visible, Infrared, Raman, NMR, mass spectroscopy and voltammetry techniques.

4. Course Contents

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Spectrometric methods:

Theory, working principles and applications of Optical atomic spectroscopy (AAS and AES), UV/visible spectrometry, Molecular fluorescence/Luminescence spectrometry, Infrared Spectroscopy, Raman Spectroscopy, X-Ray Photoelectron Spectroscopy, NMR Mass spectrometry: Basic theory, instrument types including quadrupoles, ion traps, and chromatography coupling with examples of recent applications, Interpretation of mass spectrometric data

Separation techniques:
Theory, working principles, instrumentation and applications of Gas & liquid chromatography, HPLC, separation based on volatility, solubility, interactions with stationary phase, size and electrical field Detection: simple vs. specific (gas and liquid), detection as a means of further analysis (use of tags and coupling to IR and MS), electrophoresis (plates and capillary)

Microscopy:
Theory, working principles and applications of Light Microscopy: Polarizing Microscope, Reflected Light Microscopy, Electron Microscopy: Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Probe Microscopy: Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy (STM) & Atomic Force Microscope (AFM)

Thermometric methods:
Thermogravimetric analysis, differential scanning calorimetry, differential thermal analysis

Electroanalytical Techniques:
Principles, instrumentations and applications of conductometry, potentiometry. Principles, Instrumentation and applications of voltammetric techniques such as hydrodynamic voltammetry, polarography, cyclic voltammetry, pulse voltammetry and stripping voltammetry

Radio analytical techniques- Radiometric Analysis, Isotopic dilution techniques, neutron activation analysis X-ray-diffraction analysis: Principle, instrumentation and applications

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3		2								2	3	
CO-3	3		2								2	3	
CO-4	3		2								2	3	
CO-5	3		2								2	3	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		60
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	×		×	×
CO-2	×		×	×
CO-3		×	×	×
CO-4	×	×	×	×

CO-5	×	×	×	×
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. D.A. Skoog, D.M. West, F.J. Holler, S.R. Couch (2013) Fundamentals of analytical chemistry, Cengage Learning, USA.
3. D.A. Skoog, F.J. Holler, S.R. Couch (2017) Principles of Instrumental Analysis, 7th edn, Cengage Learning, USA
4. J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas (2006) Vogel's textbook of quantitative chemical analysis 6th edn, Pearson education, New Delhi.

b. Recommended Reading

1. P.S. Kalsi (2004) Spectroscopy of Organic Compounds 6th edn, New Age International Publishers, New Delhi
2. G. Svehla (2009) Vogel's Qualitative Inorganic Analysis 7th edn, Person Education Ltd, New Delhi

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c. **Other Electronic Resources**
   a. http://nptel.ac.in/

10. Course Organization

Course Code	CYC514A	
Course Title	Instrumental Methods of Analysis	
Course Leader's Name	As per Time Tables	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Physical Chemistry Laboratory

Course Title	Physical Chemistry Laboratory
Course Code	CYL515A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to perform quantitative analysis related to physical chemistry and instrumentation.
Students are trained to determine physical and chemical properties of given samples. They are trained to analyze the results and infer appropriate conclusions based on concepts of physical and inorganic chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Setup the experimental apparatus required to achieve the stated aim
CO 2. Conduct experiments as per the standard procedures and tabulate the measured values
CO 3. Calculate the required parameters and plot the results
CO 4. Interpret and draw conclusions
CO 5.Write laboratory report as per the prescribed format.

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4. Course Contents

1. Determination of pKa values of orthophosphoric acid using pH Meter.
2. Conductometric estimation of Lithium sulphate against Barium Chloride.
3. Potentiometric estimation of KI solution using standard KMnO4 solution.
4. Determine the creatinine content in the given sample using spectrophotometry.
5. Construction of phase diagram for three-component system (ethanol/ toluene/water).
6. Estimation of first order rate constant of hydrolysis of ethyl acetate by volumetry.
7. Determination of Critical Solution Temperature (CST) of phenol-water system
8. Determination of molecular weight of a polymer by viscosity method.
9. Conductometric estimation of a mixture of strong and weak acids by using a standard alkaline solution.

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10. Potentiometric estimation of acid mixture versus NaOH.
11. Kinetics of autocatalytic reaction between potassium permanganate and oxalic acid.
12. Determination of intrinsic viscosity of a given polymer using Ubbelohde viscometer.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3							3		
CO-2				3							3		
CO-3				3							3		
CO-4				3							3		
CO-5									3			3	3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▶	LSC1	LSC2	
Subcomponent Type ▶	Lab Report	Term Test	50 Marks
Maximum Marks ▶	25	25	
CO-1	×	×	×
CO-2	×	×	×
CO-3	×	×	×
CO-4	×	×	×
CO-5	×		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. B. Vishwanathan and P.S. Raghavan (2005) Practical Physical Chemistry, VIVA Books, New Delhi

b. Recommended Reading

1. Arthur Israel Vogel, G. H. Jeffery (1989) Vogel's text book of quantitative chemical analysis, Longman Scientific & Technical, London, UK

10. Course Organization

Course Code	CYL515A	
Course Title	Physical Chemistry Laboratory	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Qualitative and Quantitative Analysis of Inorganic Compounds

Course Title	Qualitative & Quantitative Analysis of Inorganic Compounds
Course Code	CYL516A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to perform qualitative and quantitative analysis of Inorganic compounds.

Students are trained to do the semi micro qualitative analysis of inorganic mixture containing four cations; out of which two will be rare metal ions such as W, Mo, Se, Ti, Zr, Ce, Th and V. Students will also be trained to perform quantitative analysis of inorganic compounds using volumetric and gravimetric analysis. They are trained to analyze the results and infer appropriate conclusions based on concepts of inorganic chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Setup the experimental apparatus required to achieve the stated aim
CO 2. Conduct experiments as per the standard procedures and tabulate the measured values
CO 3. Calculate the required parameters and plot the results
CO 4. Interpret and draw conclusions
CO 5.Write laboratory report as per the prescribed format.

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4. Course Contents

1. Semi micro qualitative analysis of inorganic mixture containing four cations; out of which two will be rare metal ions such as W, Mo, Se, Ti, Zr, Ce, Th and V.
   (A minimum of 4-5 salt mixture needs to be performed)
2. Preparation and quantitative analysis of hexamine cobalt (III) chloride
3. Preparation of cis and trans-dichloro bis (ethylenediamine) cobalt (III) chloride.
4. Preparation of potassium trisoxalato ferrate (III).
5. Simultaneous determination of chromium and manganese in a solution by visible spectroscopy
6. Quantitative estimation of iron and aluminum from an inorganic mixture by volumetric method followed by gravimetric method.

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7. Quantitative estimation of copper and nickel from an inorganic mixture by volumetric method followed by gravimetric method.
8. Quantitative estimation of copper and iron (as Fe_2O_3) from an inorganic mixture by volumetric method followed by gravimetric method.
9. Quantitative estimation of zinc and calcium form an inorganic mixture by volumetric method followed by gravimetric method.
10. Quantitative estimation of zinc and magnesium form an inorganic mixture by volumetric method followed by gravimetric method.

5. Course Map (CO-PO-PSO Map)

	Programme Specific Outcomes (PSOs)												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3							3		
CO-2				3							3		
CO-3				3								3	
CO-4				3								3	
CO-5									3				3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration usingVideos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▶	LSC1	LSC2	50 Marks
Subcomponent Type ▶	Lab Report	Term Test	
Maximum Marks ▶	25	25	
CO-1	×	×	×
CO-2	×	×	×
CO-3	×	×	×
CO-4	×	×	×
CO-5	×		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

Essential Reading

1. G. Svehla (1989) Vogel's – A Text Book of Macro and Semimicro Qualitative Inorganic Analysis, 5th Edition, Longman Group Limited, London, UK

b. Recommended Reading

1. G.H. Jeffery et. al. (1989) Vogel's Text book of quantitative chemical analysis, Longman Scientific & Technical, NY, USA

10. Course Organization

Course Code	CYL516A	
Course Title	Qualitative & Quantitative Analysis of Inorganic Compounds	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Seminar 1

Course Title	Seminar 1
Course Code	CYS517A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.

The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and present the same.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Conduct a thorough literature review and submit a review article / scientific report
CO-2. Make a presentation to a panel of examiners

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4. Course Contents

Choose the relevant research topic

Study the literature and give a seminar

Prepare a review article/ scientific report and give a presentation on the same topic

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1		2							3				3
CO-2		2							3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		60
1. Case Study and Presentation	60	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage) (Report)	Component 2: SEE (50% Weightage)
Subcomponent ▶	LSC1	
Subcomponent Type ▶	Report	Presentation
Maximum Marks ▶	50	50 Marks
CO-1	X	

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CO-2		X
The details of LSC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

9. Course Resources

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b. Essential Reading

1. Books / Research Articles

10. Course Organization

Course Code	CYS517A	
Course Title	**Seminar 1**	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	

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Next Course Specifications Review Date	July 2024

Semester 2

Course Specifications: Physical Chemistry 2

Course Title	Physical Chemistry 2
Course Code	CYC521A
Course Type	Core Theory
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to introduce students to fundamentals and applications of certain aspects of Physical Chemistry.

In this course the students are taught the laws of thermodynamics and their applications, principles of spectroscopy, electrochemistry, and kinetics. They are also taught about macromolecules and surface chemistry. Emphasis is given on Approximate methods of quantum mechanics and numerical.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Classify the polymers, mechanisms of enzyme, chemical kinetics, adsorption isotherms, wave functions and thermodynamic functions

CO-2. Outline the chemistry & properties of polymers, mechanism & kinetics of polymerization, term symbols, perturbation theory, factors affecting surface activity and overpotential, RS and JJ-coupling. Spin-orbital interaction and term multiplicities, Zeeman effect

CO-3. Discuss the principles of quantum mechanics approximate methods, rotational, vibrational, Raman and electronic spectra, theories & kinetics of electrochemistry, corrosion of metals, polarography, amperometry, effect of various parameters on activity of catalysts/enzymes, theories of unimoleuclar reactions, radial and angular distribution function and their significance

CO-4. Apply the spectroscopic information to determine structure & properties of compounds, thermodynamic concepts & laws to determine nature of chemical interactions, various parameters which can influence catalysis to predict the surface activity/chemical reactions, electrochemical theories and properties to understand

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various electrochemical systems and quantum mechanical concepts in real life problems

CO-5. Solve numerical based on electrochemistry, polymers, quantum chemistry, spectroscopy, kinetics, thermodynamics and surface chemistry

4. Course Contents

Quantum Chemistry II:

Schrödinger equation to hydrogen atom in spherical polar co-ordinates. Solution of ϕ, θ, equation and statements of solution of R equation. Total wave functions of hydrogen atom. Quantum numbers and their characteristics. List of wave functions for few initial states of hydrogen like atoms. Diagrams of radial and angular wave functions. Radial and angular distribution function and their significance. Electron - spin, spin-orbital, anti-symmetry and Pauli-exclusion principle, Slater determinants. Numerical on effective nuclear charge. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, Term symbols (both atomic and molecular). Spin-orbital interaction and explanation of term symbols. Zeeman effect. Approximate methods: Need for approximate methods. Perturbation method. Rayleigh Schrödinger perturbation theory for time-independent non-degenerate system

Spectroscopy:

Rotational spectra of diatomic and polyatomic molecules. Applications of microwave spectra, Numerical. Vibrational spectra of diatomic and polyatomic molecules. Rotation-vibration spectra of diatomic and polyatomic molecules. Raman spectroscopy, Scattering phenomena, rotational Raman spectrum of diatomic molecules, rotation-vibration Raman spectrum. Electronic spectra, Frank-Condon principle. Explanation on spectral line intensity based on Frank-Condon principle.

Chemical Kinetics II:

Enzyme kinetics – Mechanism and kinetic of enzyme catalyzed reactions, host guest interactions, derivation Michaelis-Menton equation and interpretation, Significance of Michaelis-Menten constant, Numerical. Lineweaver-Burk plots, autocatalysis and oscillatory reactions. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity. Theories of unimoleuclar reactions- Perrin theory, Lindemann theory.

Surface chemistry- Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.

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Electrochemistry II:

Structure of electrified interface: Electrical capacitance, Helmholtz theory, Guoy- Chapman theory, Stern model. Electrocatalysis, Valcano plots and Kinetics of electrode reactions. Overpotential: Concentration overpotential and activation overpotential, Derivation of Butler-volmer equation. Electrochemical Corrosion of metals. Polarography: Ilkovic equation, half wave potential and its significance, Amperometric titrations, types and applications.

Macromolecules:

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Introduction, classification, polymerization reactions, Kinetics of addition and condensation polymerization. Molar mass of polymers, determination of molar mass of polymers – Number-average, mass-average and viscosity-average methods. Numerical problems. Conducting polymers and mechanism.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3		2								3		
CO-3	3		2								3		
CO-4	3										3	2	
CO-5	2		3								3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10

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Total Duration in Hours	**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4	X	X	X	X
CO-5	X	X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment

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14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. P. Atkins, P. J. De (2006), Atkin's Physical chemistry, 6th Edn. Oxford University Press, Noida-UP.
3. Ira Levine (2011), Physical Chemistry, 6th Edn. McGraw Hill Education (India) Pvt. Ltd., Bangalore.
4. Puri, Sharma and Pathania (2012), Principles of Physical Chemistry, 46th Edition, Vishal Publishing & Co. Jalandhar
5. Keith J. Laidler, John H. Meiser and Bryan C. Sanctuary (2002), Physical Chemistry, 4th Revised edition, Houghton Mifflin.
6. Samuel Glastone (1991), Text book of physical chemistry, 2nd edition, Mac Millan India Ltd.
7. C. N. Banwell (1994), Introduction to Molecular Spectroscopy, TMH Edition.

b. Recommended Reading

1.K. J. Laidler, Chemical Kinetics, McGraw Hill. Inc. New York (1988).
2.McQuarie and Simon, Physical Chemistry: A Molecular Approach, Viva, New Delhi, (2001).
3.R. K. Prasad, Quantum Chemistry, New Age International, 2nd edition, (2000).
4.J. J. Bikerman, Surface Chemistry: Theory and Applications, Academic Press. New York (1972).
5.D. R. Crow, Principles and applications of Electrochemistry- 3rd edition Chapmanhall London (1988).
6.S. Glasstone, Thermodynamics for Chemists, , East-West Press, New Delhi, (1960).

c. Magazines and Journals

1. Chemistry for everyone Letters; Springer ISSN: 1610-3653 Jo. No. 10311
2. Journal of Chemical Sciences; Springer ISSN:0973-7103

d. Websites

1. http://nptel.ac.in/

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e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

10. Course Organization

Course Code	CYC521A		
Course Title	Physical Chemistry 2		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cy.mp@msruas.ac.in

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Course Specifications Approval Date	14th July 2022
Next Course Specifications Review Date	July 2024

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Course Specifications: Inorganic Chemistry 2

Course Title	Inorganic Chemistry 2
Course Code	CYC522A
Course Type	Core Theory
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

The aim of this Course is to introduce students to the basic and advanced concepts of Inorganic Chemistry. The student will be introduced to the application of group theory to understand the structure and spectroscopic properties of molecules. The coordination chemistry and reaction mechanisms therein will be elaborated. The molecular orbital theory and its importance in the chemistry of coordination complexes will be highlighted. The chemistry of several important categories of inorganic compounds such as metallocenes, metal carbonyls and compounds containing metal-metal bonds will be covered. The student will learn the principles of bio-inorganic chemistry.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Outline the principles of the character table construction, Orgel diagrams and molecular orbital theory and correlate to the crystal structures, spectroscopic and magnetic properties of coordination complexes, stereochemistry of the co-ordination numbers from 2 to 6
- **CO-2.** Differentiate between closo/nido/arachno boranes, ligand substitution mechanism in square planar and octahedral complexes, d-d transition and charge transfer spectra
- **CO-3.** Predict the properties of a coordination complexes from the molecular orbital theory and LFT, and explain Metal ion storage and transport properties of biological systems, Factors affecting stability constant in solution
- **CO-4.** Discuss the concepts of group theory, chemistry of solid state materials, bonding and structures in organometallic compounds, the relevance of Orgel diagrams and transport and storage of dioxygen; haemoglobin, myoglobin and phenomenon of cooperativity, stability constants
- **CO-5.** Illustrate the potential applications of organometallic compounds and metal complexes; gold complexes and platinum complexes in medicine; Photosynthesis; chlorophyll, PS I, PS II, Biochemical importance of NO, Role of Ca in signal transduction; porphyrins, nitrogen fixation

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4. Course Contents

Coordination Compounds and Reaction Mechanisms:
Metal – Ligand Bonding: Review of basic concepts of co-ordination chemistry. Stereochemistry of complexes with coordination Nos. 2 to 12, types of Ligands, crystal field splitting in various ligand fields, structural and thermodynamic effects of crystal field splitting- octahedral ionic radii, Jahn – Teller distortion in metal complexes and metal chelates, hydration and lattice energies, Iriving-William stability order; spectrochemical series, limitations of crystal field theory, Evidences for metal – ligand orbital overlap, LFT (ACFT), nephelauxetic series, MO theory and diagrams of octahedral complexes (including π-bonding),
Factors affecting stability constant in solution – Methods of determination of stability constant, Mechanism of substitution reactions in square planar and octahedral complexes and trans effects, Mechanisms of Redox reactions.
Determination of binary formation of stability constant by pH measurements, spectrophotometry, polarography and ion exchange methods

Spectroscopic and Magnetic properties of Transition Metal Complexes:
Spectroscopic ground states, selection rules, term symbols for dn ions, Racah parameters, Orgel, correlation and Tanabe-Sugano diagrams, spectra of 3d metal aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $[CoCl_4]^{2-}$, calculation of Dq, B and β parameters, charge transfer spectra.
Origin and types of magnetic behaviour- diamagnetism, paramagnetism, ferro and antiferromagnetism, magnetic susceptibility and its measurement by the Guoy method, temperature dependence of magnetism – Curie and Curie-Weiss laws, types of paramagnetic behaviour – spin-orbit coupling.

Organometallic Chemistry: Classification of Organometallic compounds based on the nature of metal-carbon bond, Bonding in pi-metal complexes, Metallocenes; Metal carbonyls; Compounds containing metal-metal bonds.
Synthesis Bonding in pi-metal complexes, Metallocenes; Metal carbonyls; Compounds containing metal-metal bonds, Industrial Applications of organometallic compounds.

Symmetry and Group Theory:
Symmetry elements and symmetry operations, Definition of groups and subgroups, and group multiplication tables. Conjugate relationships, classes of operations, representation of symmetry operations as matrices, reducible and irreducible representations, characters of representations, great orthogonality theorem (without proof) and its corollaries, properties of irreducible representations. Mulliken's symbols for irreducible representations. Character tables of Cnv, Cnh, Dnh and Cn point groups (derivation of character table only for Cnv point group). Applications of character tables in vibrational, electronic spectroscopy, crystal field splitting.

Bioinorganic Chemistry:
Essential and trace elements in biological systems, metal complexes in medicine; Metal ion storage and transport; Ferritin, transferrin, oxygen transport, phenomenon of cooperativity, model systems (picket fence porphyrins), hemocyanin and hemerythrin, electron-transfer reactions; Rubredoxin, ferredoxins, cytochromes. photosystems PS I, PS II. Nitrogen fixation: bacterial nitrogenase system. Biochemical importance of NO, Role of Ca in signal transduction, porphyrins, nitrogen fixation.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3										3		
CO-3	3		2								3	2	
CO-4	3										3		
CO-5	3		2								3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		58
Demonstrations		02
1. Demonstration using Videos	0	
2. Demonstration using Physical Models / Systems	02	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	02	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks ▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3		X	X	X
CO-4	X	X	X	X
CO-5	X	X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

a. Essential Reading

1. Class Notes
2. F. Albert Cotton (2008) Chemical Applications of Group Theory, Wiley Interscience, USA
3. HUHEEY, J.E. (2008) Inorganic Chemistry: Principles of Structure and Reactivity. Dorling Kindersley Pvt Ltd., Noida
4. J.D. Lee (2008) Concise Inorganic Chemistry, 5th Edn. Oxford University Press, New Delhi.
5. Carey and Sundberg, 1990, Advanced Organic Chemistry – Part A & B, 3rd Edn, Plenum Press, New York.
6. Shriver and Atkins, 2006, Inorganic Chemistry, WH Freeman and Company, New York.

b. Recommended Reading

1. C. E. Housecroft and Alan G. Sharpe (2008), Inorganic Chemistry, Prentice Hall, NJ, USA
2. BANNERJEE,D.(1993), Coordination Chemistry, Tata Mc Graw Hill Publishing Co., New Delhi.

c. Websites

1. http://www-jmg.ch.cam.ac.uk/data/c2k/cj/inorganic.html
2. https://www.nature.com/subjects/inorganic-chemistry

d. Other Electronic Resources

1. http://www.freebookcentre.net/chemistry-books-download/Inorganic-Chemistry-(PDF-194p).html
2. https://ocw.mit.edu/index.htm (MIT free open Course materials)

10. Course Organization

Course Code	CYC522A	
Course Title	Inorganic Chemistry 2	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Organic Chemistry 2

Course Title	Organic Chemistry 2
Course Code	CYC523A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to introduce students to various named reactions, oxidation reduction reagents, molecular arrangements, nucleic acids and proteins.
Students will be able to analyses and select appropriate reagents, reaction conditions and synthons for synthesis of various organic molecules. Emphasis is given on natural products and their applications in various industries.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Discuss the reactive intermediates, stereochemistry, oxidation and reduction, molecular rearrangements reaction mechanisms, pericyclic reactions, sigmatropic reactions, heterocyclic compound synthesis, named reaction, natural products, nucleic acids, protein structure and reagents in organic synthesis
CO 2. Illustrate nucleophilic, electrophilic, radical reactions, specific reagents for oxidation and reduction, heterocyclic reactions and organometallic reagents
CO 3. Identify heterocyclic motifs, reagents, named reaction, molecular rearrangements, stereochemistry in natural products and drug molecules
CO 4. Apply named reaction, heterocyclic synthesis, and organic reagents for synthesis of natural and pharmaceutically important products
CO 5. Design small organic molecules considering factors such as stereochemistry and reagents for various applications

4. Course Contents

Oxidizing and Reducing agents in Organic Chemistry:

Oxidizing Agents: Oxidation with chromium and manganese reagents (CrO_3, $K_2Cr_2O_7$, PCC, PDC, Jones reagent, MnO_2, $KMnO_4$), Pb (OAC)4, NBS, SeO_2, $KMnO_4$, OsO_4, Sommelet oxidation, Oppenauer oxidation, Fenton's reagent, Sharpless epoxidation.

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Reducing Agent: Catalytic hydrogenation (homogeneous and heterogeneous, reduction by dissolving metals (Na, Pd, Mg). reduction by hydride transfer (NABH4, LiAlH4, Al-t- BuO, DIBAL-H, NaCNBH4), selectivity in, diborane as reducing agent, tributyl tinhydride, stannous chloride, Bakers yeast, Organoboron compounds.

Named Reactions: Mechanism of Named Reactions:

Arndt-eistert reaction, Baylis–Hillman Reaction, Curtius Reaction, Gabriel Synthesis, Haloform Reaction, Heck Reaction, Hell–Volhard–Zelinskii Reaction, Knoevenagel Reaction, Kolbe–Schmitt Reaction, Lossen Reaction, Mannich Reaction, McMurry Reaction, Michael Reaction, Mitsunobu Reaction, Nef Reaction, Paterno–Buchi Reaction, Robinson Annulation, Sakurai Reaction, Schmidt Reaction, Stork Enamine Reaction, Strecker Synthesis, Vilsmeier Reaction, Weiss Reaction, Wittig Reaction and its application in organic synthesis.

Molecular Rearrangements:

General mechanistic considerations, Rearrangement to electron deficient carbon; Pincol –Pinacolone, Wagner –Meerwein, Dinenone-phenol, Allylic, Rearrangement to electron deficient nitrogen; Hofmann, Curtius, Schmidt, Lossen, Beckmann, rearrangement to
electron deficient oxygen atom; Bayer-Villiger, Dakin, Rearrangement to electron rich atom; Favorskii, Wittig, Stevens, Intramolecular rearrangement; Claisen, Benzidine, Fries rearrangement.

Reagents in Organic Synthesis:

Complex Metal Hydrides, Gilman's Reagent, Lithium Dimethylcuprate, Lithium Disopropylamide (LDA), N,N'-Dicyclohexylcarbodimide (DCC), 1,3-Dithiane (Reactivity Umpolung), DDQ, Green chemistry (Phase Transfer Catalysts, Crown Ethers, Merrifield Resin), Peterson's Synthesis, Wilkinson's Catalyst, Baker Yeast.

Amino Acids and Peptides:

Synthesis and reactions of amino acids. Classification and nomenclature of peptides. Sanger and Edman methods of sequencing. Cleavage of peptide bond by chemical and enzymatic methods. Peptide synthesis- Protection of amino group (Boc-, Z- and Fmoc-) and carboxyl group as alkyl and aryl esters. Use of DCC, EEDQ, HOBt and active esters, acid halides, anhydrides in peptide bond formation reactions. Deprotection and racemization in peptide synthesis. Solution and solid phase techniques. Introduction to peptidomimetics.

Protein Structure:

Primary and secondary structure of proteins: alpha helix, beta-pleated sheet, tertiary structure of proteins: Covalent bonds, Ionic bonds, hydrogen bonds, Van der Waals bonds, repulsive forces, Relative importance of binding forces, the quaternary structure of proteins

Nucleic acids: Structure of DNA: Primary, secondary and tertiary structure of DNA, Interaction of drugs on DNA

Chemistry of Natural Products:

Carotenoids, Flavanones, Plant Pigments, Porphyrins: Prostaglandins: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule.

Pericyclic reactions:

Introduction, molecular orbital symmetry, frontier orbitals of ethylene, 1, 3-butadiene, thermal and photochemical reactions, classification of pericyclic reactions: Electrocyclic reactions, Sigmatropic reactions and Cycloaddition reactions

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (Pos)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2			2								3		
CO-3	2										3		
CO-4			3									3	
CO-5										2		3	

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		60
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme

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Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X	X	X	X
CO-4	X	X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

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a. **Essential Reading**

1. Course and class notes

2. J. March (1992) Advanced Organic Chemistry, USA, John Wiley & Sons.
3.E. J. Eliel (2009) Stereochemistry of Carbon Compounds, USA, McGraw Hill.
4.Brian S. Furniss (1996) Vogel's Text Book of Practical Organic Chemistry, 5th edition, ELBS Longman.
5.Frank Settle (1997) Instrumental techniques for Analytical Chemistry, London, Prentice Hall.

b. Recommended Reading

1.S. H. Pine (1987) Organic Chemistry, USA, McGraw Hill.
2.D. Nasipuri (1994) Stereochemistry of Organic Compounds, USA, Wiley.

c. Other Electronic Resources

1. http://nptel.ac.in/

10. Course Organization

Course Code	CYC523A	
Course Title	Organic Chemistry 2	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Computational Methods in Chemistry

Course Title	Computational Methods in Chemistry
Course Code	CYC524A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this Course is to introduce students to the concept of computational chemistry

Computational chemistry helps chemists to make predictions before running the actual experiments and to be better prepared for making observations. Students are taught the basic mathematics that are relevant to chemists. Emphasis is given on concepts of computer modeling and simulation including ab initio approaches based on quantum chemistry and empirical approaches to study the structures and properties of molecules and materials.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	4:0:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Differentiate theoretical approaches such as HF(Hartree-Fock), DFT(Density Functional Theory) and force field methods
- **CO-2.** Identify various methods for simulating/modeling various scientific problems and discuss their advantages/disadvantages
- **CO-3.** Illustrate the principles of differentiation, integration and data modeling
- **CO-4.** Assess and recommend suitable computational chemistry tool for theoretical predictions
- **CO-5.** Apply semi-empirical and computational modeling to make theoretical predictions of outcome of a reaction, suitable methods for calculating electronic properties of simple molecules and crystals

4. Course Contents

Vectors and Matrices: Linear algebra, linear system, eigen values and eigen vectors, applications of matrices

Differentiation and Integration: Differential calculus with functions of single variable, different methods of evaluating integrals, Numerical integration by trapezoidal and Simpson's rule

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Data Modelling: Interpolation, curve fitting by least square method.

Hartree Self-Consistent Field method. Spin orbitals for many electron atoms symmetric and antisymmetric wave functions. Pauli's exclusion principle. Slater determinants. Qualitative treatment of Hartree-Fock Self-Consistent Field (HFSCF) method. Roothan's concept of basis functions, Slater type orbitals (STO) and Gaussian type orbitals (GTO), sketches of STO and GTO

Computational chemistry as a tool and its scope: Potential energy surface: stationary points, concept of transition state with examples, local and global minima, Hessian Matrix.
Molecular mechanics methods: force fields-bond stretching, angle bending, torsional terms, non-bonded interactions, electrostatic interactions. Mathematical expressions. Radial distribution, functions, Important features of commonly used force fields like MM3, MMFF, AMBER, OPLS and CHARMM

Ab initio methods: Hartree Self-Consistent Field method. Spin orbitals for multi electron systems symmetric and antisymmetric wave functions. Pauli's exclusion principle. Slater determinants. Qualitative treatment of Hartree-Fock Self-Consistent Field (HFSCF) method. Roothan's concept of basis functions, Slater type orbitals (STO) and Gaussian type orbitals (GTO), sketches of STO and GTO. Basis set approximation, Classification of basis sets - minimal, double zeta, triple zeta, split valence, polarization and diffuse basis sets, contracted basis sets, Pople style basis sets and their nomenclature, correlation consistent basis sets, Hartree-Fock limit. Electron correlation. Qualitative ideas on post Hartree-Fock methods-variational method, basic principles of Configuration Interaction (CI). Perturbational methods-basic principles of Møller Plesset Perturbation Theory.

General introduction to semi-empirical methods: Huckel MOT with suitable examples: ethane, propenyl and other systems, Calculation of properties- energy, delocalization energies, bond order. Introduction to Density Functional Theory (DFT) methods: Hohenberg-Kohn theorems. Kohn-Sham orbitals. Exchange correlation functional. Local density approximation. Generalized gradient approximation. Hybrid functionals (basic principles and terms). Comparison of molecular mechanics, ab-initio, and DFT methods. .

Computational Chemistry Calculations: Molecular geometry input-Cartesian coordinates and internal coordinates, Z-matrix. Z-matrix of single atom, diatomic molecule, non-linear triatomic molecule, linear triatomic molecule, polyatomic molecules. General format of GAMESS / ORCA input files. GAMESS / ORCA key word for: basis set selection, method selection, charge, multiplicity, single point energy calculation, geometry optimization, constrained optimization and frequency calculation.

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3												3		
CO-2	3		2										3		
CO-3	3		2											3	
CO-4				3										3	
CO-5			3	2										3	

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3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		50
Demonstrations		05
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	05	
Numeracy		05
1. Solving Numerical Problems	05	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**70**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	

Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

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a. Essential Reading

1. Class Notes
2. Christopher J Cramer (2004) "Essentials of computational chemistry", 2nd edition, England, John Wiley & Sons
3. Jan Jensen (2010) "Molecular modeling basics", 1st edition, Boca Raton, CRS press, Taylor & Francis Group.
4. Alan Hinchliffe (2003) "Molecular modeling for beginners", 2nd edition, England, John Wiley & Sons

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b. Recommended Reading

1. Szabo & Ostlund (1996) "Modern quantum chemistry", 1st edition revised, New York, McGraw-Hill

2. Wolfeam Koch (2001) "A chemist's guide to DFT" 2nd edition, New York, Wiley-VCH

c. Magazines and Journals

1. Journal of computational chemistry

2. Journal of chemical theory and computation

d. Websites

http:// www.wag.caltech.edu/home/ch121/

10. Course Organization

Course Code	CYC524A	
Course Title	Computational Methods in Chemistry	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Computational Techniques in Chemistry

Course Title	Computational Techniques in Chemistry
Course Code	CYL525A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to perform quantitative analysis related to physical and computational chemistry.

Students are trained to determine physical and chemical properties of given samples. They are trained to analyze the results and infer appropriate conclusions based on concepts of physical and inorganic chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Plan the experimental setup to achieve the stated aim
- **CO-2.** Conduct experiments as per the standard procedures and tabulate the measured values
- **CO-3.** Calculate the required parameters and plot the results
- **CO-4.** Interpret, compare with standard results and draw conclusions
- **CO-5.** Write laboratory report as per the prescribed format

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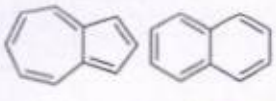
4. Course Contents

List of Experiments:

1. Draw and perform the geometry optimization of the given structures using semi-empirical method.



Azulene Naphthalene

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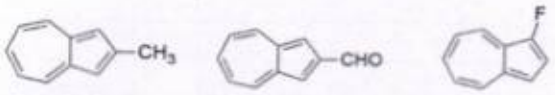
2. Calculate the HOMO-LUMO energy gaps in conjugated systems.
3. Determine the UV-Vis spectra of unsubstituted and substituted azulene structures using suitable computational methods.



2-methylazulene azulene-2-carbaldehyde 1-fluoroazulene

4. Optimize the di-atomic and tri-atomic molecules using DFT and determine the bond length, bond angle and dipole moment.
5. Perform geometry optimization and energy calculation on the following molecules. Visualize the frontier molecular orbitals and interpret the results for bonding in following molecules. Benzene, Naphthalene, and Azulene.
6. Perform the frequency analysis of given set of molecules and determine IR spectra.
7. Plot electrostatic potential map (ESP) surface of given molecule and predicts the electron rich and electron deficient sites.
8. Study the mechanism of SN2 reaction.
9. Calculate the ionization potential (IP) and electron affinity (EA) of a given set of molecules using fundamentals of conceptual DFT.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3							3		
CO-2				3							3		
CO-3				3								3	
CO-4				3								3	
CO-5									3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	

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5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent▶	LSC1	LSC2	50 Marks
Subcomponent Type ▶	Lab Report	Term Test	
Maximum Marks▶	25	25	
CO-1	X	X	X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

9. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work

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4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory work, examination
10.	Verbal Communication Skills	Laboratory examination
11.	Presentation Skills	---
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	---

10. Course Resources

a. Essential Reading

1. Laboratory Manual
2. Christopher J Cramer (2004) "Essentials of computational chemistry", 2nd edition, England, John Wiley & Sons
3. Jan Jensen (2010) "Molecular modelling basics", 1st edition, Boca Raton, CRS press, Taylor & Francis Group.
4. Alan Hinchliffe (2003) "Molecular modelling for beginners", 2nd edition, England, John Wiley & Sons

b. Recommended Reading

1. Szabo & Ostlund (1996) "Modern quantum chemistry", 1st edition revised, New York, McGraw-Hill
2. Wolfeam Koch (2001) "A chemist's guide to DFT" 2nd edition, New York, Wiley-VCH

c. Magazines and Journals

1. Journal of Chemical Education; ACS, ISSN: 0021-958

d. Websites

1. https://nptel.ac.in/

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e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

11. Course Organization

Course Code	CYL525A	
Course Title	Computational Techniques in Chemistry	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Qualitative and Quantitative Analysis of Organic Compounds

Course Title	Qualitative and Quantitative Analysis of Organic Compounds
Course Code	CYL526A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to perform qualitative and quantitative analysis of organic compounds.
Students are trained to prepare some of the organic compounds and carry out the qualitative and quantitative analysis of organic compounds. They are trained to analyze the results and infer appropriate conclusions based on concepts of organic chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Setup the experimental apparatus required to achieve the stated aim
CO 2. Conduct experiments as per the standard procedures and tabulate the measured values
CO 3. Calculate the required parameters and plot the results
CO 4. Interpret and draw conclusions
CO 5.Write laboratory report as per the prescribed format.

4. Course Contents

I. Qualitative analysis of organic compounds (Any four types):

a. The Systematic analysis of a two component/three component mixture involves the following:
1. Nature of the mixture
2. Type of the mixture
3. Separation of the mixture into two/three components.

II. Systematic analysis of each component involves the following:
1. Preliminary Tests.
2. Detection of elements.
3. Detection of the functional group.
4. Physical constants. (M.P. or B.P.)
5. Conformation with preparation of derivatives.

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6. Result

II. Qualitative Analysis of organic compounds (Any two):

1. Estimation of sugar
2. Estimation of amines
3. Estimation of amine salts
4. Estimation of carboxylic acid
5. Estimation of salts of carboxylic acid

III. One pot synthesis (Any two):

1. Preparation of aspirin from salicylic acid
2. Preparation of paracetamol from p-aminophenol
3. Preparation of m-dinitrobenzene from nitrobenzene

5. Course Map (CO-PO-PSO Map)

											Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3							3		
CO-2				3							3		
CO-3				3								3	
CO-4				3								3	
CO-5									3				3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00

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1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ▶	LSC1	LSC2	
Subcomponent Type ▶	Lab Report	Term Test	50 Marks
Maximum Marks ▶	25	25	
CO-1	X	X	X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination

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10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. ARTHUR I. VOGEL, 1970, Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis, England, LONGMAN.

b. Recommended Reading

1. Brian S Furniss, et al. (2005) Vogel's Text book of practical organic chemistry, 5th Edition, Pearson Education, UK

10. Course Organization

Course Code	CYC526A	
Course Title	Qualitative and Quantitative Analysis of Organic Compounds	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Seminar 2

Course Title	Seminar 2
Course Code	CYS527A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.

The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and present the same.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Conduct a thorough literature review and submit a review article / scientific report
CO-2. Make a presentation to a panel of examiners

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4. Course Contents

Choose the relevant research topic

Study the literature and give a seminar

Prepare a review article/ scientific report and give a presentation on the same topic

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1			2						3				3
CO-2			2						3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		60
1. Case Study Presentation	60	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)	**Component 2: SEE (50% Weightage)**
Subcomponent ▶	**LSC1**	
Subcomponent Type ▶	**Report**	**Presentation**

Maximum Marks ▶	50	50 Marks
CO-1	X	
CO-2		X
The details of LSC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

9. Course Resources

a. Essential Reading

1. Books / Research Articles

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10. Course Organization

Course Code	CYC527A	
Course Title	**Seminar 2**	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
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Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Semester 3

Course Specifications: Chemistry of Agrochemicals, Textiles and Polymers

Course Title	Chemistry of Agrochemicals, Textiles and Polymers
Course Code	CYC611A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

11.Course Summary

This Course aims at introducing students to the fundamental knowledge and skills that are required in the agrochemical, textile & polymer manufacturing sector.
Students will gain insights into some of the most commonly used manufacturing operations in the aforesaid industries. They will get familiarized with various physical and chemical treatments employed in manufacturing units to improve quality and for better yields of products. During the course students will learn the chemical aspects of these materials, their applications in different fields and effect on environment.

1. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

2. Course Outcomes (COs)

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

CO 1. Illustrate the synthesis and applications of fertilizers, insecticides, herbicides, fungicides, rodenticides and polymers
CO 2. Outline the concepts of high energy materials, chemical warfare agents, glass transition temperature, factors affecting Tg, polymer characterization, processing, recycling, degradation, stabilization of polymers and methods of fiber production & polymerization
CO 3. Discuss the chemistry of pesticides and starch, different types of pre fabric treatments and working principles of common unit operations, structure, composition and properties of various types of fibers
CO 4. Recommend the common unit operations for various manufacturing processes, formulation of pesticides, suitable polymers and fibers for different applications
CO 5. Assess the environmental aspects of fertilizers, insecticides, herbicides, fungicides, rodenticides and polymers

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3. Course Contents

Unit Operations:

Evaporation - Types of evaporators - Vacuum and film evaporators, multiple effect evaporators; Drying - Spray drying, freeze drying, super critical drying; Distillation - Simple and Steam Distillation, distillation with reflux, fractional distillation; Extraction - Single and multistage continuous counter current extraction; Leaching - Single and multistage leaching; Filtration; settling; sedimentation; centrifugal separation processes; Size reduction and separation

Insecticides, Herbicides, Fungicides, Rodenticides, Pesticides:

General introduction, synthesis, structure, application and environmental aspects of (a) Insecticides: DDT, BHC, aldrin, malathion, monocrotophos, Finitrothion, triazophos, methomyl, quinolophols, phorate, parathion, deltamethrin, permethrin, fluvalinate, fenvalerate, (b) Herbicides: 2,4-dichloro phenoxy acetic acid, dalapon, paraquat, banalin, butacarb, alachlor, suphonylureas , (c) Fungicides: Boardeaux mixture, copper oxychloride, benomyl , (d) Rodenticides: Warfarin, sodium monofluoroacetate, zinc phosphide

Formulation of pesticides: Purpose of formulation, Adjuvants, Synergism, Wettable and Flow able powders, Emulsions, Emulsifiable oils, Solubility limitations, Solution concentrates, Aqueous suspensions, Chemicals formulations, Dusts for spraying, Aerosols, Smokes, Granules preparation, Baits, Micro-encapsulation, Soluble emulsions, etc.

Fertilizers and Textiles:

Production, target application, advantages and environmental aspects of Fertilizers: Ammonium nitrate, Urea, Calcium Cyanamide, Calcium Ammonium Nitrate, Sodium Nitrate, Ammonium Chloride; Normal super phosphate, Triple Super Phosphate, Ammonium Phosphate, Potassic fertilizers, Mixed fertilizers

Textiles: Chemistry of starch and its hydrolytic & oxidative decomposition, methods of desizing-hydrolytic & oxidative, bromitedesizing, enzymatic desizing - rot steep and acid steep, chemistry of cotton fiber- alkali scouring, surfactants, concept of micelle, critical micelle concentration, HLB value, cloud point, wetting, detergency and emulsification, Bleaching - methods, agents - hypochlorite, chlorite, peroxide bleaching, optical whitening agents. Mercerization of cellulose -Treatment with liquid ammonia.

Polymers, Warfare Agents and High Energy Materials:

Commercial Polymers, their properties and significance in the Domestic and Industrial World: Chemistry and Mechanism of Polymerization, Methods of Polymerization, glass transition temperature, factors affecting Tg, Structure-property relationships, Polymer Characterization, Plastics, Polymer processing, polymer recycling, Polymer degradation & stabilization

Fibres: Structure, properties and applications of acetate, cuprammonium, viscose, alginate fibers, polyesters, polyamides, polyurethanes, acrylics, polyolefin's, polyvinyl chlorides, polyester, polyamide, poly acrylonitrile fibres and aramid fibers. Method of Fiber Production: Melt spinning, dry spinning & wet spinning; viscosity of melts and solutions, concept of quenching.General introduction, detection and protection of Chemical Warfare Agents: Vesicants, Nerve agents, Cyanogenic agents, Chocking agents, Psychomimetic agents, Riot Control agents.

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High Energy Materials: Propellants, Pyrotechnics, Explosives

4. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3										3		
CO-3	3										3		
CO-4	3		3								3		
CO-5	3		3								3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M Sc. (Industrial Chemistry) Programme. The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	100 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	
CO-5	X	X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--

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12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

8. Course Resources

b. Essential Reading

1. Class Notes
2. Marshall Sitting, M & Gopala Rao, (2012) Dryden's Outlines of Chemical Technology for the 21st Century. 3rd Edition. Affiliated East-West Press Pvt. Ltd. New Delhi
3. Christie J Geankoplis, (1993), Transport Process and Unit Operations. Prentice Hall, New Delhi
4. Seema Sekhri, (2011) Textbook of Fabric Science: Fundamentals to Finishing. PHI Learning Private Limited, New Delhi
5. Gowarikar, V.R. Vishwanathan, N.V. And Jayadev Sreedhar, (2006) Polymer Science. New Age Publishers, New Delhi
6. Jai Prakash Agrawal, (2010), High Energy Materials: Propellants, Explosives and Pyrotechnics, Wiley-VCH, Weinheim, Germany
7. Timothy C. Marrs, Robert L. Maynard, Frederick R. Sidell, (2007) Chemical Warfare Agents: Toxicology and Treatment, 2nd Edition, John Wiley & Sons, Ltd, New Jersey, USA

c. Recommended Reading

1. Christie J Geankoplis, (2003) Transport Processes and Separation Process Principles. 4th Edition. Prentice Hall India Ltd. New Delhi
2. Randolph Norris Shreve, George T Austin, (1984) Shreve's Chemical Process Industries. 5th Edition. McGraw-hill. USA
3. Chester L. Foy, David W. Pritchard (1996) Pesticide Formulation and Adjuvant Technology. 1st Edition, CRC Press. Florida, USA
4. DA Knowles (1998) Chemistry and Technology of Agrochemical Formulations. Springer Science, NY, USA

9. Course Organization

Course Code	CYC611A	
Course Title	Chemistry of Agrochemicals, Textiles and Polymers	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

Course Specifications: Chemistry of Industrial Minerals

Course Title	Chemistry of Industrial Minerals
Course Code	CYC612A
Course Type	Core Theory
Department	Chemistry
Faculty	Faculty of Mathematical and Physical Sciences

1. Course Summary

In this course students will learn the principles involved in the extraction of metals from natural minerals.
Physical and chemical treatments employed in mineral processing industry are dealt with. The production of cement and ceramics will also be emphasized. Students will be taught the principles of metallurgy.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Discuss the composition, structure, symmetry and elementary crystallography of different minerals
CO-2. Describe the size reduction, separation and purification of important minerals/ores
CO-3. Explain the principles of extraction, concentration and refining of metals from their ores
CO-4. Compare conventional and modern methods for the mineral processing in terms of efficiency, cost effectiveness, time consumption and environmental impacts
CO-5. Analyze the importance, pros & cons of mineral beneficiation and their unit operations involved in metallurgy

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4. Course Contents

Mineral and Crystal Chemistry: Introduction to minerals. Definition & identification of minerals. Physical and chemical properties of minerals. Classification of minerals. Uses of minerals. Calculations of structural formulae and end - member compositions from chemical analyses and distribution coefficients. Solid solution and exsolution in minerals, mineral chemistry of common gem and industrial minerals. Structure of minerals and symmetry.

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Unit cell, crystal systems, Bravais lattices, Miller indices and limiting radius ratio, defects in crystals, closed packed structures, crystal structure of minerals-rock salt, zinc blende & Rutile.

Unit Operations in Mineral Industries: Particle size analysis, fine particle production, crushers and grinding mills, industrial particle size control, screens and gravity classifiers, hydrocyclones, particulate separation processes, heavy- media separations, jigging and hindered settling, flowing film - spirals, tables, and cones, magnetic separators, electrostatic separators.

Surface - chemical processing: Floatation - froth and column, reagents used, flotation machines, flotation of sulphide and non - sulphide metalliferrous minerals; coal flotation; Principles of coagulation, flocculation and dispersion; chemistry and stability of colloidal dispersions; Industrial applications of coagulation and flocculation. Inorganic coagulants; polymeric flocculants; selective flocculation

Solid/Liquid Separation and Fine Particle Processing: Dewatering in mineral processing - thickeners, filters, centrifuges and drying. Agglomeration-balling, briquetting, Nodulizing and sintering. Small scale beneficiation techniques.

Ore Processing: Production of cement. Types, properties and hydration of cement. Industrial minerals-apatite, lime & lime cycle, magnesium oxide, manganese, mica, bauxite, chromite, asbestos, fluorite, gypsum, ochre, phosphorite, silica sand and mineral sands.

Metallurgy: Hydrometallurgical processes relating to the production of metals and compounds. Leaching processes and methods. Solution concentration and purification, solvent extraction, use of ion exchangers and activated carbon for solution concentration and purification. Metal recovery processes: cementation, gaseous reduction, compound precipitation, electrowinning. Industrial extraction and refining of gold, silver, copper, nickel and aluminum from their ores. Operations utilizing heat - drying, calcination, roasting, sintering, smelting and converting, oxidation-reduction; furnace types - advantages and disadvantages. Pyrometallurgy - extraction and refining processes for recovery of gold, silver, copper and nickel. Fire refining: principles of fire refining of metals. Smelting and refining of gold, silver and copper.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3										3		
CO-3	3										3		
CO-4	3						1				3		
CO-5	3									2	3	2	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

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Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		43
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		02
1. Solving Numerical Problems	02	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	25 Marks
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4	X	X	X	X

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CO-5	X	X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

8. Course Resources

a. Essential Reading

1. Class Notes
2. Lab Manual
3. Barry A Wills (2006) Willi's Mineral Processing Technology, 7 ed, Butterworth-Heinemann; USA
4. Andrew Putnis. (1992) An Introduction to Mineral Sciences, Cambridge University Press, UK

b. Recommended Reading

1. Hand book of minerals and minerals based industries (2006) EIRI Books, New Delhi.
2. Dexter Perkins.(2002) Mineralogy. Prentice Hall, USA.
3. Jessica ElzeaKogel (2006) Industrial Minerals & Rocks. 7th Ed, Society for Mining, Metallurgy, and Exploration, USA.
4. Peter A. Ciullo (1996) Industrial Minerals and Their Uses. Elsevier, NY,USA.
5. Chiranjib Kumar Gupta (2006) Chemical Metallurgy: Principles and Practice. Wiley. USA.
6. Patrick Degryse (2003) Industrial Minerals: Resources, Characteristics, and Applications. Leuven University Press, Belgium.

c. Magazines and Journals

1. Chemistry for everyone Letters; Springer ISSN: 1610-3653 Jo. No. 10311
2. Physics and Chemistry of Minerals; Springer ISSN:1432-2021

d. Websites

1. http://nptel.ac.in/

e. Other Electronic Resources

1. Electronic resources on the subject area are available on MSRUAS library

9. Course Organization

Course Code	CYC612A	
Course Title	Chemistry of Industrial Minerals	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Petroleum Chemistry

Course Title	Petroleum Chemistry
Course Code	CYC613A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The Course covers general aspects of source of petroleum, properties, its refining, petroleum products and biofuels.
Student will learn about the composition and characteristics of petroleum and its derived products. Students will be taught on the refining and purification of crude oil and the preparation of petrochemicals. Students will also learn about the bio renewable energy sources such as biomass and biofuels.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

After undergoing this course students will be able to:

CO 1. Identify the composition of petroleum & derivatives, biofuels and natural gas
CO 2. Illustrate the refining of crude oil, manufacturing processes of petrochemicals, petroleum products and biofuels.
CO 3. Discuss the characteristics of crude oil, petroleum products, petrochemicals, natural gas and biofuels.
CO 4. Analyze the challenges faced by petroleum industries in terms of quality of crude oil and methods of improvement in the processes
CO 5. Judge the importance of biofuels by considering their efficiency, impact on food security, environmental effects, renewability, cost effectiveness and adaptability.

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4. Course Contents

Oil and Gas: Introduction to oil and gas: Significance and recent advances in the petroleum industry. Composition of petroleum – Appearance, composition and properties, Hydrocarbon constituents of straight-run distillates, monomer hydrocarbon constituents of gasoline, structural group constituents of diesel and vacuum distillates, non- hydrocarbon constituents - sulfur, nitrogen and oxygen compounds, resin and asphaltene of petroleum. The properties of petroleum and product: volatility - vapor pressure, boiling point range, average boiling point, density, specific gravity, average molecular weight, characteristic factor (k), viscosity, critical and thermal properties. Quality of petroleum products: diesel, gasoline and alternative fuels.

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Crude oil and refining: Overview of crude oil refining, crude distillation, cracking, reforming and Isomerization, Hydro processing, alkylation, visbreaking and coking, gas processing and polymerization, Refinery supporting processes Lubricants: Introduction, principles and function, types of lubrication and mechanism - hydrodynamic, boundary, extreme pressure lubrication. Lubrication and wear, classification and properties of lubricants-viscosity, flash and fire point, cloud and pour point, aniline point, neutralization number, etc.
Heavy oil: heavy oil chemistry, solvent deasphalting and other processing techniques.

Petrochemicals: Petrochemicals: Overview of petrochemicals, Building blocks of petrochemical industries Olefins: ethylene - LDPE, HDPE, propylene – PP, Butadiene, vinylchloride, PVC, acrylonitrile, Cumene, Isoprene and oxo-processing, acetone, isopropanol Aromatics: Xylenes, styrene, phenol, phthalic anhydride, and polymers such as polystyrene, styrene butadiene rubber, polyethylene and polyurethanes.

Synthesis gas: ammonia, methanol, formaldehyde, urea and other fertilizers. Mechanism and Catalytic cycle of important industrial processes such as alkene hydrogenation (willkinson's catalysts, Synthetic gas (Fischer Tropsch reaction), Ziegler-Natta Catalysts.
Natural gas, liquefied natural gas, methanol. Chlor-alkali, chlorine and caustic soda- impact on petrochemicals.

Biorenewables: Biofuels - Sources of biomass feedstock, use of vegetable oil (straight chain vegetable oil) and waste vegetable oil (WVO). Conversion of feedstock into biodiesel (trans esterification reaction with mechanism), fermentation and anaerobic digestion.
First generation bio-fuels: Ethanol, vegetable oil, bioethers, syngas, solid biofuels, non-food crops like jatropha, rape seed, palm oil, switch grass. Second generation bio-fuels: Biomethanol, DMF, Bio-DME, Fischer-Tropsch diesel, biohydrogen diesel, mixed alcohols and wood diesel, bioalcohols. Third generation bio-fuels ("oilgae"): Algal biomass

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3										3		
CO-3	3										3		
CO-4	3		3									2	
CO-5	3						2				3		2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4	X	X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
1. I.D. Mall (2015) Petroleum refining technology, CBS Publishers, New Delhi
2. B.K.B. Rao (2005) Modern Petroleum Refining Process, Oxford & IBH New Delhi
3. I.D. Mall (2017), Petrochemicals Process Technology, Trinity Press, Bengaluru

b. Recommended Reading

1. James G. Speight (2014) The Chemistry and Technology of Petroleum, Florida – USA, CRC Press
2. D.M. Mousdale, 2010, Introduction to Biofuels, Florida – USA, CRC Press
3. S. Matar, L. F. Hatch. 2001, Chemistry of Petrochemical Processes, Houston-Texas, Gulf Professional Publishing

10. Course Organization

Course Code	CYC613A	
Course Title	Petroleum Chemistry	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Chemistry of Oils, Fats, Surfactants and Coatings

Course Title	Chemistry of Oils, Fats, Surfactants and Coatings
Course Code	CYC614A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this Course is to introduce students to chemistry oils, fats, surfactants and coatings. This Course discusses the chemistry of oils, surfactants and protective coatings with emphasis on industrial production. The student will also learn to assess the quality of various oils and fats. The physico-chemical properties of surfactants will be discussed. Students will be taught about corrosion and its control through the use of protective coatings.

2. Course Size and Credits:

Number of Credits	03
Credit Structure (Lecture: Tutorial: Practical)	3:0:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO 1.** Outline the extraction methods for various perfumery compounds and manufacture of industrial surfactants, preparation of paints and coatings
- **CO 2.** Evaluate the corrosion problem and suggest suitable coatings in industrial applications, print and heavy duty coatings etc.
- **CO 3.** Recognize the importance of surfactants, coatings and their applications.
- **CO 4.** Assess the quality of oils and fats and evaluate the degree of adulteration
- **CO 5.** Summarize the physico-chemical properties of oils, fats and essential oils.

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Oils and Fats:

Classification, role of fats, fatty acids and glycerol derived from oils and fats; physical properties; reactions of fats-rancidity, reversion, polymerisation, saponification, addition, hydrogenation; adulteration tests for vegetable and animal fats ,oils and their chemistry. Physico-chemical characteristics of natural oils, fats and their fatty acids, oiliness and viscosity, density and coefficient of expansion, melting point, smoke, fire and flashpoints, boiling point, solubility, miscibility and refractive index. Production of oils and fats Surfactants, classification and physico-chemical properties of surfactants, practical applications of surfactants in various fields, manufacturing of

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various industrial surfactants

Coatings and essential oils:

Coatings

Paints- Introduction, constitution, preparation and applications, principles of paint formulation, concept of pigment volume concentration, theory of pigment wetting and dispersion, dispersion technology. Corrosion and its types, heavy duty protective coatings and marine coatings for corrosion control, Print coatings for metals, Coating applications in various industries

Essential oils : Sources, nature, constituents, production and uses of the following natural essential oils from-Lemongrass, Lemon, Citronella, Bergamot, Neroli, Palmarosa, Rosemary, Eucalyptus, Turpentine, Jasmine, Lavender, Rose, Geranium, Sandalwood, Clove , Cinnamonoil, Vetiver and Peppermint.

Hydrocarbons and Derivatives:

Ocimene, p-Cymene, Limonene, Carene, Pinene, Camphene, Fenchene, Bisabolene, Zingiberene and Caryophyllene. Alcohols-Linalool, Geraniol, Citronellol, Terpineol, Menthol, Borneol, Isoborneol, Farnesol, Fenchyl Alcohol, Sandalols and Leaf alcohol. Aldehydes-Citral, Citronellal and hydroxyl citronellal, Ketones-Methyl Heptenol, Menthone, Piperitone, Pulgone, Carvone, Fenchone, Camphor, Ionones and Irones

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2	3		2								3	2	
CO-3	3										3	2	
CO-4	3		3								3		
CO-5	3										3		
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00

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1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**55**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			**Component 2: SEE (50% Weightage)**
Subcomponent▶	**TSC1**	**TSC2**	**TSC3**	**100 Marks**
Subcomponent Type ▶	**Mid Term Test**	**Assignment**	**Innovative**	
Maximum Marks▶	**50**	**25**	**25**	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5	X	X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following

teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. CHAKRABARTY, MM. (2003) Chemistry and Technology of Oils & Fats. Allied Publishers, Mumbai
3. FARN, RJ. (2006) Chemistry and Technology of Surfactants. Wiley, New Jersey, USA
4. KHANNA, AS. (2011) Protective Coatings: An Overview. Wiley, New Jersey, USA

b. Recommended Reading

1. BAILYE'S, AE. (1964) Bailey's Industrial oil and fat products, Interscience Publishers, Michigan, USA
2. GUNSTONE, FD. (2004) The Chemistry of Oils and Fats: Sources, Composition, Properties and Uses, Blackwell Pub, New Jersey, USA
3. NANETTI, P. (2006) Coatings from A to Z. Hannover: Vincentz Network, Germany

c. Magazines and Journals

1. Surface and Coatings Technology - Elsevier
2. Journal of Coatings Technology and Research - Springer
3. ACS Applied Materials & Interfaces

d. Websites

1. www.sspc.org
2. http://www.european-coatings.com
3. http://www.corrosionclinic.com

e. Other Electronic Resources

1. http://www.materialstoday.com
2. http://www.paintcenter.org
3. http://ncptt.nps.gov

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10. Course Organization

Course Code	CYC614A		
Course Title	Chemistry of Oils, Fats, Surfactants and Coatings		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date		14th July 2022	
Next Course Specifications Review Date		July 2024	

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Course Specifications: Research Methodology

Course Title	Research Methodology
Course Code	MPF615A
Course Type	Core Theory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of the course is to introduce students to the principles of research, research methodology and significant phases of research.
Students are taught the significant role of Literature Review in a research cycle and the expectations from good literature review as well as procedure for systematic literature review. The essential aspects of technical communication to develop desirable writing skills for the preparation of research document including research paper as well as the skills for an effective presentation are also discussed. The module also emphasizes the desirable close knit relation between innovation and concept of out of the box thinking. Students will get an insight into the privilege, honour and the associated responsibilities of a researcher.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Describe the value, scope, relevance and mandatory steps of research as well as principles of effective research
- **CO-2.** Discuss and demonstrate the application and utility of the Systematic approach and out of box thinking concepts for research to be effective
- **CO-3.** Explain and apply the procedures outlined for a systematic Literature Review
- **CO-4.** Outline the principles to prepare a well-structured research proposal and research paper
- **CO-5.** Identify and apply the essential skills desirable for an effective technical presentation

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4. Course Contents

Foundations of Research:

Definitions of Research, Mandatory Steps in Research, Types of Research, Relevance of Research for Innovation and Technology Development, Effective Research and Self Discipline. Out of the Box

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Thinking and Systematic approach in Research – Transformation to Impossible Thinking, Convergent and Divergent Thinking, Generation, Evaluation and Selection of Ideas.

Literature Review:

Importance of Literature Review, Constituents of Good Literature Review, Strategies for Literature Search, Referencing, Paraphrasing, and Summarizing Academic Standards and Ethics. Statistical Methods and Data Analysis

Research Proposal:

Structure of a Good Research Proposal, Getting Started, Tips for Compilation of Good Research Proposal. Technical Communication - Research Paper for Publication- Significance of Problem Statement and its scope, Formulation of Hypothesis, Adequacy of Methodology, Significance of Presentation and Discussion of Results, Relevance and Importance of references.

Effective Presentation:

Preparation, Templates, Balance between Good Design and Good Content, Planning and Sequencing, PAMPERS (Projection, Articulation, Modulation, Punctuation, Enunciation, Repetition and Speed) rule, PEOPLE (Position & Gestures, Eye Contact, Orientation, Proximation, Looks & Appearance, and Expressions & Emotion) rule, 4P's Rule (Plan, Prepare, Practice and Present), Essentials of Effectiveness, Effective Pausing and Inclusive Answering.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3										3		
CO-2			3		3				3	3		3	
CO-3			3	3	3				3	3		3	3
CO-4			3		3				3	3		3	3
CO-5				3					3	3		3	3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures35		30
Demonstrations		
1.Demonstration using Videos	00	00
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		
1. Solving Numerical Problems	00	00

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Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	00
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	00
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		05
Total Duration in Hours		**35**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		**Component 2: SEE (50% Weightage)**
Subcomponent ▶	**TSC1**	**TSC2**	
Subcomponent Type ▶	**Term Test**	**Assignment**	**50 Marks**
Maximum Marks ▶	**25**	**25**	
CO-1	X		X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X		X
CO-5	X		X
The details of TSC1 and TSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

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The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	Group discussions, assignment
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Booth, W. C, Colomb and G.G Williams., (2005) The Craft of Research, Chicago University Press, USA
3. Willium M.K and Trochim. (2003)Research Methods, 2nd Edition, Biztantra Publicshres, New Delhi
4. Jonathan Grix. (2004) The Foundation of Research, Palgrave Macmillan; Study Guide edition, USA

b. Recommended Reading

1. Wisker Gina. (2001) The Post Graduate Research Handbook, , Palgrave Macmillan, USA.
2. Rugg G. and Petre M. (2004) The Unwritten Rules of Ph.D Research, Open University Press, UK

c. Other Electronic Resources

1. http://nptel.ac.in/

10. Course Organization

Course Code	MPF615A	
Course Title	Research Methodology	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Industrial Chemistry Laboratory 1

Course Title	**Industrial Chemistry Laboratory1**
Course Code	CYL616A
Course Type	Core Laboratory
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to synthesis or analyse related to agro, Textiles and Polymeric materials.

Students are trained to determine physical and chemical properties of given samples. They are trained to analyze the results and infer appropriate conclusions based on concepts of Industrial chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Setup the experimental apparatus required to achieve the stated aim
CO 2. Conduct experiments as per the standard procedures and tabulate the measured values
CO 3. Calculate the required parameters and plot the results
CO 4. Interpret and draw conclusions
CO 5.Write laboratory report as per the prescribed format

4. Course Contents

1. Colorimetric estimation of phosphorous
2. Barium active method for textiles
3. Preparation of polyaniline or Polypyrrole
4. To determine the molecular weight of PANI (Polyanilne) or PPY(polypyrrole) using ostwald's viscometer
5. Estimation of nitrogen from the given soil sample by colorimetric method
6. Flame photometric estimation of potassium
7. Determine the percentage of alcohol by specific gravity method
8. Determination of soil pH
9. Analysis of Pyrolusite

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10. To estimate the percentage purity of the given sample of Ascorbic acid
11. Estimation of percentage purity of Fe and Fe2O3 in a given sample of Haematite ore using Ce(IV) solution
12. Analysis of stainless steel
13. Gravimetric analysis of copper in brass
14. Analysis of potash alum

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3								3	
CO-2				3								3	
CO-3				3								3	
CO-4				3								3	
CO-5									3				3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems		
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent▶	LSC1	LSC2	50 Marks
Subcomponent Type ▶	Lab Report	Term Test	
Maximum Marks▶	25	25	
CO-1	X	X	X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory work, examination
10.	Verbal Communication Skills	Laboratory examination
11.	Presentation Skills	---
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	---

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a. Essential Reading

1. Laboratory Manual
2. B. Vishwanathan and P.S. Raghavan (2005) Practical Physical Chemistry, VIVA Books, New Delhi
3. O.P. Pandey, D.N. Bajpai and S. Giri, (2008) Practical Chemistry, S. Chand New Delhi

b. Recommended Reading

1. Arthur Israel Vogel, G. H. Jeffery (1989) Vogel's text book of quantitative chemical analysis, Longman Scientific & Technical, London, UK

10. Course Organization

Course Code	CYL616A	
Course Title	Industrial Chemistry Laboratory 1	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Industrial Chemistry Laboratory 2

Course Title	**Industrial Chemistry Laboratory 2**
Course Code	CYL617A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

This course intends to train the students to synthesis or analyze related to mineral and petroleum chemistry.

Students are trained to determine physical and chemical properties of given samples. They are trained to analyze the results and infer appropriate conclusions based on concepts of Industrial chemistry.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO 1. Setup the experimental apparatus required to achieve the stated aim
CO 2. Conduct experiments as per the standard procedures and tabulate the measured values
CO 3. Calculate the required parameters and plot the results
CO 4. Interpret and draw conclusions
CO 5.Write laboratory report as per the prescribed format

4. Course Contents

1. Determination of acid value of given vegetable oil
2. Determination of iodine value of given oil
3. Determination of saponification value of given oil
4. Preparation of biodiesel from a vegetable oil
5. Estimation of percentage purity of separated glycerol from biodiesel volumetrically
6. Determination of flash point, pour point and cloud point of a biodiesel
7. Determine the viscosity coefficient of prepared biofuel
8. Determination of calorific value of biodiesel
9. Detection of tea seed oil from olive oil
10. To detect the presence of adulterants in oil and butter

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11. Essential oil extraction by soxhlet apparatus (mint leaves, lemon)
12. Extraction of cinnamaldehyde from cinnamon by steam distillation
13. To detect the presence of adulterants in milk(formalin, gelatin, urea, anionic detergent)
14. Preparation of soap from soybean oil

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1				3								3	
CO-2				3								3	
CO-3				3								3	
CO-4				3								3	
CO-5									3				3

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems		
Practical Work		60
1. Course Laboratory	60	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1, LSC2) COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent▶	LSC1	LSC2	50 Marks
Subcomponent Type ▶	Lab Report	Term Test	
Maximum Marks▶	25	25	
CO-1	X	X	X
CO-2	X	X	X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X		
The details of LSC1, LSC2 are presented in the Programme Specifications Document.			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.
Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Laboratory instruction
2.	Understanding	Laboratory instructions and experiments
3.	Critical Skills	Laboratory work
4.	Analytical Skills	Laboratory work
5.	Problem Solving Skills	Laboratory work
6.	Practical Skills	Laboratory work
7.	Group Work	Laboratory work
8.	Self-Learning	Laboratory work
9.	Written Communication Skills	Laboratory work, examination
10.	Verbal Communication Skills	Laboratory examination
11.	Presentation Skills	---
12.	Behavioral Skills	Course work
13.	Information Management	Laboratory work
14.	Personal Management	Course work
15.	Leadership Skills	---

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9. Course Resources

a. Essential Reading

1. Laboratory Manual
2. B. Vishwanathan and P.S. Raghavan (2005) Practical Physical Chemistry, VIVA Books, New Delhi
3. O.P. Pandey, D.N. Bajpai and S. Giri, (2008) Practical Chemistry, S. Chand Co., New Delhi

b. Recommended Reading

1. Arthur Israel Vogel, G. H. Jeffery (1989) Vogel's text book of quantitative chemical analysis, Longman Scientific & Technical, London, UK

10. Course Organization

Course Code	CYL617A	
Course Title	Industrial Chemistry Laboratory 2	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Seminar 3

Course Title	Seminar 3
Course Code	CYS618A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.

The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and present the same.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Conduct a thorough literature review and submit a review article / scientific report
CO-2. Make a presentation to a panel of examiners

4. Course Contents

Choose the relevant research topic

Study literature and give seminar

Prepare a review article/ scientific report and give a presentation on the same topic

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1		2							3				3
CO-2		2							3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		60
1. Case Study Presentation	60	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**68**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage) (Report)	**Component 2: SEE (50% Weightage) (Presentation)**
Subcomponent ▶	**LSC1**	
Subcomponent Type ▶	**Assignment**	
Maximum Marks ▶	**50**	**50 Marks**
CO-1	**X**	
CO-2		**X**
The details of LSC1 are presented in the Programme Specifications Document.		

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

9. Course Resources

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a. Essential Reading

1. Books / Research Articles

10. Course Organization

Course Code	CYS618A	
Course Title	**Seminar 3**	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Semester 4

Course Specifications: Internship

Course Title	Internship
Course Code	CYI621A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

Aim of The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.
The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and present the same.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	120
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Write a report on experiences during internship
CO-2. Make a presentation to a panel of examiners

4. Course Contents

Choose relevant industry/business organization/research organization/university

Undergo internship

Prepare a scientific report and give a presentation on the same topic

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1									3				3

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CO-2									3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		120
1. Case Study Presentation	120	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**128**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation

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	Component 1: CE (50% Weightage)	Component 2: SEE (50% Weightage)
Subcomponent ▶	SC1	
Subcomponent Type ▶	Report	Presentation
Maximum Marks ▶	50 Marks	50 Marks
CO-1	X	
CO-2		X
The details of LSC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

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9. Course Resources

a. **Essential Reading**

1. Literature / Discussion with allotted supervisor/s

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10. Course Organization

Course Code	CYI621A		
Course Title	Internship		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details		**Phone:**	+91-804-906-5555
		E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date		14th July 2022	
Next Course Specifications Review Date		July 2024	

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Course Specifications: Seminar

Course Title	Seminar
Course Code	CYS621A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.

The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and give a presentation on the chosen topic.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	0:0:4
Total Hours of Interaction	120
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Conduct a thorough literature review and submit a review article
CO-2. Make a presentation to a panel of examiners

4. Course Contents

Choose the relevant research topic

Study literature give seminars

Prepare a review article and present the same

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1		2										3	
CO-2		2							3				3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		120
1. Case Study Presentation	120	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		08
Total Duration in Hours		**128**

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)	**Component 2: SEE (50% Weightage)**
Subcomponent ▶	**LSC1**	
Subcomponent Type ▶	**Report**	**Presentation**
Maximum Marks ▶	**50 Marks**	**50 Marks**
CO-1	**X**	
CO-2		**X**
The details of LSC1 are presented in the Programme Specifications Document.		

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

9. Course Resources

a. Essential Reading

1. Research Articles /Dissertation Reports / Books

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10. Course Organization

Course Code	CYS621A	
Course Title	**Seminar**	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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Course Specifications: Dissertation

Course Title	Dissertation
Course Code	CYP622A
Course Type	Laboratory Course
Department	Chemistry
Faculty	Mathematical and Physical Sciences

1. Course Summary

The aim of this module is to train a student to carry out research work.

The research work will be carried out at MSRUAS or in any other laboratory of student's choice under the supervision of a senior researcher. The duration of the research work is for six months. The student is expected to submit a dissertation and make a presentation to the examiners in the faculty.

2. Course Size and Credits:

Number of Credits	15
Credit Structure (Lecture: Tutorial: Practical)	0:0:15
Total Hours of Interaction	450
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	300
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- **CO-1.** Recognize the need for developing a new or improving an existing scientific problem through an organized survey of literature
- **CO-2.** Define scientific problem
- **CO-3.** Design and perform the experiments
- **CO-4.** Analyse the results obtained
- **CO-5.** Write a technical Report and give presentation

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4. Course Contents

Selection of topic for research
Critical review on the chosen topic
Performance of experiments
Collection of relevant data
Interpretation of data
Preparation of dissertation report and presentation of the same

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5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		3		3						3		
CO-2			3		3			3				3	3
CO-3			3	3	3			3				3	3
CO-4					3			3				3	3
CO-5						3			3	2			3
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		450
1. Case Study Presentation / Solving Research Problem	450	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		**460**

7. Course Assessment and Reassessment

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The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Industrial Chemistry) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (LSC1), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (33% Weightage)	Component 2: (67% Weightage)
Subcomponent ▶	LSC1	
Subcomponent Type ▶	Pre-project (40 marks) and Mid Term (60 Marks) Presentation	Final Project Presentation (50 Marks), Report (100 Marks) Journal Article (50 Marks)
Maximum Marks ▶	100	200
CO-1	X	X
CO-2	X	X
CO-3	X	X
CO-4	X	X
CO-5		X
The details of LSC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

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8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report

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14.	Personal Management	Course work
15.	Leadership Skills	---

9. Course Resources

a. Essential Reading

1. Research Articles / Dissertation Reports / Books
2. Lecture Sessions on individual project, Thesis Preparation delivered by the concerned Head of Department.

10. Course Organization

Course Code	CYP622A	
Course Title	Dissertation	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	**Phone:**	+91-804-906-5555
	E-mail:	hod.cy.mp@msruas.ac.in
Course Specifications Approval Date	14th July 2022	
Next Course Specifications Review Date	July 2024	

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