MGM University

Vision

To ensure sustainable human development which encourages self-reliant and self-content society.

To promote activities related to community services, social welfare and also Indian heritage and culture.

To inculcate the culture of non-violence and truthfulness through vipassanna meditation and Gandhian Philosophy.

To develop the culture of simple living and high thinking

Mission

To impart state of art education and technical expertise to students and give necessary training to teachers to create self-reliant society for future.

To encourage students to participate in Indian and International activities in sports, literature, etc. so that future generation becomes base for free and liberal society

To educate students in areas like Management, Finance, Human relations to inculcate philosophy of simple living and high thinking value of simple economic society.

To inculcate culture of non-violence and truthfulness through Vipassana.

To sustain activities of Indian culture (viz. classical dance, music and fine arts) through establishing institutes like Mahagami, Naturopathy, etc.

विद्यापीठ गीत

अत्त दिप भव भव प्रदिप भव,

स्वरूप रूप भव हो

ज्ञान सब्ब विज्ञान सब्ब भव ,

सब्ब दिप भव हो

अत्ताहि अत्त नो नाथो ,

अत्ताहि अत्त नो गति

अत्त मार्गपर अप्रमादसे है तुझे चलना

सब्ब का कल्याण हो ,

वो कार्यकुशल करना

सब्ब का उत्तम मंगल , पथप्रदर्शक हो

अत्त दिप भव भव प्रदिप भव ,

स्वरूप रूप भव हो

ज्ञान सब्ब विज्ञान सब्ब भव ,

सब्ब दिप भव हो

बुद्धमं शरनं गच्छामि :

धम्मं शरनं गच्छामि :

संघं शरनं गच्छामि :

The School of Basic and Applied Sciences (SBAS) was established in the year May-2021. The School comprises of various department such as Physics, Chemistry, Mathematics & Statistics at the time of establishment of SBAS. The departments of Geology, Forensic Science, Home Science and Cosmetic Technology were established in 2022. School of Basic and Applied Science offers UG, PG and PhD programmes in various discipline of basic and applied science.

Vision

- The vision of the department is to provide high quality education and skills to undergraduate, postgraduate and doctorate students.
- Make the learning of basic sciences exciting through high class teaching with innovative ideas, curiosity and creativity.
- The department is committed to inculcate competence, critical, logical ethical thinking and communications skill amongst the students.

Mission

- To establish, build and sustain the department of the highest international standard by the excellent teaching, quality research, generating new knowledge and ideas in basic and applied sciences.
- To impart and nurture various skills, human values and social concerns that prepare students to built their carrier across the world in various areas.
- To collaborate with reputed academic and research institutes to strengthen the basic science education and research ecosystem.
- To enhance engagement with society and industry through various programs

Programs offered at SBAS

Undergraduate Programmes	Postgraduate Programmes	PhD Programmes	PG Diploma Programmes	Certificate Programmes
B. Sc (General) PCM				
B. Sc.(Hons/Research) Physics	M. Sc. Physics	Ph. D Physics		
B. Sc.(Hons/Research) Chemistry	M. Sc. Chemistry	Ph. D Chemistry		
B. Sc.(Hons/Research) Mathematics	M. Sc. Mathematics	Ph. D Mathematics		
B. Sc.(Hons/Research) Statistics	M. Sc. Statistics	Ph. D Statistics		
B. Sc.(Hons/Research) Geology	M. Sc. Applied Geology	Ph. D Geology		Ground water Surveying and rain water harvesting
B. Sc.(Hons/Research) Forensic Science	M. Sc. Forensic Science	Ph. D Forensic Science	Forensic Science and crime scene management	

Department of Chemistry

Department of Chemistry was established in 2023 and works with dedication towards teaching, learning, evaluation, research, innovation, student placement and academic progression.

Updated and advanced Outcome Based Curriculum Framework designed by experienced Academicians and Industry Experts integrating various ability enhancement, value education, skill, vocational and advanced laboratory courses which is required to build skills and competency for development of skilled and knowledgeable human recourse for institutions, industry, startups, and society.

Continuous internal evaluation thorough unit test, tutorial, assignment, case study, project work, field work, student seminar for holistic development of students.

Rigorous laboratory training and guidance to the students for nurturing chemistry with safety and responsibility for development of innovative research.

The department offers four year **B. Sc. (Honours/Research) Chemistry, (UG)** programme which is designed as per NEP-2020. Beside this department offers minor course in Analytical

Chemistry and open electives for students of within faculty and other faculty. In addition, this program is uniquely designed to increase the employability and to prepare students to work in a Multi-disciplinary work environment.

The department offers **M. Sc. Chemistry (PG)** Programme with specializations in :

1. Organic Chemistry
2. Analytical Chemistry
3. Physical Chemistry,
4. Medicinal Chemistry,
5. Polymer Chemistry
6. Industrial Chemistry

Students of M. Sc. Chemistry Programme can choose any one specialization for second year (III and IV semester) after completion of first year which is common for all specialization. Department of Chemistry also offers Ph. D programme in Chemistry**.**

Programs offered at Department of Chemistry School of Basic and Applied Sciences, MGM University

Undergraduate Programmes	Postgraduate Programmes	PhD Programmes
B. Sc. (Hnonours) / B. Sc (Honours/Research) Chemistry	M. Sc. Chemistry with Specializations in: 1. Organic Chemistry 2. Analytical Chemistry 3. Physical Chemistry 4. Medicinal Chemistry 5. Polymer Chemistry 6. Industrial Chemistry	Ph. D Chemistry
BS-MS (Industrial Chemistry)		
B. Sc. General Chemistry (PCM)		

Name of Program- **M. Sc. Chemistry with Specialization in Industrial Chemistry**

Duration -Two Years after 03 Year UG degree/01 Year after 04 Year UG degree in Chemistry

Eligibility -

- He / She Must have passed B. Sc. With chemistry or chemistry as one of the subject or chemistry as major subject.

PROGRAMME OBJECTIVES:

- To develop skilled and competent researcher, scientist, trained chemical analyst as an executive work force with strong fundamentals and advanced knowledge and skill in chemical science domain.
- To produce good scholars who are capable of contributing towards strengthening of the scientific foundation of Chemical Industries. Besides this, such manpower would be scientifically multifaceted personalities able to pursue careers either in academics, pharmaceutical, fine chemical and material industries or as an entrepreneur.

PROGRAMME OUTCOME:

- Comprehensive knowledge of theoretical and practical aspects of inorganic, organic , physical and analytical chemistry
- Develop appreciation of hands-on wet chemistry, analytical, instrumentation, and experimental data handling skills to solve scientific problems to address technological challenges in various domains.
- Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.
- Skills for material synthesis, characterization and applications for development of product and materials.
- Develop the ability to exercise independent learning, thinking and problem solving skills
- Develop the ability to interact in a cross-cultural environment and acquire time and project management skills for carrying out guided research work in any of the research areas related to science and technology
- Develop skills to communicate scientific learning and present ideas

PROGRAMME SPECIFIC OUTCOME

- Development of competent scholars and professionals who have comprehensive knowledge of and Industrial and Inorganic Chemistry discipline who could work in tandem with the chemical engineers on transferring small scale chemical reactions to large industrial scale.
- Development of competency for doing research and development for chemical process optimization by identifying industrial requirements for product development in a particular area.
- Competency in synthesis, isolation, purification and extraction of organic and inorganic compounds, functional material, polymer and composites.
- Competency in instrumental and wet chemical analysis
- Competency in various Spectroscopic techniques for characterization and chromatographic methods for separation, purification and quantification of chemicals.
- Comprehensive knowledge in frontiers of advanced coordination chemistry, bioinorganic chemistry, industrial catalysis, surface and interface chemistry, spectroscopy, chemistry of nanomaterials, organic functional material, paint, pigment, polymer, glass, ceramics, porous materials, agro biomass technology, fertilizers and agrochemicals, material balance and process optimization.

Name of Faculty: Basic and Applied Sciences
Name of the College/Institute/Department/School: School of Basic and Applied Sciences
Name of the Programme: M. Sc. Chemistry
Programme Type (UG/PG): PG
Duration: 02 Year (04 Semester)

M. Sc. Chemistry : Semester-I

Course Category	Course Code	Course Title	Nature of Course	No. of Credits	Teaching (Contact hrs/ week)		Evaluation Scheme (Marks)			Minimum Passing (Marks)		
					L	P	Internal	External	Total	Internal	External	Total
MM	MCH43MML501	Group Theory & Coordination Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML502	Organic Reaction Mechanism & Stereochemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML303	Thermodynamics & Electrochemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP501	Inorganic Chemistry Lab Course-I	P	2	-	4		20	50	-	8	20
MM	MCH43MMP502	Organic Chemistry Lab Course-I	P	2	-	4	30	20	50	-	8	20
MM	MCH43MMP503	Physical Chemistry Lab Course-I	P	1	-	2	30	20	50	-	8	20
ME		**Major Elective-I**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL501	Chromatographic Methods of Analysis										
	MCH43MEL502	Material Chemistry										
	MCH43MEL503	Computational & Quantum Chemistry										
ME	MCH43MEP501	Analytical Chemistry Lab Course-I	P	1	-	2	30	20	50	-	8	20
RM	MCH43RML501	Research Methodology	L	4	4	-	60	40	100	-	16	40
Total				**22**	**16**	**12**	**390**	**280**	**700**		**112**	**280**

Note:
Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

First Year-Semester-II:M. Sc. Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML504	Inorganic Reaction Mechanism &Organotransition Metal Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML505	Organic Reactions & Rearrangements	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML506	Chemical Dynamics & Biophysical Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP504	Inorganic Chemistry Lab Course-II	P	2	-	4	30	20	50	-	8	20
MM	MCH43MMP505	Organic Chemistry Lab Course-II	P	2	-	4	30	20	50	-	8	20
MM	MCH43MMP506	Physical Chemistry Lab Course -II	P	1	-	2	30	20	50	-	8	20
ME (Choose Any One)		Major Elective-II	L	3	3	-	60	40	100	-	16	40
	MCH43MEL504	Spectroscopic Methods of Analysis										
	MCH43MEL505	Pharmaceutical & Forensic Analysis										
	MCH43MEL506	Spectroscopic & Thermal Methods of Analysis										
ME	MCH43MEP502	Analytical Chemistry Lab Course-II	P	1	-	2	30	20	50	-	8	20
FP	MCH43FPP501	OJT/ Field Project-I	J	4	-	8	60	40	100	-	16	40
				22	**12**	**20**	**420**	**280**	**700**		**112**	**280**

Note:

Nature of Course:L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Exit option: PG Diploma in Chemistry (44 Credits) after Three Year UG Degree.

Second Year- Semester III : M. Sc. Chemistry With Specialization (Elective) in: Organic Chemistry													
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML607	Applications of Spectroscopy	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML608	Reagents in Organic Synthesis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML609	Photochemistry & pericyclic reactions	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP607	Organic Chemistry Lab Course-III (Ternary Mixture)	P	2	-	4	30	20	50	-	8	20
MM	MCH43MMP608	Organic Chemistry Lab Course –IV (Green Synthesis)	P	2	-	4	30	20	50	-	8	20
MM	MCH43MMP609	Organic Chemistry Lab Course-V (Spectroscopy Lab)	P	1	-	2	30	20	50	-	8	20
ME (Choose any one)		**Major Elective-III**		3	3	-	60	40	100	-	16	40
	MCH43MEL607	Asymmetric Synthesis & Bioorganic Chemistry	L									
	MCH43MEL608	Advanced Stereochemistry										
	MCH43MEL609	Chemistry of Nanomaterials										
ME	MCH43MEP603	Organic Chemistry Lab-VI (Chromatography Lab)	P	1	-	**2**	30	20	50	-	8	20
RP	MCH43RPJ601	Research Project	J	4	-	**8**	60	40	100	-	16	40
Total				**22**	**12**	**20**	**420**	**280**	**700**	_	**112**	**280**

Second Year- Semester IV M. Sc. Chemistry With Specialization (Elective) in: Organic Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML610	Organic Synthesis: Retro synthetic Approach	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML611	Chemistry of Heterocyclic & Bioactive Molecules	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML612	Chemistry of Natural Products	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML613	Green Chemistry	L	3	3	-	60	40	100	-	16	40
ME (Choose any one)		**Major Elective-IV**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL610	Medicinal Chemistry										
	MCH43MEL611	Chemoinformatics										
	MCH43MEL612	Organic High Polymers										
ME	MCH43MEP604	Organic High Polymers Lab	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ602	Research Project (PG Thesis with Presentation and Seminar)	J	6	-	12	60	40	100	-	16	40
			Total	**22**	**15**	**14**	**390**	**260**	**650**	**_**	**104**	**260**

Note

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Organic Chemistry** PG Degree (44 credits) after Four Year UG Degree.

Second Year - Semester III M. Sc. Chemistry With Specialization (Elective) in: Analytical Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML607	Applications of Spectroscopy	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML614	Food Fertilizers & Pesticide Analysis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML615	Quality Assurance & Quality Control	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP610	Analytical Chemistry Lab Course Lab-III	P	2	-	4	30	20	50	-	08	20
MM	MCH43MMP611	Analytical Chemistry Lab Course-IV	P	2	-	4	30	20	50	-	08	20
MM	MCH43MMP612	Analytical Chemistry Lab Course-V	P	1	-	2	30	20	50	-	08	20
ME (Choose any one)		**Major Elective-III**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL613	Chemistry of Nanomaterials										
	MCH43MEL614	Isolation, Extraction & Purifications Techniques										
	MCH43MEL615	Cosmetic Analysis										
ME	MCH43MEP605	Analytical Chemistry Lab-VI	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ603	Research Project	J	4	-	8	60	40	100	-	16	40
Total				**22**	**12**	**20**	**420**	**280**	**700**	**-**	**112**	**280**

Second Year- Semester IV M. Sc. Chemistry With Specialization (Elective) in: Analytical Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/ week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML617	Advanced Instrumental Methods of Analysis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML618	Pharmaceutical & Forensic Analysis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML619	Electro-Analytical Techniques	L	3	3	-	60	40	100	-	16	40
	MCH43MML620	Green Chemistry & Biorefinary Techniuques	L	3	3	-	60	40	100	-	16	40
ME (Choose any one)		**Major Elective-IV**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL616	Analysis of Ores, Alloys & Minerals										
	MCH43MEL617	Environmental and Industrial Material Analysis										
	MCH43MEL618	Polymer and Petrochemical Analysis										
ME	MCH43MEP605	Analytical Chemistry Lab-VII	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ604	Research Project	J	6	-	12	60	40	100	-	16	40
Total				**22**	**15**	**14**	**390**	**260**	**650**		**104**	**260**

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Analytical Chemistry** PG Degree (44 credits) after Four Year UG Degree.

Second Year - Semester III M. Sc. Chemistry With Specialization (Elective) in: Physical Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43 MML607	Applications of Spectroscopy	L	3	3	-	60	40	100	-	16	40
MM	MCH43 MML621	Solid state chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43 MML622	Nanochemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43 MMP620	Spectroscopy Laboratory course	P	2	-	4	30	20	50	-	8	20
MM	MCH43 MMP613	Surface tention and conductometry Laboratory course	P	2	-	4	30	20	50	-	8	20
MM	MCH43 MMP614	Chemical Kinetics and Thermodynamics Laboratory course	P	1	-	2	30	20	50	-	8	20
ME (Choose any one)		**Major Elective-III**	L	3	3	-	60	40	100	-	16	40
	MCH43 MEL619	Nuclear Chemistry										
	MCH43 MEL620	Environmental chemistry,										
	MCH43 MEL621	Advanced electrochemistry										
ME	MCH43 MMP606	Advanced Physical Chemistry-I	P	1		2	30	40	50		8	20
RP	MCH43 RPJ605	Research Project	J	4	-	8	60	40	100	-	16	40
				22	**12**	**20**	**420**	**300**	**700**	**-**	**112**	**280**

Second Year – Semester IV M. Sc. Chemistry With Specialization (Elective) in: Physical Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML623	Surface and magnetochemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML624	Polymer chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML625	Chemical dynamics and catalysis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML626	Statsical Thermodynamics	L	3	3	-	60	40	100	-	16	40
ME (Choose any one)		**Major Elective-IV**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL622	Atomic Spectroscopy and Microscopic Techniques										
	MCH43MEL623	Quantumchemistry										
	MCH43MEL624	Chemical mathematics and computer programming										
ME	MCH43MEP607	Advanced Physical Chemistry Lab-II	P	1		2	30	40	50		8	20
RP	MCH43RPJ606	Research project (Dissertation, presentation and Seminars)	J	6	-	12	60	40	100	-	16	40
				22	**15**	**14**	**390**	**280**	**650**	**-**	**104**	**260**

Note:
Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Physical Chemistry** PG Degree (44 credits) after Four Year UG Degree.

Second Year - Semester III M. Sc. Chemistry With Specialization (Elective) in Medicinal Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML627	Drugs Synthetic Methods	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML628	Fundamentals of Medicinal Biochemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML629	Advanced Spectroscopic Methods	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP616	Chemistry Lab Course Lab-III	P	2	-	4	30	20	50	-	08	20
MM	MCH43MMP617	Chemistry Lab Course-IV	P	2	-	4	30	20	50	-	08	20
MM	MCH43MMP618	Chemistry Lab Course-V	P	1	-	2	30	20	50	-	08	20
ME (Choose any one)		**Major Elective-III**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL625	Chemical Industries										
	MCH43MEL626	Food Fertilizers & Pesticide Analysis										
	MCH43MEL613	Chemistry of Nanomaterials										
ME	MCH43MEP608	Chemistry Lab-VI	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ607	Research Project	J	4	-	8	60	40	100	-	16	40
				22	**12**	**20**	**420**	**280**	**700**	**-**	**104**	**280**

Note:

Nature of Course : L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project.

Second Year - Semester IV. Sc. Chemistry With Specialization (Elective) in Medicinal Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credit**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML630	Medicinal Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML631	Stereo Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML632	Drug Discovery	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML612	Chemistry of Natural Products	L	3	3	-	60	40	100	-	16	40
ME (Choose any one)		**Major Elective-IV**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL611	Chemoinformatics										
	MCH43MEL627	Organic Synthesis										
	MCH43MEL628	Bioactive Heterocyclic Chemistry										
ME	MCH43MEP609	Chemistry Lab-VII	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ608	Research Project	J	6	-	12	60	40	100	-	16	40
				22	**15**	**14**	**390**	**260**	**650**	**-**	**104**	**260**

Note:
Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Medicinal Chemistry** PG Degree (44 credits) after Four Year UG Degree.

Second Year - Semester III M. Sc. Chemistry with Specialization (Elective) in : Polymer Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML633	Principles of Polymer Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML634	Polymer Compounding	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML635	Polymeric materials	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML636	Inorganic & Natural Polymers	L	3	3	-	60	40	100	-	16	40
MM	MCH43MMP619	Polymer Chemistry Lab-III	P	2	-	4	30	20	50	-	08	20
ME (Choose any one)		**Major Elective-III**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL629	Physical chemistry of polymers										
	MCH43MEL630	Polymers Blends & Composites										
	MCH43MEL631	Flocculants and dispersants										
ME	MCH43MEP610	Polymer Chemistry Lab-I	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ609	Research Project	J	4	-	8	60	40	100	-	16	40
				22	**16**	**12**	**420**	**280**	**700**	**-**	**112**	**280**

Second Year - Semester IV M. Sc. Chemistry with Specialization (Elective) in : Polymer Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML637	Chemistry of High Polymers	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML638	Structure – Property relationship in polymers	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML639	Polymer Characterization	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML640	Polymer Membrane & Drug Delivery	L	3	3	-	60	40	100	-	16	40
ME (Choose any one)		**Major Elective-IV**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL629	Rubbery Technology										
	MCH43MEL630	Surface Coatings & Adhesion Technology										
	MCH43MEL631	Latex and foam technology										
ME	MCH43MEP611	Polymer Chemistry Lab-II	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ610	Research Project (PG Thesis with Presentation and Seminar)	J	6	-	12	60	40	100	-	16	40
				22	**15**	**14**	**390**	**260**	**650**	**-**	**104**	**260**

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,
Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Polymer Chemistry** PG Degree (44 credits) after Four Year UG Degree.

Second Year - Semester III:M. Sc. Chemistry with Specialization (Elective) in : Industrial Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML607	Applications of Spectroscopy	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML641	Applied Inorganic Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML642	Chemistry of Nanomaterials	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML608	Reagents in Organic Synthesis	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML620	Inorganic Chemistry Lab-III (Chemical analysis of industrial raw materials Inorganic material synthesis)	P	2	-	4	30	20	50	-	08	20
ME (Choose Any One)		**Major Elective-III (Industrial Chemistry)**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL635	Chemistry of Paint, Pigments, and Polymers										
	MCH43MEL636	Chemistry of Glass, Ceramics and Semiconductors.										
	MCH43MEL637	Industrial Organic Chemistry										
ME	MCH43MEP612	Industrial Chemistry Lab-I	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ611	Research Project	J	4	-	8	60	40	100	-	16	40
Total				**22**	**15**	**14**	**420**	**280**	**700**	**-**	**112**	**280**

Second Year - Semester IV:M. Sc. Chemistry with Specialization (Elective) in : Industrial Chemistry												
Course Category	**Course Code**	**Course Title**	**Nature of Course**	**No. of Credits**	**Teaching (Contact hrs/week)**		**Evaluation Scheme (Marks)**			**Minimum Passing (Marks)**		
					L	**P**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
MM	MCH43MML643	Unit Process in Chemical Industries	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML644	Agro Biomass Technology	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML645	Transition metal and Bioinorganic Chemistry	L	3	3	-	60	40	100	-	16	40
MM	MCH43MML646	Industrial Catalysis and Process Chemistry	L	3	3	-	60	40	100	-	16	40
ME (Choose Any One)		**Major Elective-IV (Industrial Chemistry)**	L	3	3	-	60	40	100	-	16	40
	MCH43MEL638	Chemical Process at surface and interface										
	MCH43MEL639	Fertilizer, pesticide and Agrochemicals										
	MCH43MEL640	Industrial Inorganic Chemistry										
ME	MCH43MEP613	Industrial Chemistry Lab-II	P	1	-	2	30	20	50	-	08	20
RP	MCH43RPJ612	Research Project (PG Thesis with Presentation and Seminar)	J	6	-	12	60	40	100	-	16	40
Total				**22**	**15**	**14**	**390**	**260**	**650**	**-**	**104**	**260**

Note:s

Nature of Course: L- Lecture, P-Practical, S-Seminar, J-Project, I-Internship, D-Dissertation,

Course Category: MM-Major Mandatory, ME-Major Elective, MI-Minor, OE-Generic / Open electives, VSC-Vocational skill course, SEC-Skill Enhancement course, AEC-Ability Enhancement course, IKS-Indian Knowledge system, VEC-Value Education course, OJT-On Job Training / Internship / Apprenticeship, FP-Field project, CEP-Community engagement and service, CC-Co – curricular course, RM-Research methodology, RP-Research project

Award of 2 Years-4 Sem. M. Sc. Chemistry PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem. **M. Sc. Chemistry with Specialization (Elective) in: Industrial Chemistry** PG Degree (44 credits) after Four Year UG Degree

Syllabus Semester-I

Course code:MCH43MML607 **Course name:** Group Theory & Coordination Chemistry **Course category:**MM
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of principle of Coordination Chemistry, interaction of group theory and structure and bonding.
Course Objectives:
1. To understand applications of various theories of chemical bonding in metal complexes.
2. To develop understanding of symmetry operations on molecule its applicatio.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe various symmetry elements and symmetry operation of moleuces and identify their point group and thire application
CO2: Derive the charcter table for point group
CO3: Describe structure and bonding in Metal complexes.
CO4: Describe the structure and function of metal ions and metal complexes, metalloenzymes in biological system
CO5: Explain the the stability of metal complexes.

Contents –

Unit	Content	Teaching hours
1	**Group theory and Symmetry concepts** Symmetry elements and symmetry operations, Center of symmetry(i), Axis of symmetry (Cn), Plane of symmetry (σv, σh, σd), Rotation reflection axis of symmetry(Sn), Identity(E). point groups, classifications of point groups, Identification of point group of : H2O, NH3, CO2, BF3, C2H4, PCl3, PCl5, [PtCl4]-- , cis and trans [PtCl2(NH3)2], [CoCl2(NH3)4] , [FeF6], H2, HCl, CO, BeF2, , C2H2Cl2 , C6H6, and substituted benzene molecule. Application of point group with respect to dipole moment, polar and non polar molecules, definition of group, properties of group	09
2	**Represntation of Group** Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part), wave function as basis for irreducible representations	09
3	**Theories of Metal-Ligand Bonding in Complexes** Valence Bond Theory (VBT): Assumptions of VBT, application VBT to study structure, geometry, and magnetic properties of inner & outer orbital complexes. Limitation of VBT. **Crystal Field Theory (CFT)**: Important features of CFT, Crystal field splitting of d-orbital in octahedral, tetrahedral, square-planar and tetragonal complexes. Crystal Field Stabilization Energy (CFSC), calculation of CFSC for octahedral and tetrahedral complexes. Factors affecting on crystal field splitting, applications of CFT Jahn-Teller effect. **Molecular Orbital Theory:** Introduction, application of MOT to octahedral complexes, energy level diagram, Muliken symbol.	09
4	**Inorganic chemistry in biological systems** Essential and trace elements in biological systems and their functions , structure and function ofmetalloporphyrins, Hemoglobin, cytochrome and hemocyanine. Electron transfer, Respiration and photosynthesis reaction, Metal deficient diseases of Fe, Zn, Cu and Mn and their therapy.	09

5	**Metal ligand equilibria in solution**: Definition of stability constant, step wise and overall formation constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Determination of formation constant for binary complexes using pH-metric technique..	09

Text Books: 1.Textbook of bioinorganic chemistry, A. K. Das.
2. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson
Reference Books: 1.Selected Topic in Inorganic Chemistry, Wahid U. Malik, G.D.Tuli and R.D.Madan**.**
2. Symmetry and Spectroscopy of Molecules, K.Veera Reddy.
3.Inorganic Chemistry, J.E.Huhey and Keiter R. L.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. http://www.digimat.in/nptel/courses/video/104105033/L10.html

Syllabus Semester-I

Course code:MCH43MML502**Course name:** Organic Reaction Mechanism & Stereochemistry **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of organic functional groups and organic reaction mechanism.
Course Objectives:
1. 1.To understand applications of various electronic effect in organic reaction mechanism.
2. To understand stereochemistry of molecules and its application in reaction mechanism
3. To understand various types of aliphatic and aromatic nucleophilic substituion reactions.
Course Outcomes: At the end of the course, the students will be able to -
CO1: To describe the chemical and molecular processes that takeplace in organic chemical reactions.
CO2: To perform aliphatic nucleophilic substitution reactions.
CO3: Analyze the reaction mechanism of analysis food preservatives including structure.
CO3: To differentiate the various types of aliphatic nucleophilic substitution.
CO4: To describe the various types of aromaticity.
CO5: To explain the stereochemistry substitution reaction and identification of stereochemical notations.

Contents –

Unit	Content	Teaching hours
1	**Nature of Bonding in Organic Molecules** Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non- alternant compounds, Huckel rule, energy level of π-molecular orbitals, annulenes, aromaticity, Bonds weaker than covalent - addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes	09
2	**Stereo-chemistry-I** Elements of symmetry, chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature. Molecules with more than one chiral center, Threo and Erythro isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions..	09
3	**Stero Chemistry-II** Optical activity in the absence of Chiral Carbon (Biphenyls, allenes and Spiranes), Chirality due to helical shape. Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous. Conformational analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, effect of conformation on reactivitity	09
4	**Aliphatic Substitution Reactions** Aliphatic Nucleophilic:Types of Aliphatic nucleophilic substitution Reactions-SN1, SN2, SET mechanism, Aliphatic Electrophilic: a) Types of Aliphatic electrophilic substitution reaction: SE1, SE2, SEi.b) Electrophilic substitution accompanied by double bond shift. c) Effect of substrate, leaving group and solvent polarity on the reactivity)	09
5	**Aromatic Substitution Reactions** Aromatic Nucleophilic Substitution: SN1, SN2 SNAr and SRN1 mechanism. Aromatic nucleophilic substitution via benzyne intermediate. Factor affecting	09

	reactivity in aromatic nucleophilic substitution reaction. electrophilic aromatic substitution: Introduction, the arenium ion mechanism, orientation and reactivity. Energy Profile diagram, steric effect and the ortho/para ratio, ipso attack, introduction of a third group into benzene ring, Electropihilic substitution in polycyclic and heterocyclic ring system.	

Text Books: 1.Advanced Organic Chemistry by J. March, John Wiley & Sons, 1992.
2. Organic Chemistry by S. H. Pine, McGraw Hill, 1987.
Reference Books: 1.Advanced Organic Chemistry, IV Edition: J. March
2. Organic Chemistry by S. H. Pine, McGraw Hill, 1987.
3.Advanced Organic Chemistry by J. March, John Wiley & Sons, 1992
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/104/101/104101005/

Syllabus Semester-I

Course code:MCH43MML503**Course name:** Thermodynamics & Electrochemistry **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of organic functional groups and organic reaction mechanism.
Course Objectives:
1. To Apply fundamental concepts of thermodynamics to engineering applications.
2. To understand representing electrochemical cell.
3. To apply the knowledge to calculate electrochemical cell parameters, over potential, active surface areas.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Estimate thermodynamic properties of substances in solid, gas and liquid state.
CO2: Determine thermodynamic efficiency of various energy related processes.
CO3: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics
CO3: Explain various over potential involved during the operation the cell.
CO4: To describe the various types of thermodynamics.

Contents –

Unit	Content	Teaching hours
1	**Classical Thermodynamics** Nernst heat theorem, the third law of thermodynamics, determination of absolute entropies of solids, liquids and gases. Partial molar properties : Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity.	09
2	**Electro-Chemistry-I** Debye-Huckel theory of strong electrolytes, Debye-Huckel-Onsager equation Testing of the equation, Debye-Falkenhagen effect, Wein effect, activity coefficient, mean ionic activity coefficient; Debye-Huckel limiting law ionic strength. Electrocapillary phenomena, and its measurements. Effect of anions, cations and molecules on electrocapillary curves. Electrocapillary properties of mercury-solution interface.	09
3	**Polarography:** the Ilkovic equation and its derivation, concentration polarization, instrumentation, advantages of DME, half wave potential. Applications of polarography, numerical.	09
4	**Conversion and storage of electrochemical energy** Introduction of storage cells, fuel cells, solar cells Types of storage cells (batteries) ,measure of cell performance , charging and discharging , introduction of classical batteries , modern batteries –zinc-air , nickel-metal oxide and lithium batteries. Brief history of fuel cells, efficiency of fuel cells, hydrogen-oxygen fuel cell, phosphoric acid fuel cell, direct methanol and biochemical fuel cells; Solar cells introduction, principle and working of solar cells, advantages.	09
5	**Polarization and Overpotentials** Polarization, concentration polarization, decomposition potentials, over voltage, hydrogen, oxygen and metal overvoltages, types of overvoltages, factors affecting overvoltages, experimental determination of decomposition potential and	09

	overvoltage, Tafels theory and Tafel equation, simultaneous deposition of metals .Numericals.	

Text Books: 1.Principles of Physical Chemistry, Puri,Sharma and Pathania.
2. Advanced Physical Chemistry, Gurtu and Gurtu.
Reference Books: 1.Theoretical Electrochemistry, L.Antropov
2. An Introduction to Electrochemistry, Samuel Glasstone.
3.Modern Electrochemistry, Vol 1,2A and 2B, John O" M Bokris
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/104/106/104106137/

Syllabus Semester-I

Course code:MCH43MMP501**Course name:** Inorganic Chemistry Lab Course -I **Course category:**MM
Credits:02**Teaching scheme:**P-4**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: As an upper-level course, the inorganic chemistry laboratory students have to learn and practice the skills and knowledge of chemistry by performing inorganic chemistry work.
Course Objectives:
1. To conduct the experiments for the preparation, characterization of metal complexes.
2. To conduct chemical analyses by qualitative and quantitative analysis of metal ions.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Describe basic and advanced concepts of synthesis and its applications.
LO2: To identify the industrial processes in metal complexes.
LO3: Synthesis of Transition Metal Complexes with various ligands and estimation of percentage composition.
LO4: To conduct separation and estimation of amount of metal ions in binary metal ion mixture.
LO5: Enhancement in the qualifications, salaries, and job outlooks for the respective field.

Contents –

Sr.No.	Title of the Experiment
Preparation and estimation of percentage metal ion present in a metal complexes.	
1	$Ti(C_9H_8NO)_2.2H_2O$
2	$VO(acac)_2$
3	Cis-$K[Cr(C_2O_4)2(H_2O)_2]$
4	$[Mn(acac)_3]$
5	$K_3[Fe(C_2O4)_3]$
6	$[Co(III)(NH_3)_6]Cl_3$
7	$[Co(III)(NO_2)(NH_3)_5]Cl_2$
8	$[Ni(NH_3)_6]Cl_2$
Separation and estimation of amount of metal ions from the following mixture solutions (Any Two)	
1	Copper- Nickel,
2	Nickel- Zinc

3	Iron- Magnesium

Text Books: 1.A Text book of Quantitative Inorganic Analysis; A. I. Vogel
Reference Books: 1.PracticalInorganic Chemistry; Pass Geoffrey and Haydn Sutcliffe.
2. Advanced Practical Inorganic Chemistry; Gurudeep Raj.
3. Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Longman Ltd
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://nitttrc.edu.in/nptel/courses/video/104105033/lec29.

Syllabus Semester-I

Course code:MCH43MMP502**Course name:** Organic Chemistry Lab Course -I**Course category:**MM
Credits:02**Teaching scheme:**P-4**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: The methods for the preparation of useful compounds using named reaction and safty practices in the laboratory.
Course Objectives:
1. To demonstrate/apply the techniques involved in organic binary mixture separation
2. To use the technique of separation, crystallization derivatization and function group detection
Course Outcomes: At the end of the course, the students will be able to -
LO1: Describe basic and advanced concepts of synthesis and its applications.
LO2: Application of techniques involved in organic binary mixture separation.
LO3: Separation, crystallization derivatization and function group detection of organic compounds.
LO4: Method development for synthesis of useful compounds using named reaction.
LO5: Enhancement in the qualifications, salaries, and job outlooks for the respective field.

Contents –

Sr.No.	Title of the Experiment
Qualitative Organic Analysis:	
	Separation, purification and identification of binary (Solid-Solid) mixtures. The separation should be carried out using chemical method.
	The two components are solid-solid mixtures.
	Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.
	Single Stage Preparations:
	Preparation of p-nitroacetanilide from acetanilide.
	Preparatin of Dibenzylideneacetone from Benzaldehyde
	The preparations should be carried out using (0.02 to 0.05mole) of the starting material.
	The yield, melting point and TLC of the recrystalised product should be recorded.

Text Books: 1.A Text book of Quantitative organic Analysis; A. I. Vogel.
Reference Books: 1.PracticalInorganic Chemistry; Pass Geoffrey and Haydn Sutcliffe.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://nitttrc.edu.in/nptel/courses/video/104105033/lec29.

Syllabus Semester-I

Course code:MCH43MMP503 **Course name**: Physical Chemistry Lab Course -I **Course category:**MM
Credits:02**Teaching scheme:**P-4**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: As an upper-level course, the inorganic chemistry laboratory students have to learn and practice the skills and knowledge of chemistry by performing inorganic chemistry work.
Course Objectives:
1. To understand various fundamental concepts of physical chemistry through instrumental and non instrumental methods.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Demonstration of the experiment on various instrumental techniques.
LO2: Description of the principles behind the experiment performed in the laboratory
LO3: To interpret the experimental results obtained by conductometer, spectrophotomer, pH- meter, polarometr etc.
LO4: Enhancement in the qualifications, salaries, and job outlooks for the respective field.

Contents –

	Title of the Experiment
1.	Determination of strengths of halides in a mixture potentiometrically.
2.	Determination of the strength of strong and weak acid in a given mixture conductometrically.
3.	Determination of solubility and solubility product of sparingly soluble salt BaSO4.
4.	Determine the pK1 and pK2 value of phosphoric acid by pH metry.
5.	Determine the indicator constant of given indicator by colorimetric measurements.
6.	Study of kinetics of inversion of cane sugar.
7.	To study the kinetics of H^+ catalyzed hydrolysis of an ester.
8.	To study the kinetics of saponification of an ester.
9.	To study the kinetics of Fe^{3+} catalyzed decomposition of hydrogen peroxide
	Non-Instrumentation. (Any Six)
1	To study the effect of surfactants (sodiumchloride) on surface tension of given liquid.
2	To determine the radius of molecule by viscosity measurements.

3	Determine the solubility of benzoic acid in waterat different temperature and hence its heat of solution.
4	Determine the formula of the complex for med between Cu(II) and ammonia by distribution method.
5	Determine the velocity constant of hydrolysis of ester.
6	To study the quenching of fluorescence of organic dye(s).
7	To study the variation in miscibility of phenol in water with temperature and to find out the critical solution temperature (CST) and also to investigate the effect of impurity on CST

Text Books: 1. Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
Reference Books: 1.Experiments in chemistry – D.V. Jahagirdar
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://nitttrc.edu.in/nptel/courses/video/104105033/lec29.

Syllabus Semester-I

Course code:MCH43MEL501**Course name:**Chromatographic Methods of Analysis**Course category:**ME-I
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of organic functional groups and organic reaction mechanis
Course Objectives:
1.To understand working principle, instrumentation and applications of various chromatographic methods of analysis.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Separtion of organic compounds by chromatographic methods
CO2: Quantification of compound by chomatogrhpy.
CO3: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics
CO3: Application of chomatogrhpy in qualitative analysis of compounds.
CO4: To describe the various types of the analytical techniques.

Contents –

Unit	Content	Teaching hours
1	**Fundamentals of chromatographic separation methods** Definition, Principles of chromatography, sorption mechanisms - differential migration, partition and adsorption phenomena; Classification of different chromatographic methods; Methods of developmentElution development, Gradient elution development, displacement development and frontal analysis. Dynamics of chromatography-efficiency of chromatographic column, zone spreading, Height Equivalent to Theoretical plate (HETP).	09
2	**Chromatographic Systems Thin Layer & Paper Chromatography** **Thin Layer Chromatography** Principle, chromatographic media-coating materials, applications, activation of adsorbent, sample development, solvent systems, development of chromatoplate, types of development, visualization methods, documentation, applications in the separation, HPTLC principle, technique, applications.	09
3	**Paper chromatography:** Principle, papers as a chromatographic medium, modified papers, solvent systems, mechanism of paper chromatography, experimental technique, different development methods-ascending, descending, horizontal, circular spreading, multiple development, two-dimensional development, reverse phase paper chromatographic technique visualization and evaluation of chromatograms, applications.	09
4	**Column & Ion Exchange chromatography:** Column Chromatography: Principle, experimental details, theory of development, columnefficiency, factors affecting column efficiency, and applications. Adsorption isotherms, chromatographic media, nature of forces between adsorbent and solutes, eluents, (mobile phase), column chromatography without detectors and liquid chromatography with detectors and applications. Advanced flash chromatography.	09
5	**Advanced Chromatographic Techniques** **Gas chromatography (GC):**	09

	Theory, Instrumentation - description of equipment and different parts, columns (packed and capillary columns), detector specifications –thermal conductivity detector, Flame ionization detector, electron capture detector, nitrogen-Phosphorous detector, photo ionization detector, programmed temperature gas chromatography, applications in the analysis of gases, petroleum products etc. **High Performance Liquid Chromatography (HPLC): Theory,** Instrumentation - description of the different parts of the equipment, stationary phases (columns), mobile phase, detectors - UV detector, RI detector, Fluorescence detector, Photo Diode Array detector, ELSD, conductometric detector, and electrochemical detector, applications, advantages and disadvantages.	

Text Books:	1.Principles of Physical Chemistry, Puri,Sharma and Pathania.
	2. Advanced Physical Chemistry, Gurtu and Gurtu.
Referance Books: 1.	Douglas A. Skoog, Donald M. West and F. James Holler, analytical chemistry anintroduction, saunders college publishing, New york, 1990.
1.	J. Bassett, R.C. Denny, G. Jeffery and J. Mendham. Vogel's text book of inorganic
2.	Quantitative analysis, 4th edition, Longman group Ltd, Harlow, 1985.
3.	Pietrazyk and Frank. Analytical chemistry, 1990.
4.	Werner Funk, Vera Damman, GerhildDonnervert. Quality Assurance in Analytical
5.	Chemistry,VCH Publishers, New York, NY (USA), 1997.
6.	BertamdL.Hanser and Prabhakar Ghani. Quality Control and Applications, Prentice-Hall
7.	Analytical Chemistry, Gary Christian, VI Ed, John Wiley & Sons Inc, New York.
8.	Fundamentals of Analytical Chemistry, Skoog & West.
9.	Pharmaceutical Drug Analysis, Ashtoshka.
10.	Vogel's Text Book of Quantitative Chemical Analysis, 6th Ed, Pearson Education Ltd.
11.	Instrumental Methods of Chemical Analysis–Galen W. Ewing.
12.	Douglas A. Skoog, Donald M. West and F. James Holler, analytical chemistry an
Online Resources:	1.NPTEL / SWAYAM lectures.
1.	https://nptel.ac.in/courses/103108100

Syllabus Semester-I

Course code:MCH43MEL502**Course name:** Chemistryofmaterials**Course category:**ME-I
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of materials, unctional groups, bond formation andradii, types of reactions etc..
Course Objectives:
1. To understand properties, structure, characterization and application of functional materials.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe the objectives of inorganic nanocomposite materials , preparation by using physical and chemical methods
CO2: To analyze the formation of nanomatrials by microscopic, diffraction and spectroscopic techniques.
CO3: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics
CO4: Describe the importance and properties of defects in solids.
CO4: To describe the various types of the solid materials techniques.

Contents –

Unit	Content	Teaching hours
1	**Imperfections in solids** Perfect and imperfect crystal, point defects, stoichiometric defects, Schootky & Frankle defects, thermodynamics of their formation, colour centers, Non-stoichiometric defects, metal excess and metal deficiency defects, line imperfections, Edge dislocation, Screw dislocation, Burgers circuits, Surface imperfections, grain boundaries & stacking falts.	**09**
2	**Unit II: Bonding in Solid materials** Reactions in the solid state and phase transitions: General principles, kinetics of solid-state reactions-nucleation and diffusion rate, Wagner mechanism, Kirkendall effect. X-ray powder diffraction.	09
3	**Synthesis of Nanomaterials by Chemical Methods** Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.	09
4	**Analysis Technique** Introduction, microscopes, electron microscopes, SEM, TEM, Scanning probe microscope (SPM), Scanning Tunneling microscope, Atomic force microscope, X-ray diffraction, UV- visible and IR spectroscopy.	09
5	**Magnetic Materials** Introduction, Magnetization, Electron spin and magnetic moment, Theory of diamagnetism, langevins theory & paramagnetic susceptibility of solids, ferromagnetism, Domain theory. Hysteresis in magnetism, ferrimagnetisms (ferries) Applications of magnetic materials	09

Text Books:	1.Principles of the Solid State- H.V. Keer (Wiley Eastern Limited)
Referance Books: 1.	Solid State Chemistry and applications- A.R. West (John Wiley and Sons).
	2. Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
	3. NANO- The next revolution –Mohan Surendra Rajan(National book Trust, India)
	4. The British Glass Website- Types of Glass://www.britiglass.org.uk.
Online Resources:	1.NPTEL / SWAYAM lectures.
	1. https://nptel.ac.in/courses/103108100

Syllabus Semester-I

Course code:MCH43MEL503**Course name:** Computational & Quantum Chemistry**Course category:**ME-I
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of materials, unctional groups, bond formation andradii, types of reactions etc..
Course Objectives:
1. To understand various advanced theories in quantum mechanics and application of computational techniques in study of structure and bonding.
Course Outcomes: At the end of the course, the students will be able to -
CO1: To explain the concept of wave function, oscillators, time dependent Perturbation Theory
CO2: To explain Hertreefock theory with reference to computation aspects.
CO3: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics
CO3: Describe the electronic properties of molecules by Semi-empirical method, densitys.
CO4: To describe the various functional method and Configuration Interaction and its limitations and application.

Contents –

Unit	Content	Teaching hours
1	**Perturbation Theory:** Energy and wave-function corrections to wave-function degenerate states, applications including stark effect, hydrogen atom, anharmonic, - quartic oscillators, particle in a box- ground and excited states, time dependent perturbation theory.	09
2	**Hartree Fock Theory**: Slater determinants, Postulate of antisymmetry, Slater- Condon rules for matrix elements, Hartree-Fock equations, Koopman and Brillouin theorems, Roothaan formulation, basis sets, computational aspects, UHF method, Pople Nesbet equations	09
3	**Semi-empirical Theories:** Recapitulation of Huckel method, extended Huckel method, ZDO approximation, CNDO/INDO methods, Molecular Properties, Computational aspects, MINDO, AM1, PM3 methods, comparison of these methods.	09
4	**Density Functional Theory:** Introduction, Hohenberg Kohn Theorem, N and V representablity, Levy Functional, Kohn Sham equations, Functional derivatives and local potentials, Thomas Fermi theory, The Kohn- Sham construction, Fractional occupation numbers, Janak's theorem, Slater transition state, Electronegativity, hardness	09
5	**Configuration Interaction:** Multi-configuration wave function, full CI matrix, doubly excites CI, illustrations, Natural orbitals, Introduction to MC-SCF methods. Truncated CI and size-consistenc	09

Text Books: 1.Density Functional Theory of Atoms and Molecules, R. G. Parr and W. Yang, Oxford University Press, Oxford (1989)

2.Molecular Modeling, A. Leach, Longman, Landon (1996)
Referance Books: 1. .Modern Quantum Chemistry, A. Szabo and N.L. Ostlund, Dover, New York (1996).
2.Approximate Molecular Orbital Theory, J. A. Pople and D. L. Beveridge, McGraw Hill, New York (1971)
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/104/101/104101095/

Syllabus Semester-I

Course code:MCH43MEP501 **Course name:** Analytical Chemistry Lab Course-I **Course category:**ME
Credits:01**Teaching scheme:**P-2**Evaluation scheme:** CA–30, ESE–20
1. Pre-requisites: As an basic understanding of chemical analyses by qualitative and quantitative analysis of compounds.
Course Objectives:
1. To inculcate skill of various wet chemical analysis.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Analysis of various food, drug and cosmetics samples for purity.
LO2: To identify the industrial processes in analysis.
LO3: Hand on training of predation of standard solutions, and wet chemical analysis.
LO4: To conduct separation and estimation of amount of metal ions.
LO5: Enhancement in the qualifications, salaries, and job outlooks for the respective field.

Contents –

Sr.No.	Title of the Experiment
1.	Determination of saponification value of an oil sample.
2.	Determination of active chlorine in the given sample of bleaching powder.
3.	Determination of ion exchange capacity of given ion-exchange resin.
4.	Determination of Mg^{++} from given sample of talcum powder
5.	Determination aspirin in the given tablet.
6.	Determination of hardness of the water sample
7.	Determination of phosphoric acid content in cola beverage by pH meter.
8.	Assay of sulpha drug.
9.	Estimation of vitamin C by 2, 6 dichloro-indophenol method.
10	Determination of chemical oxygen demand (COD) of the given water sample.
11	Determination of concentration of sulphuric acid, acetic acid & copper sulphate in the given solution
12	Determination of Iron- Magnesium from given sampl

Text Books: 1.A Text book of Quantitative Inorganic Analysis; A. I. Vogel
2.Indian Pharmacoepia volume –I, II& III
Reference Books: 1. Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
2. Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
3. Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Longman Ltd
Online Resources: 1.NPTEL / SWAYAM lectures.
2. https://nptel.ac.in/courses/103108100.

Syllabus Semester-I

Course code: MCH43RML501 **Course name:** Research methodology **Course category:** RM	
Credits:4 **Teaching scheme:** L-4 **Evaluation scheme:** CA–60, ESE–40	
Pre-requisites: Nil	
Course Objectives: The student will get exposure of various research methodologies.	
1. To understand various spectroscopic methods used for material analysis.	
Course Outcomes: At the end of the course, the students will be able to –	
CO1: Understand fundamenntal concepts in research	
CO2: Understand fundamental of literature survey	
CO3: Learn about various software used to carry out research work	
CO3: Learn and understand the features of research design	
CO4: Understand concept of hypothesis	
CO5: Learn skill of research proposal writing	

Contents –

Unit	Content	Teaching hours
1	**Introduction to Research methodology:** Meaning of Research, Objectives, Motivation, Types of Research, approaches, process, significance of research, and criteria for ideal research, Research Methods versus Methodology, Research Problem, selection of research problem and techniques. Testing of hypothesis, procedure for hypothesis testing and limitation.	**09**
2	**Fundamentals of literature survey**: Information of search engines like Google, SCOPUS, etc, Compilation of literature, Brief literature review on the given topic, Preparation of review articles, Evaluation of review written by students. Hands on training of hadalling various software such as Chemdraw, Orignin, P-XRD, MS-office.	09
3	**Research Design**, features of good design, dependent and independent variables, extraneous variable, control, confounded relationship, experimental and non-experimental hypothesis, Research Designs- Exploratory research studies, descriptive and diagnostic research studies.	09
4	**Research hypothesis**, Procedure for Hypothesis Testing, Important Parametric, Flow Diagram/chart, Differences between Means, Comparing Two Related Samples, Hypothesis Testing of Correlation Coefficients, Limitations of the Tests of Hypotheses.	09
5	**Interpretation techniques,** Report writing, types- technical and popular, mechanism of writing research report, precaution for writing research report, few case studies Interpretation techniques, Report writing, types- technical and popular, mechanism of writing research report, precaution for writing research report, few case studies.	09

Text Books:
1. C.R. Kothari &GauravGarg, Research Methodology Methods and Techniques, III Edition, New Age International Publishers.
2. Ackoff Russell L., Scientific Method, New York: Wiley &Sons, 1962.
Online Resources: 1.NPTEL / SWAYAM lectures.
2. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Syllabus Semester-II

Course code:MCH43MML504**Course name:** Inorganic Reaction Mechanism & Organo Transition Metal Chemistry**Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of reaction, metal and lingand bond formation, basicity of ligands, Coordination number of ligands etc.
Course Objectives:
1. To understand reaction mechanism in transition metal complexes.
2.To understand structure, properties, reactions and applications of organotransition metal compounds.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe various substitionn and electron transfer reactions of transition metal complexes
CO2: Describe the structure and bonding aspects of simple organometallic compounds.
CO3: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics
CO3: Apply different electroncounting rules to predict the shape/geometry of organotransition metal compound.
CO4: Describe the methods of synthesis, properties of mono, di, tri, tetra, penta and hexahaptoorganotransition metal compound.

Contents –

Unit	Content	Teaching hours
1	**Reaction mechanism of transition metal complexes**. Classification of inorganic reactions, ligand substitution reaction and their mechanisms of octahedral complexes. Acid hydrolysis, factors affecting the acid hydrolysis. Base hydrolysis, conjugate base mechanism. Electron transfer reaction: mechanism of inner and outer sphere electron transfer reactions in octahedral complexes	09
2	**General Properties of Organotransition Metal Compounds** Definition, Classification based on the number of coordinated carbon (Hapticity), number of electrons donated by ligands, and type of bonding. Nomenclature, 16, 17, 18 Electron complexes and ligand substitutions, electron counting for common ligands and geometry of organo transition metal compounds. Applications of organo transition metal compounds.	09
3	**Alkyl, aryl Carbene and carbyne transition metal compounds** General method of synthesis of alkyl and aryl transition metal compounds, (i.e Ti, V, W, Mn, Ir, Co, Fe), Chemical properties, stability and decomposition pathways. **Carbene transition compounds**: Types of carbine compounds, properties of carbene ligands, Synthesis of Fischer type carbine compounds, Chemical reaction on coordinated carbine compounds. Carbyne transition metal compounds : Synthesis and chemical properties	09
4	**Transition metal compounds with Unsaturated organic molecules:** **Alkene transition metal compounds: G**eneral methods of the synthesis, Chemical properties: Reaction with nucleophiles and Electrophiles, Structure and bonding (DCD	09

	model) **η^2alkyne transition metal compounds:** Introduction, preparation, chemical properties, Structure and bonding. **η^3 allyl transition metal compounds:** Introduction, Structural verities inallyltransition metal compounds, General methods of preparation, chemical properties, structureandbonding.	
5	**Cylic Lignad Organometallic compounds** η^4 butadiene transition metal compounds: Introduction, General methods of preparation, reactionon coordinated ligand, structure and bonding. η^4 Cyclobutadiene transition metal compounds: Preparation and chemical properties of (C4H4)Fe (CO)3, structureand bonding. η^5 Cyclopentadienyl transition metal compounds: Introduction, classification ofη^5- Cyclopentadienyl derivatives, Preparation and chemical properties of (η^5-C5H5)2 Mn, (η^5-C5H5) Mn(CO)3,structure and bondingin Ferrocene.	09

Text Books: 1.Organo metallic Chemistry, R. C. Mehrotra, & A. Singh
2.Principal and applications of organotransition metal Chemistry, J. P. Collman, L. S. Hegedus, J. R. Norton
3.Inorganic Chemistry , Attkin and Shriver
4.Advanced Inorganic Chemistry, Gurdeep Raj.
5.Inorganic Chemistry, J. E. Huhey
Referance Books: 1. .Mechanism of Inorganic Reaction. II Edn. Fred Basolo and R.G.Pearsons.
2.Selected Topic in Inorganic Chemistry, Wahid U. Malik, G.D.Tuli and R.D.Madan
3.Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson.
4.Advanced Inorganic Chemistry, Volume I and II Gurdeep Raj
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/104/101/104101121/

Syllabus Semester-II

Course code:MCH43MML505**Course name:**Organic Reactions &Rearrangements**Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of reaction, metal and lingand bond formation, basicity of ligands, Coordination number of ligands etc.
Course Objectives:
1. To understand various reactions involved in addition to C-C and C-O, C=X double bond, sterochemical aspects and name reaction and rearrangements.
Course Outcomes: At the end of the course, the students will be able to -
CO1: To describe various reactions involved in addition to C=C and C=O and C=X.
CO2: To Explain the stereochemical aspects in addition reaction
CO3: ToExplain aromaticnucleophilicsubstitutionreactions
CO3: To demonstrate/apply the concepts involved in elimination reaction.
CO4: To describe the basic concepts in molecular rearrangement.

Contents –

Unit	Content	Teaching hours
1	**Elimination Reactions** The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hoffman versus Saytzeff elimination, Pyrolytic syn-elimination, Competition between substitution and elimination reactions, Reactivity: - Effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions, Pyrolytic elimination reactions.	09
2	**Addition Reactions for C=C** Addition to Carbon-Carbon Multiple Bonds: Electrophilic addition to C-C double bond, Mechanism and stereo chemical aspects of addition reaction involving electrophile, nucleophile and free radicals, Regio and chemo selectivity, orientation and reactivity, conjugate addition, Addition to cyclopropane, hydroboration, Micheal reaction, Sharpless asymmetric epoxidation, hydroxylation of alkene-diol formation.	09
3	**Addition Reactions for C=X (Heteroatom)** Addition to Carbon-Heteroatom Multiple Bonds: Some general and steriochemical aspect of addition to carbonyl compounds, Mechanism and stereochemistry of metal hydride reduction, Addition of organo metallic compounds to carbon-heteromultiple bond (organo zinc, organo copper, organo lithium, reagents to carbonyl and unsaturated carbonyl compounds).	09
4	**Name Reactions and Rearrangements** Types of migration and nature of the migrating group/atom, migratory aptitude, memory effect, pinacole pinacolone, Benzil–Bezilic acid, Beckmann, Hoffman and Fries rearrangements, Wittig Rearrangement, Wolff Rearrangement and Baker-Venkataraman Rearrangement; Name reactions- Arndt-Eistert Synthesis, Biginelli Reaction, Dakin Reaction, Hantzsch Dihydropyridine Synthesis (Pyridine Synthesis), Suzuki Coupling,	09
5	**Coupling Reactions:** Ulman coupling reaction, Heck- Suzuki couplining	

	reaction, Click Chemistry.	

Text Books:	1.A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
	2.Advanced Organic Chemistry: Reaction Mechanisms, R. Bruckner, Academic Press
	3.Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication
	4.Reaction Mechanism in Organic Chemistry, S.M. Mukherji, S.P. Singh, MacmillanPublishers, India..
Referance Books: 1.	Organic Chemistry, Part A and B, Fifth edition,2007, Francis A. Carey and Richard J. Sundberg, Springer.
	2. Carbenes, Nitrenes and Arynes. Von T. L. Gilchrist, C. W. Rees. Th. Nelson and Sons Ltd., London 1969.
	3.Organic reactive intermediates, Samuel P. MacManus, Academic Press
	4. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001)
	5.Advanced Organic Chemistry: Reactions & Mechanisms, second edition, B. Miller and R. Prasad, Pearson.
Online Resources:	1.NPTEL / SWAYAM lectures.
	2. https://archive.nptel.ac.in/courses/104/101/104101005/

Syllabus Semester-II

Course code:MCH43MML506**Course name:** Chemical Dynamics & Biophysical Chemistry**Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of kinetics ofreaction, bio-chemical bond formation, chemistry of biological molecules, atomicity of biomolecules etc.
Course Objectives:
1. To understand dynamics of chemical reactions and biological process.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe various theories in chemical dynamics.
CO2: Describe various photochemical reactions
CO3: Explain the structures and functions of biological membranes, as well as model systems and relevant, macromolecules in solution, conformational equilibria, membrane equilibria, ligand methods for the study of these structures and functions.
CO3: Explain the basic concepts within statistical thermodynamics and apply this to biological systems binding and cooperativity.
CO4: Apply spectroscopic methods for the study of structures and functions in biological systems.

Contents –

Unit	Content	Teaching hours
1	**Chemical Dynamics-I** Collision theory, modified collision theory, weakness of the collision theory, Theory of absolute reaction rates, equilibrium hypothesis, Derivation of the rate equation, statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate..	09
2	**Chmical Dynamics-II** Primary salt effect, secondary salt effect. Dynamics of uni-molecular reactions, Lindmann and Hinshelwood theory Kinetics of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and NMR method. Reactions in solution: Reaction between ions, influence of solvent-double sphere model, single sphere model, influence of ionic strength, numericals	09
3	**Photochemical Reactions** Photochemical Reactions Introduction, low of photochemical equivalence, photocatalytic reactions, types of photocatalytic reactions, photooxidation photoreduction photosensitization, photocatalytic degradation. Chemiluminescence, photosynthesis. Numericals	09
4	**Ionic Equilibria and Biological Reactions** Exact treatment of the dissociation of week acids and bases, Dissociation constant of polyprotic acids, Statistical effects in polyprotic acids, Dissociation constant of complex ions, Logarithmic expression for pH and pOH, Calculations involving buffer solution, buffer capacity and buffer index, Salt effect and solubility product and its applications. Thermodynamics of biochemical reactions, Binding of oxygen by myoglobin and hemoglobin, Reaction between microscopic and macroscopic dissociation constant	09
5	**Bio-physical Techniques** Electrophoresis: Factors affecting electrophoretic mobility, types of electrophoresis, free electrophoresis, zone electrophoresis and gel electrophoresis, electrophoresis in genetic analysis, DNA sequencing and DNA foot printing.	09

Text Books:	1.Chemical Kinetics - Laidler (McGraw-Hill)
	2.Kinetic and Mechanism of Chemical Transformations - J. Rajaram and J.C
	3.Text Book of Physical Chemistry - S.Glasstone (McMillan).
Referance Books: 1.	Advanced Physical Chemistry - Gurdeep-Raj (Pelenum).
	2. Physical chemistry – Robert A .Alberty ., Robert J .Silbey.
	3.4.Physical Chemistry - G. M. Barrow
Online Resources:	1.NPTEL / SWAYAM lectures.
	1. https://archive.nptel.ac.in/courses/104/106/104106089/

Syllabus Semester-II

Course code:CH43MMP504**Course name:** Inorganic Chemistry Lab course-II**Course category:**MM
Credits:2**Teaching scheme:**P-4**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basic understanding of metal ion solublity, ligand solublity, kinetics of metal complexes etc.
Course Objectives:
1. To provide hand on training and develop skill of separation, estimation of metal ions from various sources.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To conduct the experiments on semimicro qualitative analysis of inorganic mixture.
LO2: To identify acid and basic radicals from the mixture.
LO3: Anlysis of ores and minerals for find percent composition.
LO4: Separation and estimation of metal ions from mixture.
LO5: Apply spectroscopic methods for the study of metal complexes and systems.

Contents –

Sr.No.	Title of the Experiment
I	**Semi micro qualitative inorganic analysis**
	Identification of three acidic and three basic radicals including one rare earth from the given mixture **Note:** Each mixture should contain different rare earth elements
II	**Alloy analysis: (Any 02)**
1.	Solderalloyanalysis
2.	Brass alloyanalysis
3.	Bronzealloyanalysis.
4.	Copper nickel alloy
III	**Ore analysis: (Any 02)**
1.	Analysis of dolomiteore
2.	Analysis of calcite ore
3.	Analysis of Haematite ore
IV	**Separation and estimation of amount of metal ions from the followingmixturesolutions (Any 02)**

1.	Copper-Barium
2.	Iron–Aluminum
3.	3. Copper-Iron

Text Books: 1.A Text book of Micro and Semi micro Qualitative Inorganic Analysis, IV edn, A. I. Vogel
2.A Text book of Quantitative Inorganic Analysis; A. I. Vogel
Reference Books: 1. Practical Inorganic Chemistry- Pass Geoffrey and Haydn Sutcliffe.
2. Advanced Practical Inorganic Chemistry- Gurudeep Raj;.
3. Vogel's Qualitative Inorganic Analysis, VII Edn. Orient Longman Ltd. D. Svehla
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://nptel.ac.in/courses/104103069.

Syllabus Semester-II

Course code:MCH43MMP505 **Course name:**Organic Chemistry Lab course-II **Course category:**MM
Credits:2 **Teaching scheme:**P-4 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basic understanding and basic skills of synthetic organic chemistry practicals with handling, properties and MSDS of organic compounds.
Course Objectives:
1. To provide hand on training and develop skill of separation, identification and analysis of elements, functional group and physical constant of organic compounds from mixture.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To Perform/demonstrate the techniques involved in organic binary mixture separation specially solid- liquid mixture.
LO2: To perform distillation techniques for purification of organic compounds.
LO3: Anlysis of organic compounds for find percent composition.
LO4: To use/ apply the technique of separation, crystallization derivatization and function group detection.
LO5: To use the methods for the preparation of useful compounds using named reaction

Contents –

Sr.No.	Title of the Experiment
I	**Qualitative Organic Analysis:**(Analysis of at least five mixtures should be carried out.)
Separation, purification and identification of binary (Solid-Liquid) mixtures. The separation should be carried out using Chemical method.	
Single Stage Preparations:	
II	1. *p*-Bromo acetanilide from acetanilide.
	2. 1,4-dichlorobenzenefromp-chloroaniline
	3. Benzophenone from benzene (FriedalCraft)
Note: i) The preparations should be carried out using (0.02 to 0.05 mole) of the starting material. ii) The yield, melting point and TLC of the recrystalised product should be recorded. Note : Student will not be allowed for practical examination if his/her record book is not completed and certified	

Text Books: 1.A Text book of Quantitative organic Analysis; A. I. Vogel,
2.A Text book of Quantitative organic Analysis; A. I. Vogel recent addition
Reference Books: 1. Practical In organic Chemistry; Pass Geoffrey and Haydn Sutcliffe.
2.Vogel's Qualitative organic Analysis, D. Svehla
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://onlinecourses.nptel.ac.in/noc20_cy30/preview.

Syllabus Semester-II

Course code:MCH43MMP506 **Course name:** Physical Chemistry Lab course-II**Course category:**MM
Credits:2**Teaching scheme:**P-4**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: The basic understanding of handling and MSDS of refractometer, spectrophotomer, pH-meter, potentiometer etc.
Course Objectives:
1. To provide hand on training on various instruments to study various physicochemical properties of matter.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To interpret the experimental results obtained by refractometer, spectrophotomer, pH- meter, potentiometer.
LO2: To conduct the experiment on various instrumental techniques.
LO3: To describe the principles behind the experiment performed in the laboratory.
LO4: To use/ apply the technique of solution preparation in various concentrations.

Contents –

Sr. No.	Title of the Experiment
1	Determination of dissociation constants of phosphoric acid potentiometrically.
2	Determination of dissociation constants ofweak acid potentiometrically.
3	Determination of acidic and basic dissociation constants of anamino acid and its isoelectric point.
4	Determination of equilibrium quotient for the formation of monothiocynato iron (III)complex.
5	To study the kinetics of mutarotation of glucose/fructose polarographically.
6	To study the adsorption of acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and langmuir's isotherm.
7	To construct the phase diagram for three component system (chloroform-acetic acid- water).
8	To study auto catalysis reaction between potassium permanganate and oxalic acid.
9	Determine the rate constant of the reaction between potassium persulphate and potassium iodide having equal/unequal concentration of the reacting species.
10	To study the variation of viscosity with the composition of mixtures (ethanol-water- HNO3-chloroform) and to determine the formation of complex between two liquids.

Text Books: 1.Systematic experimental physical chemistry – T. K. Chondhekar & S.W. Rajbhoj
Reference Books: 1. Experiments in chemistry – D.V. Jahagirdar
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://onlinecourses.nptel.ac.in/noc20_cy22/preview.

Syllabus Semester-II

Course code:MCH43MEL504**Course name:** Spectroscopic Methods of Analysis **Course category:**ME-II
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic concepts of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization etc.
Course Objectives:
1. Describe basic concept of microwave spectroscopy and classify molecules on the basis of structural parameters like moment of inertia and intermolecular distances.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe and understand the basic profile of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization and Classify electromagnetic spectrum ion of spectra.
CO2: Describe basic concept of microwave spectroscopy and classify molecules on the basis of structural parameters like moment of inertia and intermolecular distances analyse the effect of isotopic substitution and nonregid bond and polyatomic molecules.
CO3: Explain and determine the: Rotation of molecules, rotational spectra, diatomic molecules.
CO3: Describe the Classical and quantum of theory of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, rule of mutual exclusion, overtone and combination vibrations, Rotational fine structure, outline of technique and instrumentation, applications.
CO4: To Describe UV-Visible spectra of molecules.

Contents –

Unit	Content	Teaching hours
1	**Microwave Spectroscopy** Introduction: Characterization of electromagnetic radiation, quantization of energy, regions of the spectrum, interaction of radiation with molecular systems, Microwave: classification of molecules, rigid rotor model, selection rules, intensity of spectral lines, effect of isotopic substitution. Stark effect, non-rigid rotor, selection rules, mechanism of interaction, spectra of symmetric and asymmetric top molecules, applications of microwave spectroscopy numerical problems.	09
2	**Vibrational Spectroscopy** Infrared: Principle and applications of FT-IR, Review of harmonic oscillator, selection rules, vibrational energy of diatomic molecules, zero point energy, force constant and bond strength; finger-print region, functional group identification	09
3	**Raman Spectroscopy:** Classical and quantum theories of Raman Effect, Stokes and antistokes lines, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principles, structure determination of di-, tri- and tetra-atomic molecules from Raman and IR spectra, effect of polarization of light.	09
4	**Molecular Spectroscopy** Molecular Spectroscopy: Energy levels, MO, vibronic transitions, Franck- Condon principle, Electronic spectra of polyatomic molecules. Emission spectra, radiative and non-radiative decay, internal conversion. Photoelectron spectroscopy. Basic principles, ESCA- Introduction - ESCA - ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Principle, instrumentation, applications, Auger electron spectroscopy	09
5	**Electron Spectroscopy Photoelectron spectroscopy:**	09

	Basic principles, ESCA- Introduction- ESCA - ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Principle, instrumentation, applications, Auger electron spectroscopy, Ultraviolet photoelectron spectroscopy.	

Text Books:	1. Organic Spectroscopy: P.S. Kalsi (6th Edition).
	2.Fundamentals of Molecular Spectroscopy by C. N. Banwell and E. M. McCash, Tata McGraw Hill, 1994
Referance Books: 1.	Introduction to Molecular Spectroscopy by G. M. Barrow, McGraw Hill
	2. Introduction to Atomic Spectra by H. E. White, McGraw Hill, 1934.
	3.P. S. Sindhu, "Elements of Molecular Spectroscopy", New Age International publisher, New Delhi (2010)
	4.J. M. Hill, "Modern Spectroscopy", John Wiley & Sons Ltd, (2004)
	5.Instrumental Methods of Chemical Analysis - Chatwal, Anand
	6.Instrumental Methods of Chemical Analysis - B.K. Sharma
	8.Organic Spectroscopy: P.S. Kalsi (6th Edition).
Online Resources:	1.NPTEL / SWAYAM lectures.
	2. https://onlinecourses.nptel.ac.in/noc20_cy08/preview

Syllabus Semester-II

Course code: MCH43MEL505 **Course name:** Pharmaceutical & Forensic Analysis
Course category:ME-II
Credits:3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic concepts of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization etc.
Course Objectives:
1. To understand various analytical methods in pharmaceuticals and forensic science.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe and explain the important compound of drugs and their types.
CO2: To explain the important compound of drugs and their types.
CO3: Explain the pharmaceutical Analysis and pharmaceutical legislation.
CO4: To explain the forensics sampling and analysis.
CO5: Describe the explosives and their analysis.

Contents –

Unit	Content	Teaching hours
1	**Pharmaceutical Analysis-I** General idea regarding pharmaceutical industry, Definition and classification of drugs, typesof dosage forms. Introduction to pharmaceutical formulations, Sources of impurities in pharmaceutical chemicals, raw materials & Products, Shelf life of pharmaceutical product and its determination,stability studies Standardization of finished products& their characteristics, Limit tests of As, Hg, Pb, Fe, Chlorides, and sulphates. Solubility tests, dissolution test, disintegration tests..	09
2	**Pharmaceutical Analysis-II** Assay of main classes of drugs as per IP with reference to Introduction, Type, Properties, Mode of action and Methods of Analysis.	09
3	**Pharmaceutical legislation** Introduction to drug acts, drug rules,FDA ISI, Agmark and other standard for pharmaceuticals& cosmetics particularly w.r.t. the testing of drugs, and raw materialconcerned. Pharmaceutical standards IP/BP/USP//EP. Cosmetic standards,Documentation,Record Keeping. Contents of labels, Types of packaging materials,Intellectual property rights: Introduction, role of patents in the pharmaceutical industry,recent changes, some case studies.	09
4	**Forensic Analysis** Introduction, Special features of forensic analysis, Sampling, Sample storage, Sample dissolution. Toxicology: Classification of poisons and poisoning, Lethal Dose, Significance of LD50 and LC50.	09
5	**Extraction methods in toxicology:** mortem blood for poisons like cyanides, As, Hg, Insecticides and Pesticides Isolation, Identification and determinations of: Narcotics: Heroin, Morphine, Codeine. Stimulants: Caffeine, Cocaine, Amphetamines. Despressant: Benzodiazepines- Diazepam, Oxazepam, Nitrazepam. Barbiturates- Phenobarbitone, Amylobarbitone, Pentobarbitone, Thiopentone. Hallucinogens: LSC and Cannabis. Analysis of biological stains and materials including blood, semen and	09

	saliva (qualitative and quantitative). Viscera, Stomach wash, Vomit and post	

Text Books:	1. Isolation and Identification of drug-n E. G. Clarke vol.- I.
	2.Laboratory procedure manual-Forensic Toxicology- Directorate of forensic science, MHA Govt. of India
Referance Books: 1.	Analytical Biochemistry, D. J. Holme and H.Peck, Longman
	2. Bioanalytical Chemitry,S.R. Mikkelsen and E. Corton, John Wiley and Sons.
	3.Immunoassay – a practical guide Eds,D.W.Chan and M.T.Perlstein, Academic Press
	4.Hawk's Physiological Chemistry, McGraw Hill.
	5.Pharmaceutical Analysis Edited by David C. Lee, and Michael Webb.
	6.Biochemical methods, S. Sadasivam, A .Manickam.
Online Resources:	1.NPTEL / SWAYAM lectures.
	1. https://nptel.ac.in/courses/109106408

Syllabus Semester-II

Course code:MCH43MEL506**Course name:** Spectroscopic & Thermal Methods of Analysis**Course category:**ME-II
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic concepts of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization etc.
Course Objectives:
1. To understand working principle, instrumentation and application of various spectroscopic and thermal methods of analysis.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe and understand the basic profile of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization and Classify electromagnetic spectrum ion of spectra.
CO2: Describe basic concept of microwave spectroscopy and classify molecules on the basis of structural parameters like moment of inertia and intermolecular distancesAnalyse the effect of isotopic substitution and nonregid bond and polyatomic molecules, determine the: Rotation of molecules, rotational spectra, diatomic molecules.
CO3: Describe the Classical and quantum of theory of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, rule of mutual exclusion, overtone and combination vibrations, Rotational fine structure, outline of technique and instrumentation, applications.
CO4: Application of TGA-DTA Techniques analysis of thermal stability of materials.
CO5: Describe the numerical for structural elucidation and analysis.

Contents –

Unit	Content	Teaching hours
1	**Microwave Spectroscopy** Introduction: Characterization of electromagnetic radiation, quantization of energy, regions of the spectrum, interaction of radiation with molecular systems, Microwave: classification of molecules, rigid rotor model, selection rules, intensity of spectral lines, effect of isotopic substitution. Stark effect, non-rigid rotor, selection rules, mechanism of interaction, spectra of symmetric and asymmetric top molecules, applications of microwave spectroscopy numerical problems.	09
2	**Vibrational Spectroscopy** Infrared: Principle and applications of FT-IR, Review of harmonic oscillator, selection rules, vibrational energy of diatomic molecules, zero point energy, force constant and bond strength; finger-print region, functional group identification	09
3	**Raman Spectroscopy:** Classical and quantum theories of Raman Effect, Stokes and antistokes lines, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principles, structure determination of di-, tri- and tetra-atomic molecules from Raman and IR spectra, effect of polarization of light.	09
4	**Molecular Spectroscopy** Molecular Spectroscopy: Energy levels, MO, vibronic transitions, Franck- Condon principle, Electronic spectra of polyatomic molecules. Emission spectra, radiative and non-radiative decay, internal conversion. Photoelectron spectroscopy. Basic principles, ESCA- Introduction - ESCA - ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Principle, instrumentation, applications, Auger electron	09

	spectroscopy.	
5	**Thermal methods of analysis** General introduction, classification of thermal methods , thermogravimetry, principles, factors affecting thermal curve, thermogravimetric analysis, Derivative thermogravimetry, Differential thermal analysis - principles, factors affecting DTA curve, applications, differential scanning colorimetry - principles, instrumentation and applications, thermomechanical and dynamic mechanicalanalysis, thermometric titrations, numericals.	09

Text Books: 1.P. S. Sindhu, "Elements of Molecular Spectroscopy", New Age International publisher, New Delhi (2010).
Referance Books: 1. Fundamentals of Molecular Spectroscopy by C. N. Banwell and E. M. McCash, Tata McGraw Hill, 1994.
Online Resources: 1.NPTEL / SWAYAM lectures.
2. https://archive.nptel.ac.in/courses/104/106/104106122/

Syllabus Semester-II

Course code:MCH43MEP502 **Course name**: Analytical Chemistry Lab Course-II **Course category:**ME-II
Credits:1**Teaching scheme:**P-2**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basic understanding of analysis of various methods with accuracy and precision.
Course Objectives:
1. To provide hand on training on various analytical instruments and its applications in chemical analysis.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To interpret the experimental results obtained from experiments of spectrophotomer, pH-meter, potentiometer and conductomete.
LO2: Toconducttheexperimentonvariousinstrumental techniques
LO3: To describe the principles behind the experiment performed in the laboratory.
LO3: Separation and estimation of individual constituents from mixture.
LO4: Apply analytical methods for the study of various industrial processes.

Contents –

Sr.No.	Title of the Experiment
I	**Spectrophotometer: (Any 2)**
1.	Estimate the amount of copper and bismuth ions using EDTA
2.	Determine the stability constant, empirical formula, □max. by job's method, mole ratio and slope ratio method.
3.	Determine the PKa of Methyl red indicator
II	**PH metrically (Any 2)**
1.	Determine the Pk value of benzoic acid by using irrivaing Rossotgi method. by PH metric method and metal ligand stability constant of its complex.
2.	Determine the Pk value of Glycine by using irrivaing Rossotgi method. by PH metric
3.	Determine the metal ligand stability constant of copper benzoate complex by pH metric method.
II	**PH metrically (Any 2)**
1.	Determine the Pk value of benzoic acid by using irrivaing Rossotgi method. by PH metric method and metal ligand stability constant of its complex.
2.	Determine the Pk value of Glycine by using irrivaing Rossotgi method. by PH metric
3.	Determine the metal ligand stability constant of copper benzoate complex by pH metric method.
III	**Conductometry(Any 2)**

1.	Analyze the acid mixture hydrochloric acid and acetic acid by conductometric method.
2.	Analyze the mixture of copper sulphate, hydrochloric acid and acetic acid by conductometric method.
IV	**Potentionmetry**
1.	Determine the redox potential of Fe(II)/Fe(III) system and hence determine the number of electron involved in the system using K2Cr2O7 by potentiometric method.

Text Books: 1.A Text book of Quantitative Inorganic Analysis; A. I. Vogel
2.Indian Pharmacoepia volume –I, II& III
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
2. Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
3. Vogel's Qualitative Inorganic Analysis, D. Svehla, VII Edn. Orient Longman Ltd
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://nptel.ac.in/courses/103108100.

Syllabus
Semester-III

Course code: MCH43MML614	**Course name: Applications of Spectroscopy**
Course category: MM	
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE
Pre-requisites: Bachelors' degree basic chemistry.	

Course Objectives:

3. To learn basic principles of NMR, IR, UV-Vis spectroscopy and mass spectrometry and to use these spectroscopic methods for structure elucidation of organic compounds.

Course Outcomes: At the end of the course, the students will be able to -

CO1: Describe: Electronic transition, law of absorption, role of solvent, terminology used in UV-Vis spectroscopic techniques.

CO2: Interpret: IR spectra for identification of functional groups

CO3: Deduce: Number and types of hydrogen atom for structural elucidation from ^{1}H-NMR spectrum

CO4: Identify: Molucue on the basis of Mass spectra

CO5: Apply iorganic and organic spectroscopic techniques for structural elucidation.

Contents –

Unit	Content	Teaching hours
1	**UV-Visible Spectroscopy** Principles of absorption spectroscopy, Electronic transitions, presentation of electronic spectra.chromophores, Auxochromers, Bathochromic and Hypochromic Shifts, Effect of solvent and conjugation on electronic transitions, calculation of absorption maximum(λ_{max}) on the basis of Woodward-Fieser rules for dienes, enones and aromatic compounds, study of UV spectra of some organic compounds. Applications of UV-Visible Spectroscopy.	9
2	**Infrared Spectroscopy** Fundamental principle, Modes of vibration in polyatomic molecules, overtone and combination bands, Bond properties and absorption trends, Hooke's Law, Infrared spectrometer. Vibrational frequency for various functional groups, factors influencing vibrational frequency, interpretation of IR spectra of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds. Problems based on structural elucidation from FT-IR spectrum.	9
3	**NMR Spectroscopy** NMR phenomenon, spin ½ nuclei, (^{1}H, ^{13}C, ^{31}P and ^{19}F), **^{1}H NMR**, Zeeman splitting, effect of magnetic field strength on sensitivity and resolution, chemical shift and shielding, magnetic anisotropy, factors affecting on chemical shift, chemical and magnetic equivalence of spins, spin-spin coupling, types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB,AX,ABX,AMX) spin decoupling, shift reagents, Nuclear Overhauser effect (NOE) **^{13}C NMR Spectroscopy:** Elementary ideas, chemical shifts (aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons); Effect of substituent on chemical shifts.	9
4	**Mass spectrometry** Basic principles, ionization techniques, isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution MS, soft ionization methods, ESI-MS and MALDI-MS, basic principle of ionization and ion analysis, illustrative examples from simple organic molecules to macromolecules and supramolecules. Structural elucidation problems using	9

	the above spectroscopic techniques.	
5	**ESR and Mossbauer Spectroscopy** Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals. **Electron Spin Resonance Spectroscopy:** Principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications	9

Text Books:
Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Ltd.
Spectroscopy, B.K. Sharma, Goel Publication
Organic Spectroscopy: Principles and Application, Jag Mohan, Narosa Publication
Reference Books:
H. Gunther, NMR Spectroscopy, 2nd edition. John Wiley and Sons, 1995.
D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, Spectroscopy, Cengage Learning, New Delhi, 2007.
W. Kemp, Organic Spectroscopy, 2nd edition, ELBS-Macmillan, 1987.
T. D. W. Claridge, High Resolution NMR Techniques on Organic Chemistry, Pergamon, New York, 1999.
R. S. Macomber, A Complete Introduction to Modern NMR Spectroscopy, R. S. Macomber, Wiley, 1997
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MML608	**Course name: Reagents in Organic Synthesis**
Course category: MM	
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Bachelors' degree basic chemistry.	

Course Objectives:

To acquire knowledge of oxidation, reduction, organometallic compounds and their applications in name reactions and C-C bond forming reactions.

Course Outcomes: At the end of the course, the students will be able to -

CO1: Depict the mechanism of oxidation reactions and its applications in organic synthesis.

CO2: Depict the mechanism of reduction reactions and its applications in organic synthesis.

CO3: Perform organic reaction using organomettalic reagents

CO4: Describe the mechanism and applications of name reactions.

CO5: Explain the synthesis and applications of organometallic reagents.

Contents –

Unit	Content	Teaching hours
1	**Oxidation** (a) Oxidation of alcohol to aldehyde, ketone or acid: Jones reagent, Swern oxidation, Collins reagent, Fetizones reagent, PCC, PDC, PFC, IBX, Activated MnO_2, Chromyl chloride (Etard reaction), TEMPO, CAN, NMO, Moffatt oxidation (b) Oxidative cleavage of Carbon-Carbon double bonds: $KMnO_4$, Ozonolysis. (c) Oxidations using SeO_2, PhSeBr. (d) Selective cleavages at functional groups: Cleavage of glycols, IO-4, $Pb(OAc)_4$.	9
2	**Reduction** (a) Catalytic Hydrogenation; (b) Reduction of nitriles, oximes and nitro compounds; (c) Reduction of acids and Esters; (d) Reduction with metal hydride- Sodium cyanoborohydride, Diborane, L- & K-Selectrides, $LiBH_4$, DIBAL-H; (e) Birch reduction and related reactions, (h) Luche reagent, Wolf-Kishner reduction, Clemmenson reduction, Wilkinson catalyst, TBTH.	9
3	**Organometallic and Other Reagent** Synthesis and applications of organo Lithium, Magnesium, Titanium, Cerium, Copper, Chromium, Zinc, Boron, Silicon and Cadmium DCC, EDC, DDQ, 1,3 Dithiane, LDA, DMDO, OsO_4, RuO_4, SmI_2, Dess-Martin Periodinane, Diazomethane, Lawesson's reagent.	9
4	**Name reactions and Rearrangements** Pummerer, Payne, Eschenmoser fragmentation, Brook, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with lewis acid, Dienone-Phenol rearrangement, Tiffeneau-Demjanov, Favorskii, von Richter, Wittig, Neber, Smiles, Fries, Curtius, Lossen, Schmidt, Steven, Hofmann, Iodolactonisation	9
5	**Formation of Carbon-Carbon bonds via organometallic reagents** Synthesis and applications of organo Lithium, Magnesium, Titanium, Cerium, Copper,Chromium, Zinc, Boron, Silicon, Cadmium	9

Text Books:
Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri
Organic Synthesis(Reaction mechanism and reagents), Giridhar Joshi, Sanjay Kumar, Saikat Dutta, Medtech Science Press, 2022
Organic Reactions And Their Mechanisms, P S Kalsi, New Age International Private Limited, Fifth edition
Reference Books:
Organic Chemistry: Clayden, Greeves, Warren &wother 2nd edition, Oxford University press ISBN 978-0-19-927029-3
Advanced Organic Chemistry Part A & Part B: F. A. Carey & R. J. Sundberg AdvancedOrganicChemistryPart A &Part B: F.A.Carey&R.J.Sundberg, 5th edition, Springer, ISBN13;978-0387-68346
Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen
Modern Organic Synthesis: An Introduction: G. S. Zweifel& M. H. Nantz
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MML609		**Course name: Photochemistry and Pericyclic Reactions**
Course category: MM		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To impart advanced level knowledge about the various aspects photochemical and pericyclic reactions and their applications in organic synthesis.		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Differentiate between various types of radiative and non-radiative processes.		
CO2: Apply the knowledge Woodward-Hoffmann selection rules for pericyclic reactions		
CO3: Predict the stereochemistry of product of pericyclic reaction		
CO4: Predict the stepwise mechanism of photochemical reaction.		
CO5: Describe the photochemical reactions involving addition to C-C multiple bonds.		

Contents-

Unit	Content	Teaching hours
1	**Pericyclic Reactions-I** Features and classification of pericyclic reactions, Phases, nodes and symmetry properties of molecular orbital in ethylene, 1,3-butadiene, 1,3,5-hexatriene. Allyl cation, allyl radical, pentadienyl cation and pentadienyl radical. Thermal and photochemical reactions. **Electrocyclic reactions**: Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions by: (i) Symmetry properties of HOMO of open chain partner; (ii) Conservation of orbital symmetry and orbital symmetry correlation diagram and (iii) Huckel-Mobius aromatic and antiaromatic transition state method.	12
2	**Pericyclic Reactions-II** **Cycloaddition reactions:** Diels-Alder reaction. Woodward-Hoffmann selection rules for cycloaddition reactions. Explanation for the mechanism of cycloaddition reactions by 1) Conservation of orbital symmetry and orbital symmetry correlation diagrams 2) Fukui Frontier Molecular Orbital (FMO) theory and (3) Huckel-Mobius aromatic and antiaromatic transition state method. Endo-exo selectivity in Diels-Alder reaction and it's explanation by FMO theory. Examples of cycloaddition reactions.	7
3	**Pericyclic Reactions-III** **Sigmatropic reactions:** Selection rules for [i,j] shifts. Cope, degenerate Cope and Claisen rearrangements. Explanation of sigmatropic reactions by (i) symmetry properties of HOMO (ii) Huckel-Mobius aromatic and antiaromatic transition state method. Introduction to chelotropic reactions and the explanation of mechanism by FMO theory.	8

4	**Photochemistry-I** **Photochemistry of (π, π) transitions:** Excited state of alkenes, cis-trans isomerisation, photochemistry state, electrocyclisation and Sigmatropic rearrangements, di π-methane rearrangement. **Intermolecular reactions:** photocycloadditions, photodimerasation. Photoaddition reactions. Excited states of aromatic compounds, photodimerisation of benzene, photosubstitution reactions of aromatic compounds and Photo-Fries rearrangement.	9
5	**Photochemistry-II** **Photochemistry of (n, π) transitions:** Excited state of carbonyl compounds, Norrish-I and Norrish-II **Addition to C-C multiple bonds:** Paterno-Buchi reaction, photochemistry of alkyl peroxides, hypohalites and nitriles. Barton reaction. Photochemistry of azo compounds, diazo compounds, azides and diazonium salts. Singlet oxygen-photo oxygenation reactions. Ene reaction, formation of dioxetanes and endoperoxides. Chemiluminescent reactions. Oxidative coupling.	9

Text Books:
Pericyclic Reactions & Organic Photochemistry, Dr. Satyajit Dey Dr. Nirmal Kr. Hazra, Techno World publisher
Textbook Of Pericyclic Reactions : Concept And Application, K. C. Majumdar, Medtech Publisher
Photochemistry and Pericyclic Reactions, Jagdamba Singh, New Age International Publishers
Reference Books:
Advanced Organic Chemistry Part A & Part B: F. A. Carey & R. J. Sundberg Advanced Organic Chemistry Part A &Part B: F.A.Carey&R.J.Sundberg, 5th edition, Springer, ISBN13;978-0387-68346
Advanced Organic Chemistry:Jerry March 6th edition 2007 Willey-Interscience.
Organic Chemistry: Clayden, Greeves, Warren & other 2nd edition, Oxford University press ISBN 978-0-19-927029-3
Organic Chemistry: Stanley H. Pine, 5th edition 2006, Mc Graw Hill Education.
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MEL607		**Course name:** Asymmetric Synthesis
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: Explain the need for synthesizing biologically active compounds in optically pure form, the principles and strategies of making enantio enriched compounds		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Recognize the need of asymmetric synthesis and resolution in biological systems		
CO2: Describe the process for achieving asymmetric synthesis using chiral substrate.		
CO3: Use chiral auxiliary for asymmetric synthesis of bioactive compounds.		
CO4: Investigate the role of chiral reagent in the asymmetric synthesis.		
CO5: Identify the importance of chiral catalyst in the asymmetric synthesis.		

Contents-

Unit	Content	Teaching hours
1	**Introduction to asymmetric synthesis and resolution** Asymmetric synthesis Importance and basic principles - Stereoselective and Stereospecific, – Enanatioselective and Diastereoselective. Energetic considerations, strategies for asymmetric synthesis - advantages and limitations of each strategy, analytical methods for determining enantiomeric excess. Resolution - resolving agents and resolution of racemic compounds having functional groups for eg. alcohol, amine, and acid. Resolution of chiral ligands - BINOL, trans 1,2-diaminocyclohexane. Kinetic resolution of racemic mixtures. Dynamic Kinetic resolution, enzymatic resolution.	10
2	**Asymmetric synthesis on chiral substrate** Nucleophilic addition to α–chiral carbonyl compounds; Prediction of stereochemistry- Cram's rule and related modifications. Double stereo differentiation; matched pair and mismatched pair; examples from aldol condenzation and hydroboration reactions. Electrophilic addition to α – chiral olefins - epoxidation, cyclopropanation, hydroboration – oxidation, alkylation of enolates of β-chiral carbonyl compounds.	9
3	**Asymmetric synthesis using chiral auxiliary [09 hr]** Chiral Auxilary mediated reactions using various chiral auxiliaries. Chiral auxiliaries derived from proline, champhor, menthol and other chiral pool sources. SAMP / RAMP hydrazines, and other pyrrolidines, oxithiane, oxazolidine-2- one, thiazolidine-2-one, phenylethylamine, 2-phenylcyclohexanol etc. Remote chiral Induction.	10
4	**Asymmetric synthesis using chiral reagents** Chiral organo boranes -Application of chiral organoboranes, reduction (Ipc 2	8

	BCl) and allylation and crotylation reactions, Chiral modification of lithium aluminum hydride, BINAL-H - application in reduction of prochiral ketones; oxazaborolidines.	
5	**Asymmetric synthesis using chiral catalysts** Asymmetric alkylation and allylation of carbonyl compounds, Reduction of Ketones , imines. Asymmetric hydrogenation: early advances DIPAMP, DIOP and Noyori's BINAP – selected reactions / examples. Sharpless epoxidation, dihydroxylation, aminohydroxylation of alkenes	8

Text Books:
Asymmetric Synthesis, Y Vatsala, New age international publisher.
Advanced asymmetric Synthesis, G. R. Stephenson, Springer Science Business Media
Reference Books:
Asymmetric Synthesis, R. A. Aitken and S. N. Kilenyi, Springer Science Business Media, 1994.
Principles of Asymmetric Synthesis (Tetrahedron series in Organic Chemistry), R. E. Gawley, J Aube, Pergman, 1996.
Asymmetric Synthesis, G. Proctor, Oxford University Press, USA, 1997.
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MEL608		**Course name: Advanced Stereochemisty**
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To provide knowledge of stereochemistry and their applications in addition, elimination, substitution reactions along with determination of stereochemistry by spectroscopic methods.		
Course Outcomes: At the end of the course, the students will be able to		
CO1 : Generalize the concept of stereo-chemistry and reaction pathway.		
CO2 : Describe the stereo chemical and conformational structure of molecules.		
CO3: Chemical reactivity and on the mechanism of organic reaction.		
CO4: Students familiar with the basic concept of stereo chemistry, which will be used for further studies.		
CO5: Providing the knowledge and in depth understanding stereochemistry, its effect in synthesis, behaviour of chiral compounds and properties		

Unit	Content	Teaching hours
1	**Isomerism and Elimination Reactions** General introduction and classification of isomerism, entiomerism, measurement of optical activity, elements of symmetry and chirality of molecule, asymmetric and dissymmetric molecules. Stereochemistry of eliminations (syn elimination vs. anti-elimination, orientation in elimination reaction, molecular rearrangement, decarboxylation reactions, etc.).	8
2	**Addition Reactions** Stereochemistry of addition reactions of alkenes and alkynes. Electrophilic addition of bromine. Formation and reactions of epoxides, epoxide opening, orientational preferences, etc. Addition of carbons to alkenes, hydrogenation, hydroboration Oppenaeur oxidation	8
3	**Aliphatic Nucleophilic Substitution** Introduction of aliphatic nucleophilic substitution reaction.SN^2 reaction mechanism and evidence.SN^1 reaction, nucleophilic substitution of allylicsystems.SN^1 and SN^2 reactions. Rearrangement in allylic systems. Nucleophilic displacements at allylic Halides tosylates. Nucleophilic substitution at the benzylic position. Nucleophilic substitution of vinylic and aryl halides. The SN^1 mechanism, mixed $SN^1$and SN^2 reactions. Ambident nucleophiles, Regioselectivity, set mechanisms, neighboring group participation- Anchimeric Assistance and others.	10

4	**Stereochemistry of Fused ring, bridge ring and Spirans** Introduction, trans-fused ring system, cis-fused ring system, spirocyclic ring system. Reactions with cyclic transition states.	9
5	**Determination of Stereochemistry by Spectroscopic Methods** Dihedral angle and coupling constant. J Coupling and Karplus equation and its modification. Geminal coupling in six-membered, five-membered and four membered rings, Nuclear over Houser effect, etc. Geometrical isomer and coupling constants.	10

Text Books:
Stereochemistry of Organic Compounds by- D. Nasipuri,2nd Edition, New Age International(P) Ltd.(1994).
Stereochemistry: Conformation and Mechanism , P. S. Kalsi, 11th edition, 2022, New Age Publications
Reference Books:
Organic Chemistry, Volume-II, Streochemistry and Natural Product,I. .L. Finar, 5th edition, 2002 Pearson publication.
Organic Chemistry, By, J. Clayden,N. Greeves, S.Warren and P.Worthers, Oxford, University Press, (2001).
Stereochemistry of Carbon Compounds By E.L. Eliel,TataMcGrawn-Hill Pub. Co. Ltd.(1962).
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MEL613		**Course name:Chemistry of Nanomaterials**
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To understand basic and advanced level concepts of nanomaterials		
Course Outcomes: At the end of the course, the students will be able to		
CO1 : Describe the effects may emerge due to nano-dimensions of particles.		
CO2: Analyze a nano structured material of a given species through their modified chemical and physical properties		
CO3: Describe applications of nano-material chemistry and their advantages with respect to classical materials and device setups.		
CO4: Interprete chcterization data of Nanomaterials.		
Describe the toxicity of nanomaterials and their applications in medicine		
CO5: Describe the toxicity of nanomaterials and their applications in medicine.		

Unit	Content	Teaching hours
1	**Introduction and classification of Nanomaterials:** **Introduction to Nanomaterials**: Size Effects - difference between bulk and Nanomaterials - Definition of Nanomaterial. **Classification Nanomaterials**: Nanoparticles, Nanocrystal, 0-D Quantum dots, Nanostructured material (1-D Wire and rods, 2-D thin film, 3-D structures) - Carbon nanotubes (CNTs) : Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs) - Graphene.	9
2	**Properties and Synthesis of Nanomaterials:** **Proprieties of nanomaterials**: Optical, electronic, magnetic and chemical etc. **Synthesis of Nanomaterials**: Synthesis of Nanomaterials: Bottom Up and Top Down Approach - Gas Phase synthesis of Nanomaterials - Wet chemical synthesis - Chemical Vapour Deposition (CVD).	9
3	**Characterisation and Optical luminescence Nanomaterials** **Characterisation of Nanomaterials**: using UV-Visible Spectroscopy, Fluorescence Spectroscopy, Powder XRD, Particle size analysis by Dynamic Light Scattering (DLS), SEM, TEM, AFM techniques. **Optical luminescence Nanomaterials**: Optical luminescence and	9

	fluorescence from direct, bandgap semiconductor nanoparticles - White LEDs - LEDs based on nanowires - LEDs based on nanotubes- LEDs based on nanorods - High Efficiency Materials for OLEDs -High Efficiency Materials for OLEDs.	
4	**Energy Applications**: **Renewable Energy Technology**: Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies. **Nanomaterials for Storage:** and devices for energy transport, conversion and storage.	9
5	**Nanomedicine Application** **Nanomaterials in Medicine**: Introduction to Nanocarriers, Interactions of nanocarriers with blood stream, cellular targeting, Biological and chemical reagents for cell-specific targeting - Biodistribution of liposomes, dendrimers and Nanoparticles, **Toxicity of Nanomaterials:** drug delivery, tissue regeneration, cancer detection, Luminescent nanoparticle probes for bio-imaging and diagnostics.	9

Text Books:
Nanotechnology: Principal and practice, Sulabha Kulkarni
NANO- The next revolution- Mohan Surendra Rajan
Reference Books:
Fundamentals of Nanotechnology –Gabor L Hornyak, John J Moore.
Surface Science: Foundations of Catalysis and Nanoscience,K.W. Kolasinski, Wiley, 2002
Online Resources: 1. NPTEL / SWAYAM lectures.

Syllabus
Semester-III

Course code: MCH43MMP607	**Course name: Organic Chemistry Lab Course-III (Ternary Mixture)**	
Course category: MM		
Credits: 2	**Teaching Scheme: P-4**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic practical chemistry		
Course Objectives: To built skill of separation, identification and qualitative analysis of organic compounds from mixture.		
Lab Outcomes: At the end of the course, the students will be able to		
LO1: Apply the solubility nature of organic substances of different functional groups.		
LO2 : Perform the pilot separation of ternary mixtures.		
LO3: Deploy the systematic producers organic substances analysis		
LO4: Deploy the test involving identification of special elements		
LO5: Perform the confirmatory test for various functional groups.		
LO6: Perform the preparations of derivative all functional groups		
LO7: Explain the techniques involving drying and recrystallization by various methods.		

Sr.No.	Title of the Experiment
1.	Separation and identification of types of components in ternary mixture a) Solid – solid mixtures (any three) b) Liquid – liquid mixtures (any three)
2.	Qualitative analysis of ternary mixtures (any three). In a mixture at least one water soluble compound should be given. a) Acid + Base + Neutral b) Acid + Phenol + Base c) Phenol + Base + Neutral
3.	Qualitative analysis of ternary mixtures (any three). In a mixture at least two liquid components should be given. a) Acid + Base + Neutral b) Acid + Phenol + Base c) Phenol + Base + Neutral

Reference Book / Hand Books/ Lab Manual

Vogel's Textbook of Practical Organic Chemistry, Brian S Furniss, 5th edition, Pearson India

A Handbook of Organic Analysis: Qualitative and Quantitative, Clarke A, Fourth edition, CBS publisher

Practical Manual Of Qualitative Organic Analysis Book, Hetal Prajapati,Vipul Vaghela, Nirali Prakashan

Syllabus
Semester-III

Course code: MCH43MMP608	**Course name: Organic Chemistry Lab Course-IV (Green Synthesis)**	
Course category: MM		
Credits: 2	**Teaching Scheme: P-4**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic practical chemistry		
Course Objectives: To demonstrate / apply the green protocols for the synthetic routes.		
Lab Outcomes: At the end of the course, the students will be able to		
LO1: Application of techniques involved in organic synthesis		
LO2: Method development for synthesis of useful compounds using name reaction.		

List of Practical:

Sr.No.	Title of the Experiment
1	Ultrasound in synthesis: (any four) (a) 2-chloro-N-aryl anthranilic acid from 2-chlorobenzoic acid and 2-chloroaniline. (b) Bromination of acetanilide using Ceric Ammonium Nitrate (c) One-pot synthesis of 3-nitro-2H-chromenes, the reaction of o-hydroxy benzaldehyde and nitro styrene by sonication. (d) Cannizarro reaction of benzaldehyde under heterogeneous condition catalyzed by barium hydroxide and ultrasound
2	Phase transfer catalyst in synthesis: (any three) a) Darzens condensation of cyclohexanone with chloroacetonitrile to provide 1-oxaspiro-[2,5]-octane-2-carbonitrile. b) Oxidation of benzyl alcohol with hypochlorite solution. c) Flavone from o-hydroxyacetophenone and benzoylchloride. d) Toluene to benzoic acid by alkaline KMnO4. e) Salicylaldehyde from phenol and chloroform.
3	Microwave in organic synthesis: (any three) a) Esterfication of benzoic acid using microwave b) Alkylation of ethyl acetoacetate using microwave conditions in presence of a PTC c) Solvent free N-alkylltion of saccharin by microwave irradiation d) Fries rearrangement of p-cresyl acetate by microwave irradiation e) KMnO4 oxidation of toluene assisted by microwave

Reference Book / Hand Books/ Lab Manual
Vogel's Textbook of Practical Organic Chemistry, Brian S Furniss, 5th edition, Pearson India

Microwaves in Organic Synthesis, Andre Loupy (Ed.), Wiley – VCH Verlag, Weinheim, 2002
Organic Synthesis, V. K. Ahluwalia and R. Aggarwal, Narosa Publishing House, N. Delhi, 2001.
D.W. Mayo, R.M. Pike and P.K. Trumper, Microscale Organic Laboratory, John Wiley and Sons, Inc., ISBN 0-471-57505-4, 3rd edition, 1994
D.L. Pavia, G.M. Lampman and G.S. Kriz, Introduction to Organic Laboratory Techniques, Saunders College Publishing, ISBN 0-03-006232-2, 2nd edn 1995
O.R. Rodig, C.E. Bell, Jr., A.K. Clark, Organic Chemistry Laboratory, Saunders College Publishing, ISBN 0-03-012644-4, 1990

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Syllabus
Semester-III

Course code: MCH43MMP609 Course name: Organic Chemistry Lab Course-V (Spectroscopy lab)
Course category: MM
Credits: 2 **Teaching Scheme: P-4** **Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic practical chemistry
Course Objectives: To demonstrate / apply spectroscopic techniques for structural elucidation of organic compounds.
Lab Outcomes: At the end of the course, the students will be able to
LO1: Interpretation of UV-Visible, FT-IR, ^{1}H-NMR, ^{13}C-NMR and mass spectrometry data.
LO2: Handling of UV-Visible spectrophotometer, FT-IR Spectrometer.

List of Practical:

Sr.No.	Title of the Experiment
1.	To interpret the structural arrangement of unknown compound using UV-Visible spectrum. (Any five)
2.	To interpret the structural arrangement of unknown compound using FT-IR spectrum. (Any five)
3.	To interpret the structural arrangement of unknown compound using ^{1}H-NMR spectrum. (Any five)
4.	To interpret the structural arrangement of unknown compound using ^{1}H-NMR spectrum. (Any five)
5.	To interpret the structural arrangement of unknown compound using ^{13}C -NMR spectrum. (Any five)
6.	To interpret the structural arrangement of unknown compound using mass spectrum. (Any five)
7.	To elucidate the complete structure of unknown molecule using UV-Visible, FT-IR, ^{1}H-NMR, ^{13}C –NMR and mass spectrum. (Any five)

Reference Book / Hand Books/ Lab Manual
Introduction to Experimental Infrared Spectroscopy - Fundamentals and Practical Methods, MM Tasumi, John Wiley & Sons Inc
Experimental Spectroscopy, Sawyer, R. A, Dover Publication

Syllabus
Semester-III

Course code: MCH43MMP603 (Chromatography lab)	**Course name: Organic Chemistry Lab Course-VI**	
Course category: ME		
Credits: 1	**Teaching Scheme: P-2**	**Evaluation Scheme:** CA-30, ESE-20
Pre-requisites: Bachelors degree basic practical chemistry		
Course Objectives: To demonstrate /apply chromatographic techniques for separation, identification and quantification of components of mixture in organic /inorganic compounds.		
Lab Outcomes: At the end of the course, the students will be able to		
LO1: Perform separation, purification and quantification by using TLC, HPLC, GC, HPTLC, and ion exchange and Column chromatography.		
LO2: Analyze and interpret the properties of substance using obtained chromatogram		

List of Practical:

Sr.No.	Title of the Experiment
1.	Separation of alpha amino acids by paper chromatography
2.	Determination of various impurities by thin layer chromatography
3.	Determination of Rf value of glycine by ascending paper chromatography
4.	Separation of sugars, amino acids by paper and thin layer chromatography
5.	Purification of commercial anthracene by column chromatography using benzene
6.	Separation of a mixture of o- and p- nitro anilines on an alumina column
7.	Gas chromatographic analysis for a mixture of gases like O2, N2 and CO2
8.	Quantitative analysis of a mixture of chloroform and carbon tetrachloride using gas chromatography
9.	Quantitative assay of ampicillin in a powder for injection by HPLC
10.	HPLC analysis of benzaldehyde and benzyl alcohol
11.	To analyze a mixture (benzene and toluene, anthracene and naphthalene) by HPLC
12.	To determine the capacity of a cation exchange resin
13.	To determine the capacity of an anion exchange resin
14.	To estimate the sodium ion from fertilizer sample using cation exchange resin
15.	To separation and estimate the cobalt and nickel ions using an anion exchange resin

Reference Book / Hand Books/ Lab Manual
Practical Chromatography, Jose Barnett, Larsen and Keller Education
Chromatographic Methods Development, Gregory K. Webster, Jenny Stanford Publishing
Analytical Chemistry: Theory and Practice; R. M. Varma, CBS Publishers, 1994
Advanced Physical Chemistry; J. B. Yadav, Goel Publishing House, Meerut
Comprehensive Experimental Chemistry; V. K. Ahluwalia, New Age Publications,1997
Vogel's Text Book of Quantitative Chemical Analysis; Sixth Edition

Syllabus
Semester-III

Course code: MCH43RPJ601		**Course name: Minor research project**
Course category: RP		
Credits: 4	**Teaching Scheme: P-8**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic practical chemistry		
Course Objectives: To provide hands on training to understand research problem to design synthesis of target molecule		
Course Outcomes: At the end of the course, the students will be able to		
LO1: Skill to search literature on selected research oriented project work.		
LO2: Identify the advances in current research.		
LO3: Conduct experiments scientifically with safety.		
LO4: Interpret FT-IR ,^{1}HNMR,^{13}C NMR and Mass spectrometry data of the prepared molecules by physical and spectral analysis.		

Sr.No.	Title of the Experiment
1.	Student can choose project work topic as per expertise and research thrust area of department faculty members and undertake experimental work on chosen topic and present work in Viva-Voce examination and should submit project report which should contain. • Introduction: Literature review and to Limitation of existing work ,Aims and objectives of research topic, Scope of topic • Experimental section and Research methods/ Techniques • outcome of project work • References

Syllabus Semester-IV

Course code: MCH43MML610	**Course name:** Organic Synthesis: Retro synthetic approach	
Course category: MM		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To teach the concepts tools and techniques of retro-synthetic analysis to plan synthesis of a given target molecule.		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Explain retrosynthetic analysis with some examples.		
CO2: Explain the concepts of one group C-C bond disconnections.		
CO3: Describe protective groups in organic synthesis; special emphasis on protection and deprotection of hydroxyl-, carbonyl-, carboxylic acid and amines.		
CO4: Explain the concepts of two-group C-C bond disconnections.		
CO5: Describe ring synthesis via retrosynthetic approach.		

Contents-

Unit	Content	Teaching hours
1	**Disconnection Approach** An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions, importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations: chemoselectivity, stereoselectivity, Reversal of polarity, cyclization reactions, amine synthesis.	9
2	**Protecting Groups** Protection and deprotection of hydroxyl, carbonyls in aldehydes and ketones, amines, carboxylic acids, alkenes and alkynes with examples	8
3	**One group C-C Disconnections** Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.	9
4	**Two group C-C Disconnections** Two group C-C Disconnections: Diels-Alder reactions, 1,3-difunctionalized compounds and α, β unsaturated compounds, control in carbonyl condensations, 1,4-difunctionalized compounds 1,5-difunctionalized compounds, Michael addition and Robinson annelation.	9
5	**Ring Synthesis** Introduction to ring synthesis, saturated heterocycles, synthesis of 3, 4, 5 and 6 membered rings, rearrangements and photochemistry in synthesis, aromatic heterocycles.	10

Text Books:
Organic Synthesis: The Disconnection Approach: Stuart Warren

The Logic of Chemical Synthesis: E. J. Corey and Xue-Min Chelg
Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
Reference Books:
Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
Principles of Organic Synthesis: R. Norman and J. M. Coxan.
Organic Chemistry: Clayden, Greeves, Warren &wother 2nd edition, Oxford University press ISBN 978-0-19-927029-3
Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MML611 **Course name:** Chemistry of Heterocyclic & Bioactive Molecules
Course category: MM
Credits: 3 **Teaching Scheme: L-3** **Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry
Course Objectives: To classify simple heterocyclic aromatic compounds as electron deficient or electron rich and explain their reactivity based on the properties.
Course Outcomes: At the end of the course, the students will be able to
CO1: Describe the structures of classes of heterocyclic aromatic organic compounds.
CO2: Apply organometallic reactions that applied in heterocyclic chemistry.
CO3: Explain aromatic nucleophilic substitution reactions on it.
CO4: Explain on a mechanistic level, reactions and synthesis of important heterocycles.
CO5: Illustrate synthesis and chemical properties of benzofused heterocycles.

Contents-

Unit	Content	Teaching hours
1	**Synthesis and reactions of 3 and 4 membered heterocyclic compounds** 3-membered rings: Aziridines, Oxiranes, Thiiranes, 4-memberedrings:Azetidines, Oxitanes and Thietanes	9
2	**Synthesis and reactions of 5 and 6 memberedheterocyclic compounds with one heteroatoms** Five-membered rings with one heteroatom: Pyrrollidine, Furan, Pyrrole and Thiophene Six-membered rings with one heteroatom: Pyran, Pyridine	9
3	**Synthesis and reactions of 5 and 6 memberedheterocyclic compounds with two heteroatoms** Five-membered rings with two heteroatoms: Imidazole, Pyrazole, Oxazole, Isoxazole, Thiazole, Isothiazole. Six-membered rings with two heteroatoms: Piperazine, Morphine, Thiomorphine, Pyridazines, pyrimidines, pyrazines,	9
4	**Synthesis and reactions of 5 and 6 memberedheterocyclic compounds with three heteroatoms** Five-membered rings with three heteroatoms: Triazoles, Oxadiazole, Thiadiazole, Tetrazole. Six-membered rings with three heteroatoms: Hexahydro-1,3,5-triazine Six-membered rings with three heteroatoms: Tetrazine	9
5	**Synthesis and reactions of Benzofused heterocycles** Benzopyrroles, Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Quinolines, Isoquinoline, Quinazolines, Coumarins and Chromones, Purines and Pteridines	9

Text Books:
Heterocyclic chemistry, R.K. Bansal, Wiley E
Heterocyclic Chemistry, R. R. Gupta, M. Kumar, V. Gupta, Vol. 1-3, SpringerVerlag
Reference Books:
Principals of modern heterocyclic chemistry, L.A. Paquitte
Advances in Heterocyclic chemistry, A.R. Katrtzhy and A.V. Bootton
Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall.
The Chemistry of Heterocycles, T Eicher and S. Hauptmann, Thieme.
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MML612		**Course name:** Chemistry of Natural Products
Course category: MM		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To introduce the basic knowledge of terpenes, catatenoids, steroids, alkaloids, plant pigments, porphyrins and other related bio molecules.		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Describe synthesis, physical / chemical properties and applications of terpenoids and caratenoids.		
CO2: Recognize the physical / chemical properties and applications alkaloids.		
CO3: Summarize the physical / chemical properties and applications steroids.		
CO4: Explain structure determinations, isolation and synthesis of plant pigments.		
CO5: Interpret structure determinations, isolation and synthesis of porphyrins and prostaglandins.		

Contents-

Unit	Content	Teaching hours
1	**Terpenoids and Caratenoids** **Terpenoids**: Introduction, biological importance, classification, occurrence and isolation, isoprene rule, structure determination and biosynthesis of Citral, Geraniol, α-Terpineol, Menthol, Farnesol, Zingiberene **Caratenoids:** Methods of isolation. structural relationship of α-, β- and γ-carotenes. structureelucidation and synthesis of β-carotene.	10
2	**Alkaloids** Definition, nomenclature, occurrence, isolation, classification, role of alkaloids in plants, General methods of structure elucidation, Structure, stereochemistry and synthesis of the following: Ephedrine, (+)-coniine, nicotine, atropine, Quinine and Morphine.	10
3	**Steroids** Occurrence, nomenclature, basic skeleton, Diels hydrocarbon and stereochemistry, Isolation, structure determination and synthesis of Bile acids, Androsterone, Testosterone, Estrone and Progesterone, Biosynthesis of steroids.	9
4	**Plant Pigments** Occurrence nomenclature and general methods of structure determinations, isolation and synthesis,Quercetin, Quercetin-3-Glucoside, Cyanidin-7-arabinoside cyanidine, Hirsutidin Biosynthesis of Flavonoids: Acetate path way and shikimic acid path way.	8

5	**Porphyrins & Prostaglandins** **Porphyrins**: Structure and synthesis of Haemoglobin and chlorophyll **Prostaglandins:** Occurrence, nomenclature, classification, biogenesis and physiological effects Synthesis of PGE2 and PGF 2	8

Text Books:
Chemistry of Natural Products, S. V. Bhat, B. A. Nagaramgagi, M. Srikumar, Alpha Science International Ltd.
Chemistry of Natural Products, O. P. Agarwal, , Vol- 1 &Vol-2, Goel publishing House
Biogenesis of Natural Products, Baldev Kumar and Harishkumar Chopra, Narosa Publication
Chemistry of natural products: A unified approach, N. R. Krishnaswamy, University Press, India
New Trends in Natural Product Chemistry: Atta-ur-Rahman and M. I. Choudhary, Harwood Academic publishers.
Reference Books:
Total synthesis of natural products, Vol. I & VI, Apsimon, John Wiley, NY
Medicinal natural products: A biosynthetic approach, P. M. Dewick, John Wiley, Chichester
Natural products: Their chemistry and biological significance, J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe& J. B. Harborne, Longman, UK
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MML613		**Course name:** Green Chemistry
Course category: MM		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To understand green chemistry and sustainability related to environmental aspects.		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Describe 12 principles of Green chemistry.		
CO2: Describe various green protocols based on non-conventional methods.		
CO3: Apply green auxiliaries in organic synthesis.		
CO4: Demonstrate the reusability of supported catalysts.		
CO5: Summarize important applications of biocatalysts.		

Contents-

Unit	Content	Teaching hours
1	**Introduction to Green Chemistry** Green chemistry, relevance and goals, Anastas' twelve principles of green chemistry-Tools of green chemistry: alternative starting materials, reagents, catalysts, solvents and processes with suitable examples.	9
2	**Microwave mediated organic synthesis** Microwave activation, advantage of microwave exposure, specific effects of microwave, Neat reactions, solid supports reactions, Functional group transformations, condensations reactions, oxidations, reductions reactions, multi-component reactions.	9
3	**Ionic liquids and PTC** Introduction, synthesis of ionic liquids, physical properties, applications in alkylation, hydroformylations, expoxidations, synthesis of ethers, Friedel-craft reactions, Diels-Alder reactions, Knoevenagel condensations, Wittig reactions, Phase transfer catalyst, Synthesis, applications.	10
4	**Supported catalysts for Green chemistry** Introduction, the concept of atom ecomomy, supported metal catalysts, types of supports, Methods for preparation of supported catalyst and their characterization, Applications of supported catalysts in green synthesis.	8
5	**Bio-catalysts for Green chemistry** Introduction to Biocatalysts for green chemistry, modified bio catalysts, fermentations and biotransformations, fine chemicals by microbial fermentations, vitamins and amino acid, Baker's yeast mediated biotransformations, Biocatalyst mediated Baeyer-Villiger reactions.	9

Text Books:
Green Chemistry-Environmentally benign reactions. V. K. Ahluwalia. Ane Books India
Green Chemistry- Environment friendly alternatives. Rashmi Sanghi& M. M. Srivastava
Reference Books:
Green Chemistry-Designing Chemistry for the Environment. Paul T. Anastas & Tracy C.Williamson.
Green Chemistry-Frontiers in benign chemical synthesis and processes. Paul T. Anastas& Tracy C. Williamson.
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MEL610		**Course name:** Medicinal Chemistry
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To understand and apply fundamental principles of drug design, discovery and development.		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Describe methods of drug development including design and discovery.		
CO2: Explain the structure activity relationship and drug target interactions		
CO3: Apply understanding of physical, chemical property of drug for drug design		
CO4: Describe the factors that affect its absorption, distribution, metabolism, andexcretion, and hence the considerations to be made in drug design		
CO5: Describe New Drug Delivery (NDD) system.		

Contents-

Unit	Content	Teaching hours
1	**Fundamental Principles of Drug Discovery** Introduction to drug discovery, difference between drug and medicine, concepts in drug chemistry: Drug, Prodrug, Hard and Soft drugs, agonists, antagonists, affinity, efficacy, potency, isosterism, bioisosterism, pharmacophores, lead molecule, lethal dose (LD_{50}) and effective dose (ED_{50}) Therapeutic index (TI) The oriesof drug activity, Structure activity relationship(SAR), Quantitive Structure Activity Relationship (QSAR)	10
2	**Pharmacokinetics and Pharmacodynamics** Drug absorption, Distribution and depositionofdrugs.Excretionandeliminationofdrugs,Bioavailability. (i)Mechanism of drug action: Enzyme stimulation and enzyme inhibition, antimetabolites, membrane active drugs, chelation ; (ii) Drug metabolism and inactivation: Factors affecting drug metabolism ,pathways of drug metabolism [Metabolic reaction(Phase I) and conjugation reaction(PhaseII)].	9
3	**Drug Delivery System** Drug delivery and various routs of drug administration, fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Bioavailability assessment of CR systems, Polymers in CR- classification, properties biocompatible and biodegradable polymers. Oral controlled drug delivery systems, mucosal drug delivery system, ocular drug delivery systems, parenteral drug delivery systems, transdermal drug delivery systems	10

4	**Synthesis and Utilities Anti-inflammatory, Antidiabetics and Antineopastic Drugs**: Synthesis and Utilities of the following drug molecules (at least one convenient synthetic croute with possible mechanism) from following classes **Anti-inflammatory Drugs:** (a) Naproxen (b) Ibuprofen (c) Diclofenac Sodium. **Antidiabetics :**(a) Troglitazone (b) Chlorpropamide (c) Tolbutamide. **Antineopastic Drugs: (**a) Antagonist : Fluorouracil (b) Alkylatingagents : Chlorambucil Cis-Platin	8
5	**Synthesis and Utilities Anti-hypertensive and Antibiotic Drugs**: **Anti-hypertensive Drugs: (**a)Verapamil (b) Captopril (c) Atenolol. **Antibiotics:** (a) Chloramphenicol (b) Ampicillin(c) Amoxycillin (d) Antimycobactria l:Ethambutol, (e) Antiviral :Acyclovir (f) Antimicrobial : Sulfamethoxazole	8

Text Books:
Medicinal Chemistry, Ashutosh Kar, New Age Publisher
Textbook of Medicinal Chemistry 4th Edition, V Alagarsamy, CBS Publishers & Distributors Pvt Ltd
Reference Books:
An Introduction to Medicinal Chemistry, Patric, G. L., 3rd ed.; Oxford University Press: 2005.
The Organic Chemistry of Drug Design and Drug Action. Silverman, R. B., 2nd ed.; Academic Press: 2004.
Introduction of Medicinal Chemistry: A.Gringuage,Wiley-VCH.
Synthesis of Essential Drugs: R. S. Vardanyan and V. J. Hruby
Essentials of Medicinal Chemistry IInd: Andrejus Korolkovas, WileyVCH
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MEL611		**Course name:** Chemoinformatics
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To create awareness about the chemoinformatics and important sources of chemical information and their applications for drug synthesis		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Recognize various sources of cheminformatics and apply them in drug design.		
CO2: Perform molecular docking study		
CO3: Predict the stoichiometric ratio of the precursours		
CO4: Analyze biological database.		
CO5: Recognize various sources of chemoinformatics and apply them in drug design.		

Contents-

Unit	Content	Teaching hours
1	**Mathematics Process** Graph theory and molecular numerology; Logic, sets and functions; Algorithms, integers and matrices; Mathematical reasoning, induction and recursion; Counting; graphs, trees and sets, basic probability and statistics; Markov processes	9
2	**Basics of Stereochemistry** Basic Stereochemistry, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures.	9
3	**Chem Information** History of scientific information communication-chemical literature-chemical information chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources	9
4	**Biological Databases** Introduction; Experimental sources of biological data; Publicly available databases; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualisation of sequence data; Visualization of structures using Rasmol or SPDB Viewer or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics.	9
5	**Drug Design** Introduction to drugs, structure-based drug design. QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and De Novo Drug	9

	Design Virtual screening/docking of ligands. Protein structure, Drug action & enzymes. Drug action & receptors. Prediction of Binding Modes, Protein–Ligand binding free energies, Fragment-Based Drug Design, ADMET prediction.	

Text Books:
Chemoinofrmatics :Basic Concepts and Methods, Johann Gasteiger
An Introduction to Chemoinformatics, Andrew R. Leach , Valerie J. Gillet, 78-1-4020-1347-8 Published: 31 May 2003
Reference Books:
Trends in Bioinformatics,P. Shanmughavel, Pointer publishers, 2006.
Advanced Organic Chemistry-Part A & B, Francis A. Carey and Richard J. Sundberg, Third Edition, 1990.
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MEL612		**Course name:** Organic High Polymers
Course category: ME		
Credits: 3	**Teaching Scheme: L-3**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic chemistry		
Course Objectives: To study the various methods and techniques of polymerization reactions, their chemistry, mechanism, structures, properties and applications		
Course Outcomes: At the end of the course, the students will be able to		
CO1: Realize the basic concept of chemical reactions and polymerization reactions involved in the macromolecules and micro molecular reaction.		
CO2: Understand the study of methods of polymerization reaction and their properties.		
CO3: Understand the importance of macromolecules/polymers in day to day life and apply their knowledge in sustainable development of mankind.		
CO4: Understand the study of methods of polymerization reaction and their properties, advantages, disadvantages, modifications and applications		
CO5: Describe the kinetics of polymerization reaction		

Contents-

Unit	Content	Teaching hours
1	**Fundamentals of Biological Macromolecules** Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids, Protein structure and function, Properties of nucleosides and nucleotides, Composition of nucleic acids, Electrophoresis, Factors affecting on Electrophoretic Mobility; Types of Electrophoresis; Free electrophoresis and Gel electrophoresis; Electrophoresis in genetic analysis; DNA sequencing and DNA foot Printing.	10
2	**Macromolecules** Introduction, Formation of synthetic high polymers classification, Polymerization reactions: Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion	9
3	**Chemistry of Polymerization** Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts. Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques	9
4	**Electronically Conducting Polymers** Introduction, Theories of electronic conduction; Band theory of conduction, Hopping conduction, Super conduction, Mechanism of conduction, Doping mechanism, p-type, n-type, auto doping, Stimuli sensitive (smart) polymers,	9

	pH and temperature sensitive smart polymers, Applications: Photovoltaic devices, Sensors, LED and Solar cells, Electro chemical devices, Batteries etc.	
5	**Kinetics of Polymerization** Free radical chain polymerization, Anionic polymerization, Cationic polymerization, Copolymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation	8

Text Books:
Polymer Science, Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, New Age International
A Textbook of Polymer Chemistry, M S Bhatnagar, S Chand Publishing
Reference Books:
D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002) McMillan North Publication
L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.
D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication
Polymer Science and Technology. By Premamoy Ghosh.
Cantor, C. R. and Schimmel Biophysical Chemistry Vols. 1-3, W. H. Freeman (1980).95
Online Resources: 1. NPTEL / SWAYAM lectures.

Semester-IV

Course code: MCH43MEP604		**Course name:** Organic High Polymers Lab
Course category: ME		
Credits: 1	**Teaching Scheme: P-2**	**Evaluation Scheme:** CA-30, ESE-20
Pre-requisites: Bachelors degree basic practical chemistry		
Lab Objectives: To study the various methods and techniques of polymerization reactions, their chemistry, mechanism, structures, properties and applications.		
Lab Outcomes: At the end of the course, the students will be able to		
LO1: Prepare the various types of polymers and study their physical / chemical properties.		
LO2: Apply the methods of polymerization reaction for the synthesis of polymers		
LO3: Become fully aware of the stereo chemistry and physical status of polymer molecules, molecular weight, stereo specificity and stability of polymer compounds		

Contents-

List of Practical: (Any ten experiments)

Sr.No.	Title of the Experiment
1.	Polymer Preparation: (any four) 1) Preparation of polyaniline. 2) Preparation of poly (ethylene terephthalate). 3) Preparation of polystyrene by redox method. 4) Preparation of poly(acryl amide) and poly (acrylic acid) copolymers. 5) Preparation of nylon 66/6
2.	Methods of Polymerization: (any three) 1. Redox polymerization synthesis: preparation of poly (acrylamide) by free Radical polymerization 2. Precipitation polymerization of acrylonitrile 3. Suspension polymerization of methyl methacrylate. 4. Emulsion polymerization of methylmethacrylate, polyacrylonitrile
3.	Polymer characterization: (any three) 1. Determination of molecular weight by viscometry (PS-toluene/benzene, Polyacrylamide-aq.NaNO2 solution, Poly (methyl acrylate) - toluene/benzene.) 2. Determination of molecular weight by end group analysis PEG. (OH group). 3. Testing of mechanical properties of polymers. 4. Determination of hydroxyl No. of polymer using colorimetric method.

Reference Book / Hand Books/ Lab Manual
Experimental in polymer science -D.G. Hundiwale, V.D. Athawale, U. R. Kapadi, V.V.Gite., New age International (P) Limited, Pubilishers 2009.
Preparative method in polymer science, Wayne R. Sorenson, Tod W. Campbell
Material Science of Polymers for Engineers, Tim A. Oswald Georg Menges, Hanser Publications, 2012.
Preparative Methods of Polymer Chemistry, Wayne R. Sorenson and T. W. Campbell, 3rd edition, Wiley – Interscience, New York, 2001.

Semester-IV

Course code: MCH43RPJ602		**Course name:** Research Project
Course category: RP		
Credits: 6	**Teaching Scheme: P-12**	**Evaluation Scheme:** CA-60, ESE-40
Pre-requisites: Bachelors degree basic practical chemistry		
Lab Objectives: To provide hands on training to understand research problem to design synthesis of target molecule, characterization and application study		
Lab Outcomes: At the end of the course, the students will be able to		
LO1: Hands on skill of designing multistep synthesis of target molecules in laboratory using simple starting molecules.		
LO2: Optimization of reaction condition and study of role of catalyst, solvent, catalyst loading, atom economy, monitoring of reaction by TLC, isolation of product by work up procedure, column chromatography.		
LO3: Interpret FT-IR, ^{1}H-NMR, ^{13}C-NMR and Mass spectrometry data of the prepared molecules by physical and spectral analysis.		
LO4: Research paper publication.		

List of Practical:

Sr.No.	Title of the Experiment
1.	Student can continue minor research project topic at advanced level as chosen in IIIrd semester or can choose project work topic as per expertise and research thrust area of department faculty members and undertake experimental work on chosen topic. The Major Research Project work should be submitted as Post Graduate Thesis in three (3) copies and should present project work in Viva-Voce examination conducted at the end of semester. **Post Graduate Thesis should contain.** • Introduction: Rationale of research work title along with appropriate literature review which define problem statement. • Aims and objectives of research topic, Scope of topic • Experimental section and Research methods/ Techniques • outcome of project work • References Post Graduate Thesis is to prepare as per template provided by Department of chemistry, School of Basic and Applied Sciences, MGM University.

Syllabus Semester-III (Analytical Chemistry)

Course code:MCH43MML607**Course name:**Applications of Spectroscopy**Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of principle of spectroscopy, interaction of electromagnetic radiation with matter, molecular orbital theory and structure and bonding.
Course Objectives:
4. To learn basic principles of NMR, IR, UV-Vis spectroscopy and mass spectrometry and to use these spectroscopic methods for organic structure elucidation.
5. To determine structural and fuctional moities from complex determination .
Course Outcomes: At the end of the course, the students will be able to -
CO1: Electronic transition, law of absorption, role of solvent, terminology used inUV-Vis spectroscopic techniques.
CO2: IR spectra for identification of functional groups.
CO3: Number and types of carbon atoms present in organic molecules..
CO4:NMR, IR, MS, UV-Vis spectroscopic techniques for structural elucidation.
CO5: Enhancement of Problem solving ability for complex compunds.

Contents –

Unit	Content	Teaching hours
1	**Ultraviolet- Visible Spectroscopy-**Principles of absorption spectroscopy, Electronic transitions, presentation of electronic spectra.chromophores, Auxochromers, Bathochromic and Hypochromic Shifts, Effect of solvent and conjugation on electronic transitions, calculation of absorption maximum(max) on the basis of Woodward-Fieser rules for dienes, enones and aromatic compounds, study of UV spectra of some organic compounds. Applications of UV-Visible Spectroscopy.	10
2	**Infrared Spectroscopy** Fundamental principle, Modes of vibration in polyatomic molecules, overtone and combination bands, Bond properties and absorption trends, Hooke's Law, Infrared spectrometer. Vibrational frequency for various functional groups, factors influencing vibrational frequency, interpretation of IR spectra of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds. Problems based on structural elucidation from FT-IR spectrum.	09
3	**NMR Spectroscopy** NMR phenomenon, spin ½ nuclei, (1H, 13C, 31P and 19F), 1H NMR, Zeeman splitting, effect of magnetic field strength on sensitivity and resolution, chemical shift and shielding, magnetic anisotropy, factors affecting on chemical shift, chemical and magnetic equivalence of spins, spin-spin coupling, types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB,AX,ABX,AMX) spin decoupling, shift reagents, Nuclear Overhauser effect (NOE) 13C NMR Spectroscopy: Elementary ideas, chemical shifts (aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons); Effect of substituent on chemical shifts.	09
4	**Mass spectrometry** Basic principles, ionization techniques, isotope abundance, molecular ion,	09

	fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution MS, soft ionization methods, ESI-MS and MALDI-MS, basic principle of ionization and ion analysis, illustrative examples from simple organic molecules to macromolecules and supramolecules. Structural elucidation problems using the above spectroscopic techniques.	
5	**ESR and Mossbauer Spectroscopy** Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals. **Electron Spin Resonance Spectroscopy:** Principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications	09

Text Books: 1.Organic Chemistry, Clayden, 2nd Edition, 2023, Oxford University Press India .
3. Spectrometric Identification of Organic Compounds , David J. Kiemle, David L. Bryce, Francis X. Webster, Robert M. Silverstein, 8th edition, John Wiley and Sons Inc. 2014
Reference Books: 1.Spectroscopy of Organic Compounds, P. S. Kalsi, 9th Edition, 2022, New Age Publisher.
2. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, Spectroscopy, 9th Indian Edition Cengage Learning, 2011
Online Resources: 1.NPTEL / SWAYAM lectures.
2. Principles and Applications of 1H NMR Spectroscopy , NPTEL Course; https://nptel.ac.in/courses/104108078 **3.** Fundamentals of Spectroscopy, NPTEL Course; https://nptel.ac.in/courses/104106122

Syllabus Semester-III

Course code:MCH43MML614**Course name:**Food Fertilizers & Pesticide Analysis**Course category:** MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: In the complex world of modern agriculture, examining "pesticide analysis in food products" plays a crucial role in ensuring the safety of our global food supply. As the world faces the challenge of feeding a growing population, the widespread use of pesticides and herbicides in agricultural practices raises essential questions about the potential risks of these chemicals
Course Objectives:
4. The main objective of the course is to understand basic principles of various of food content and pesticide.
5. To determine and understand the role of food and fertilizers in living systems.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe basic and advanced concepts of analysis and its applications.
CO2: Identify the food preservatives and fertilizers.
CO3: Analyze the reaction mechanism of analysis food preservatives including structure
CO3: Number and types of carbon atoms present in organic molecules..
CO4: Describe the analysis of fertilizers in biological and their function.
CO5: Importance of the enhancement in food stability.

Contents –

Unit	Content	Teaching hours
1	**Food and importance of food nutrients** **Food:**Food and importance of food nutrients,Energy of food, physical and chemical constituents of food, Food safety considerations. **Food Additives:** General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers,texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour.	09
2	**Food Analysis** Food Contaminants and adultrations: Proximate composition of food and its analysis, Legislation to food. **General Considerations** Analysis of Milk Fat content, proteins, acidity, bacteriological quality and milk adulterants. Control of food adultrations.	09
3	**Fertilizers**: **Introduction to Fertilizers:** Introduction, classification of fertilizers, NPK value, Chemical composition of super phosphates, Lime and potash, Analysis of commercially available fertilizers for NPK.	09
4	**Analysis of Fertilizer-I** Legislation to Pesticides: Legislation and recent amendment to pesticide materials and formulations.	09
5	**Analysis of Fertilizer-II** Names of pesticide and their structures.	09

	Analysis of specific pesticides. Analytical methods to analyze pesticides. Applications of dosage of different pesticides.	

Text Books: 1.Food Analysis, Nelson.ISBN 978-1-4419-1477-4 e-ISBN 978-1-4419-1478-1, DOI10.1007/978-1-4419-1478-1.
2. Analytical Chemistry, Dr. Alka Gupta.Pragati Prakashan, ISBN:: 978-93-89961-19-5
Reference Books: 1.Chemistry Of Pesticides, N. K. Roy. 2017, ISBN 978-8123908540
2. Chemical Analysis of food,Pearson.Volume 65, Issue 4, 1 July 1982, Page 1037
Online Resources: 1.NPTEL / SWAYAM lectures.
2. Prof. Dillip Kumar Swain, NPTL https://onlinecourses.nptel.ac.in/noc23_ag08/https://nptel.ac.in/courses/104106122

Syllabus Semester-III

Course code:MCH43MML615**Course name:**Quality Assurance & Quality Control **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Quality assurance and quality control are both part of quality management. This guide will outline the job roles of quality assurance and quality control, along with the skills, qualifications, salaries, and job outlooks for them.
Course Objectives:
3. To understand basic principals of quality understand role of quality assurance
4. To determine quality control and processes of quality assurance and quality control..
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe basic and advanced concepts of analysis and its applications.
CO2: To identify the industrial processes in quality control department.
CO3: Analyze and understanding quality assurance in various pharmaceutical departments.
CO4: To develop understanding the quality control by industrial prospective.
CO5: Enhancement in the qualifications, salaries, and job outlooks for the respective field.

Contents –

Unit	Content	Teaching hours
1	**Quality Assurance:** Introduction to quality control and quality assurance:Concepts and significance. Quality control and statistical techniques: Quality control charts, the X-quality control chart, the R-quality control chart and its interpretation, spiked sample control charts, use of blind samples in quality control. Uses: Pro efficiency evaluation in quality control.	09
2	**Calibration and maintenance:** Instrument calibration: Linear calibration curves, equipment calibration, frequency of calibration, calibration of common laboratory instruments and equipment. Maintenance of Instruments: Analytical balance, volumetric glassware's, ovens, furnaces, UV/ visible, spectrophotometer, pH meter, conductivity meter, AAS, GC, HPLC.	09
3	**Documentation for quality assurance** Types of notebook: Types of notebooks, control of notebook, distribution and data analysis, data entry. Reagents and volumetric reagents. Sampling: Sampling methods, sample labeling, sample log in register. Sample analysis, reporting, recording, and personal training. Analytical Report: Personel training, record maintenance, filling documentation of assurance.	09
4	Good Laboratory Practices: Reduce error, enhancing both precision and accuracy, customer satisfaction.	09

5	**Laboratory accreditation-** Need of laboratory accreditation, Internal aspects of laboratory accreditation in India, Criteria for laboratory accreditation, Benefits of laboratory accreditation. ISO: Background of ISO, ISO organization, series of ISO, structure of ISO, steps for effective implementations, Significance. Quality management Principals (QMS): Principals for QMS, QMS documentation, Quality manual, Policies for QMS, etc.	09

Text Books: 1.Applying ISO 9000 Quality management systems, Intentional Trade, centre publishing, UNCTAD/WTO Geneva, Switzerland, Indian Edition Printed by D. L. Shah Trust.
2. Handbook of quality assurance for the analytical chemistry laboratory, James P. Dux, van Nostrand Reinhold, New York, 1986 .
Reference Books: 1.Training manuals on ISO 9000/2000 PQM, Girdhar J Gyani,Raj Publishing house, 2001.
2. Quality Assurance in Analytical Chemistry, BW Wenclawiak, Springer, India, 2004.
Online Resources: 1.NPTEL / SWAYAM lectures.
3. NPTL https://archive.nptel.ac.in/courses/110/104/110104080/ **4.** https://www.google.com/search?q=Quality+Assurance+%26+Quality+Control+lectrutre&oq

Syllabus Semester-III

Course code:MCH43MMP610**Course name:**Analytical Chemistry Labcourse-III**Course category:**MM
Credits:2**Teaching scheme:**P-4**Evaluation scheme:**CA–30, ESE–20
Pre-requisites: This course introduces students to the theory and applications of quantitative analytical chemistry. Acid-base reactions, volumetric analysis, and fundamentals of separations science.
Course Objectives:
1. To estimate the different constituent using the chemical methods.
2. To determine qualitative determoination from sample of food, pharmaceutical, water, fertilizer, pesticide, body fluid, etc
Course Outcomes: At the end of the course, the students will be able to -
LO1: Analyse quality of food, fertilizer and water sample
LO2: Identify adulteration in food sample.
LO3: Identification composition and contents of cosmetic material.
LO4: To develop understanding the quality control by industrial prospective.
LO5: Increase the mobility of the student in industries.

Contents –

Sr.No.	Title of the Experiment
1.	Determination of COD and BOD from waste water sample.
2.	Separate and estimate the amount of cadmium and zinc using ion exchange resin.
3.	Estimation of Nitrogen from given sample of fertilizer by Kejaldal method.
4.	Estimation of blood glucose by Folin Wu method.
5.	Estimation of chloride from food sample by Volhard titration method.
6.	Determination of volume strength of commercial hydrogen peroxide using KMnO4
7.	Moisture contenting food sample by Karl-fisher titration method.
8.	Estimation of active chlorine in the given sample of bleaching powder.
9.	Estimation of Mg from given sample of talcum powder.
10.	Estimation of Ca from given sample of chalk powder
11.	Moisture contenting pharmaceutical sample by Karl-fisher titration method.
12.	Estimation of Nitrogen from food sample of fertilizer by Kejaldal method.

Text Books: 1.ExperimentsinchemistrybyD. V. Jahagirdar,Himalayapublication.
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
Online Resources: NPTEL / SWAYAM lectures.
1. https://nptel.ac.in/courses/103108100

Syllabus Semester-III

Course code:MCH43MMP611**Course name:**Analytical Chemistry Labcourse-IV**Course category:**MM
Credits:2**Teaching scheme:**P-4**Evaluation scheme:**CA–30, ESE–20
Pre-requisites: This course introduces students to the quantitative analytical chemistry. Various instrumental techniques known to students for instrumental handling.
Course Objectives:
1. To estimate the different constituent using the chemical methods.
2. To provide hand on training on various analytical instruments
Course Outcomes: At the end of the course, the students will be able to -
LO1: To conduct the experiment on various instrumental techniques
LO2: To give industrial based hand on training and to develop accuracy and precision.
LO3: Identification composition and contents of cosmetic material.
LO4: To develop understanding the quality control by industrial prospective.
LO5: Development and encouragement for the cosmetic industry built up.

Contents –

Sr.No.	Title of the Experiment
1.	Estimation of potassium, from given sample using flame photometric method.
2.	Determination of protein by biureate method using by Spectrophotometric method.
3.	Determine the percentage composition of the mixture by refractometer.
4.	Determination of boric acid by conductometric method.
5.	Determine the Hammett constant of substituted benzoic acid by pH metric method.
6.	Determine the Hammett constant of substituted benzoic acid by pH metric method.
7.	Determination of petroleum hydrocarbons in burn-cases by GC method.
8.	Determine the lactose sugar by HPLC method
9.	Estimation of calcium and sodium from given sample using flame photometric method.
10	Estimationof organic acid by potentiometric techniques
11	Determination of C10 value hydrocarbons in burn-cases by GC method.
12	Determine the drug impurities by HPLC method

Text Books: 1.ExperimentsinchemistrybyD. V. Jahagirdar,Himalayapublication.
2. Indian Pharmacoepia volume –I, II& III
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
2.Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
Online Resources: NPTEL / SWAYAM lectures.
1. https://nptel.ac.in/courses/103108100

Syllabus Semester-III

Course code:MCH43MMP612**Course name:**Analytical Chemistry Labcourse-V**Course category:**MM
Credits:2**Teaching scheme:**P-4**Evaluation scheme:**CA–30, ESE–20
Pre-requisites: This courseconduct the experiments for the determination of oil value, dissolved oxygen value from the unknown samples
Course Objectives:
1. To estimate the different constituent using the chemical method particularly non-instrumental from sample of food, pharmaceuticaletc.
2. To provide hand on training on various analytical instruments water, fertilizer, pesticide, bodyfluid etc.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To conduct the experiment on various instrumental techniques
LO2: Perform environmental analysis like determination of DO, COD.
LO3: Perform titrations to determine the assay of drugs and other commercial preparations
LO4: To develop understanding of water and oil sample analysis.
LO5: Training for the employbility of the pollution board.

Contents –

Sr.No.	Title of the Experiment
1.	Determination of saponification value of oil.
2.	Determination of iodine value of oil.
3.	Determination of iron by chloride extraction by solvent extraction process.
4.	Determination of dissolved oxygen.
5.	Determination of iron in iron tablets.
6.	Simultaneous estimation of chromium (III) and iron (III) by EDTA titrations.
7.	Simultaneous estimation of calcium (II) and zinc (II) by EDTA titrations.
8.	Simultaneous estimation of lead (II) and magnesium (II) by EDTA titrations.
9.	Separation of amino acids/ dyes/ drugs by TLC.
10	Determination of active Mg from cosmatic product
11	Analysis of hardness of industrial water sample
12	Determine the stability of drug

Text Books: 1. Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 199.
2. Indian Pharmacoepia volume –I, II& III
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
2.Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
Online Resources: NPTEL / SWAYAM lectures.
2. https://nptel.ac.in/courses/103108100

Syllabus Semester-III

Course code:MCH43MEL613**Course name:**Chemistry of Nanomaterials**Course category:**ME-III
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: The students are expected to have a knowledge corresponding to the content in the synthesis, properties and structures of solid state materials, or the equivalent, as well as knowledge corresponding to the content in Surface Chemistry, or the equivalent.
Course Objectives:
1. To understand basic and advanced level concepts in nanomaterials
2. To determine role of capping agents and its basic theory and characterization of nanomaterials for large/industrial process.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe basic and advanced concepts of nanomaterials..
CO2: To identify the industrial processes in nanochemistry.
CO3: Understanding of advanced biological/chemical methods for industries.
CO4: To know the mechanistic pathways during electrochemical conversion.
CO5: Encouragement to students for battery, cell application for industry employment.

Contents –

Unit	Content	Teaching hours
1	**General Introduction** Size Effects - difference between bulk and Nanomaterials - Definition of Nanomaterial. **Classification Nanomaterials**: Nanoparticles, Nanocrystal, 0-D Quantum dots, Nanostructured material (1-D Wire and rods, 2-D thin film, 3-D structures) - Carbon nanotubes (CNTs) : Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs) - Graphene. **Proprieties of nanomaterials**: optical, electronic, magnetic and chemical etc.	09
2	**Synthesis of Nanomaterials:** **Synthesis of Nanomaterials**: Synthesis of Nanomaterials: Bottom Up and Top Down Approach - Gas Phase synthesis of Nanomaterials - Wet chemical synthesis - Chemical Vapour Deposition (CVD). **Characterisation of Nanomaterials**: using UV-Visible Spectroscopy, Fluorescence Spectroscopy, Powder XRD, Particle size analysis by Dynamic Light Scattering (DLS), SEM, TEM, AFM techniques.	09
3	**Optical luminescence Nanomaterials**: Optical luminescence and fluorescence from direct, bandgap semiconductor nanoparticles - White LEDs - LEDs based on nanowires - LEDs based on nanotubes- LEDs based on nanorods - High Efficiency Materials for OLEDs -High Efficiency Materials for OLEDs.	09

4	**Energy Applications**: **Renewable Energy Technology** : Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies. **Nanomaterials for Storage:** and devices for energy transport, conversion and storage.	09
5	**Nanomedicine Application** **Nanomaterials in Medicine** : Introduction to Nanocarriers, Interactions of nanocarriers with blood stream, cellular targeting, Biological and chemical reagents for cell-specific targeting - Biodistribution of liposomes, dendrimers and Nanoparticles, **Toxicity of Nanomaterials:** drug delivery, tissue regeneration, cancer detection, Luminescent nanoparticle probes for bio-imaging and diagnostics.	09

Text Books: 1.Fundamentals of Nanotechnology –Gabor L Hornyak, John J Moore, 2009, 786 pages, eBook ISBN9781315222561.
2. Nanotechnology: Principal and practice, Sulabha Kulkarni ISBN 978-9381891261.
Reference Books: 1. NANO- The next revolution- Mohan Surendra Rajan, 2009, pages:179 ISBN: 812374305X
Online Resources: 1.NPTEL / SWAYAM lectures.
1. NPTL https://archive.nptel.ac.in/courses/110/104/110104080/ **2.** https://www.youtube.com/watch?v=1xWBPZnEJk8

Syllabus Semester-III

Course code:MCH43MEL614**Course name:**Isolation, Extraction & Purifications Techniques**Course category:**ME-III
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Purification is the main basis for synthesis of new molecules and drug discovery and to know the proper techniques for isolation and purification the course having importance
Course Objectives:
1. To learn separation,crystallization derivatization of the samples.
2. To determine role of function group detection to separate molecules for isolation and purification.
Course Outcomes: At the end of the course, the students will be able to -
CO1: A student will be able to Isolate and separate synthetic and natural products.
CO2: A student will be able to synthesize natural products.
CO3: The student will be able to do mechanism for the sepration techniques.
CO4: This course will open the door and mobility for students in industry.
CO5: Awareness of sustainable development and green chemistry to students.

Contents –

Unit	Content	Teaching hours
1	**SeparationScience** Membrane separation processes: operating principles andapplications of microfiltration, ultra-filtration, reverse osmosis, dialysisandelectro-dialysis. Applications of Solvent extraction in Analytical Chemistry-recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical determination.	09
2	**Separation,AnalysisandStandardization ofHerbalbasedproducts** Herbs as a raw material: Defination of herb, herbal medicine, herbalMedicinal products, herbal drug preparation. Sources of herbs. Selection, identification and authentication of herbal materials, drying andprocessing of herbal raw materials, drying and processing of herbal rawmaterial. Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction. Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical, Spectral and toxilogical standardization, qualitative andquantitativeesimations.	09
3	**Advanced Techniques** Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers). Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectricfocusing, isotaechophoresis and miceller electro kinetic capillarychromatography, instrumentation, detection and applications.	09

4	**Nanotechnology** Introduction to Nanotechnology: Analytical techniques innanotechnology, consequences of the nanoscale, (nanoparticlesmorphology, electronic structure, optical properties) one dimensional nanomaterials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots).	09
5	**Green Chemistry** Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity. Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents. Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. Designing Greener Processes: Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring.	09

Text Books: 1.Research Methodology:Methods &Techniques byC R Kothari, 2e, Wishwa Publication, New Delhi.

2. Research Methodology by D K Bhattacharyya, 1e, Excel Books, New Delhi, 2003

3. Solvent extraction and ion exchange,J Marcus and A. S. Kertes WileyINC1969.

Reference Books: 1. Extraction Chromatography,T.Braun,G.Ghersene, ElsevierPublications1978.

2.Green chemistry and catalyst, R.A.Sheldon, Isabella Arends,UlfHanefeld Wiley V CHverlag GmBH & co.

3. Sustainableresidentialdevelopment:planninganddesignforgreenneighborhoods.AviFriedman, McGraw Hill professional

Online Resources: 1.NPTEL / SWAYAM lectures.

1. https://archive.nptel.ac.in/courses/102/103/102103013/

Syllabus Semester-III

Course code:MCH43MEL61**Course name:**Cosmetic Analysis**Course category:**ME-III
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Analytical methods for shampoo, skin-cream and toothpaste, Indian standards, Drugs and cosmetic act, standards for heavy metals in cosmetics, standards for coloring agents in cosmetics, list of colours permitted to be used in soaps, types of toothpaste, general requirements etc.
Course Objectives:
1. To understand the chemistry of commonly used chemicals (raw materials) in cosmetics.
2. To determine physical & chemical reactions and their structure involved in their application.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Formulate and evaluate various cosmetic product.
CO2: Know the key components used in different cosmeceutical products.
CO3: Recognize the role of ingredients and herbs used in cosmeceutical products.
CO4: Know the advanced current technology used for manufacturing the cosmetics at lab scale and industry scale.
CO5: Development and encouragement for the cosmetic industry built up.

Contents –

Unit	Content	Teaching hours
1	**Cosmetics** Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis. **Deodorants and antiperspirants**: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.	09
2	**Face powder and Hair tonic:[11]** Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).	09
3	**Hair tonic:** 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers).	09
4	**Creams and Lotions:** Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy)	09
5	**Lipsticks:** General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents.	09

Text Books: 1.Connors Text book of pharmaceuticals Analysis, J wiley Wiley, 1967 - Analytical chemistry - 614 p.
2. Hand book of drug law, Mehta Univ. Book agency Ahmedabad, University Book

Agency, 1997, 1557, 9.
Reference Books: 1. Analytical Biochemistry, D, J. Homes and H. Peck, Longman (1983)
2.Bioanalytical Chemistry, S. R. Mikkelesen and E. Corton, John Wiley and sons 2004
3. Analysis of food and beverages, George Charalanbous, Accademic press 1978.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. http://digimat.in/nptel/courses/video/127106137/L03.html

Syllabus Semester-III

Course code:MCH43MEP605**Course name:** Analytical Chemistry Lab-VI **Course category:**ME-III
Credits:1**Teaching scheme:**P-2**Evaluation scheme:**CA–30, ESE–20
Pre-requisites: The paper of Ion-exchange chromatography is being covered along with its instrumentation and a brief insight into its various applications in today's world. This topic comes under the broad field of Bioinstrumentation
Course Objectives:
1. To understand various fundamental concepts of analytical chemistryc.
2. To provide hand on training on various analytical instruments and quantitative analysis concern.
Course Outcomes: At the end of the course, the students will be able to -
LO1: To conduct the experiment on various instrumental techniques
LO2: Toapply ion-exchange chromatography principle for separation of cations.
LO3: Perform titrations to determine the assay of drugs and other commercial preparations
LO4: To apply kjeldhal's method for determination of total nitroge.
LO5: Enhancement of industry mobility for job.

Contents –

Sr.No.	Title of the Experiment
1.	Determination of the capacity of an cation exchange resin.
2.	Separation of Zn^{2+} and Mg^{2+} from a mixture by ion-exchange chromatography.
3.	Separation of Ni^{2+} and Fe^{3+} from a mixture by ion-exchange chromatography.
4.	Separation of Co^{2+} and Ni^{2+} from a mixture by ion-exchange chromatography.
5.	Estimation of ammoniacal nitrogen and total kjeldhal nitrogen by kjeldhal's method.
6.	Determination of the capacity of an anion exchange resin.
7.	Estimation of alcohols in a given mixture using gas chromatography
8.	Estimation of protein in food samples
9.	Analysis of Dolomite ore
10	Determination of Aspirin.
11	Analysis of water soluble ash in Ginger
12	Estimation of Nicotine from given sample

Text Books: 1. Analytical Chemistry Practice, John H. Kennedy, Saunders College Publishing, Second Edition 199.
2. Indian Pharmacoepia volume –I, II& III
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
2.Practical Pharmaceutical Chemistry, 4th Ed. part-2, Beckette, Stenlake.
Online Resources: NPTEL / SWAYAM lectures.
1. https://nptel.ac.in/courses/103108100

Syllabus Semester-III

Course code:MCH43RPJ603**Course name:**Research Project **Course category:**RP
Credits:4**Teaching scheme:**P-8**Evaluation scheme:**CA–60, ESE–40
Pre-requisites: Student can choose project work topic as per expertise and research thrust area of department faculty members and undertake experimental work on chosen topic and present work in Viva-Voce examination and should submit project report which should contain.
Course Objectives:
1. To understand various fundamental concepts of analytical chemistry understand research problem to project work.
2. To provide hands on training to design synthesis and analysis of target molecule..
Course Outcomes: At the end of the course, the students will be able to -
JO1: Skill to searchliteratureonselectedresearchorientedproject work.
JO2: Identify the advances in current research.
JO3: Perform and conduct experiments scientifically with safety
JO4: Interpret FT-IR, XRD,SEM, TEM, XPS and Mass spectrometry data of the prepared molecules by physical and spectral analysis.
JO5: Overall skill enhancement and accuracy in the practicals.

Contents –

Sr.No.	Title of the Experiment
1.	Introduction: Literature review and to Limitation of existing work , Aims and objectives of research topic, Scope of topic
2.	Experimental section and Research methods/ Techniques
3.	outcome of project work
4.	References

Text Books: 1.Literature servery
Reference Books: 1.Quantitative Inorganic Analysis including Elementary Instrumental Analysisby A.I.Vogels.
Online Resources: NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/103/106/103106071/

Syllabus Semester-IV

Course code:MCH43MEL617**Course name:**Advanced Instrumental Methods of Analysis **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Topics in analytical instrumental analysis, atomic spectroscopy, X-ray spectrometry, mass spectrometry, UV-visible spectroscopy, luminescence, infrared, Raman, and nuclear magnetic resonance spectroscopy.
Course Objectives:
1. To understand the advanced instruments and its basic principles with methods of analysis.
2. To understand the theoretical concepts ofinstrumental analysis for structure determination.
Course Outcomes: At the end of the course, the students will be able to -
CO1: To identify and aware the handling of advanced instruments.
CO2: Recognize the role of ingredients and herbs used in various industries.
CO3: Know the advanced current technology used at lab scale and industry scale.
CO4:brief knowledge of the chromatographic techniques.
CO5: Employable skills and high technical competence for Pharmaceutical Industry.

Contents –

Unit	Content	Teaching hours
1	**Gas Chromatography** Introduction, principles of gas-liquid chromatography, instrumentation-Carrier gas, Sample Introduction system, columns, detectors, substrates, temperature control, evaluation Retention volume, resolution, branches of gas chromatography, applications, numericals. **High Performance Liquid Chromatography:** Principle, instrumentation - column, column packing, mobile phone, pumping system, detector system, practical procedure, applications, HPLC adsorption and partitionchromatography.	09
2	**Hyphenated Techniques** Introduction, Need for hyphenation, possible hyphenation, Interfacing devices andapplications of the following: LC-MS, GC-IR, GC-MS,ICP-MS, MS-MS.	09
3	**Molecular Luminescence Spectrometry:** Theory of fluorescence and phosphorescence, Instruments for measuring fluorescenceand phosphorescence, Applications of photoluminescence methods,Chemiluminescence	09
4	**Surface Characterization by Spectroscopy and Microscopy:** Introduction to the study of surfaces, Spectroscopic surface methods, Ion spectroscopictechniques, Surface photons spectroscopic methods, Electron stimulatedmicroanalysis methods, Scanning probe microscopes	09

5	**Supercritical Fluids** Properties of Supercritical Fluids, Supercritical Fluid Chromatography, Supercritical Fluid Extraction.	09

Text Books: 1.Connors Text book of pharmaceuticals Analysis, J wiley Wiley, 1967 - Analytical chemistry - 614 p.
2. Instrumental methods of analysis – B. K. Sharma.,2005.
Reference Books: 1**.** Instrumental Methods of Analysis–Willard, Merritt, Dean & Settle.
2.Instrumental Analysis- Skoog, Holler, Crouch.6 th edition
3. Principles of Instrumental Analysis–Skoog, F.J.Holler & J.A.Nieman
4. Instrumental Methods of Chemical Analysis–Galen W. Ewing
5.Wilson and Wilson Compressive Analytical Chemistry. Ed. G. Svehla, A series.
6. Fundamental of Analytical Chemistry,-D.A. Skoog, D.M.West and F.J. Holler.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. http://acl.digimat.in/nptel/courses/video/103108100/L15.html

Syllabus Semester-IV

Course code:MCH43MML618**Course name:**Pharmaceutical & Forensic Analysis **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: This unique interdisciplinary programme provides students with detailed knowledge and understanding of forensic, analytical, and pharmaceutical science.
Course Objectives:
1. To understand basic principles with methods of analysis for provides students with detailed knowledge for pharmaceutical and forensic analysis.
2. To understand the important compound of drugs and their types.
Course Outcomes: At the end of the course, the students will be able to -
CO1: To explain the forensics sampling and analysis.
CO2: Describe the explosives and their analysis.
CO3: Understanding and benefited from pharmaceutical analysis.
CO4: Determination of tests for the analysis of pharmaceutical products.
CO5: The mobility enhancement in the battary industries for students.

Contents –

Unit	Content	Teaching hours
1	**Pharmaceutical Analysis-I** General idea regarding pharmaceutical industry, Definition and classification ofdrugs, types of dosage forms. Introduction topharmaceutical formulations,Sources of impurities in pharmaceutical chemicals, raw materials & Products,Shelf life of pharmaceutical product and its determination,stability studiesStandardization of finished products& their characteristics, **Linit Tests** Limit tests of As, Hg, Pb, Fe, Chlorides, and sulphates. Solubility tests, dissolution test, disintegration tests.	09
2	**Pharmaceutical legislation** Introduction to drug acts, drug rules,FDA ISI, Agmark and other standard forpharmaceuticals& cosmetics particularly w.r.t. the testing of drugs, and raw materialconcerned.	09
3	**Pharmaceutical standards:** Pharmaceutical standards IP/BP/USP//EP. Cosmeticstandards,Documentation, Record Keeping. Contents of labels, Types of packagingmaterials,Intellectual property rights: Introduction, role of patents in the pharmaceuticalindustry, recent changes, some case studies.	09
4	**Pharmaceutical Analysis-II** Assay of main classes of drugs as per IP with reference to Introduction, Type, Properties, Modeof action and Methods of Analysis.	09
5	**Forensic Analysis** Introduction, Special features of forensic analysis, Sampling, Sample storage, Sampledissolution. Toxicology: Classification of poisons and poisoning, Lethal Dose, Significance ofLD50 and LC50. Extraction methods in toxicology: Isolation, Identification and determinations of: Narcotics: Heroin, Morphine, Codeine. Stimulants: Caffeine, Cocaine, Amphetamines.	09

	Despressant: Benzodiazepines- Diazepam, Oxazepam, Nitrazepam. Barbiturates- Phenobarbitone, Amylobarbitone, Pentobarbitone, Thiopentone. Hallucinogens: LSC andCannabis.	

Text Books:	1.Isolation and Identification of drug-n E. G. Clarke vol.- I, 1986.
	2. Laboratory procedure manual-Forensic Toxicology- Directorate of forensic science, MHA Govt. of India. 1998.
Reference Books: 1. Bioanalytical Chemitry,S.R. Mikkelsen and E. Corton, John Wiley and Sons.	
2. Immunoassay – a practical guide Eds,D.W.Chan and M.T.Perlstein, Academic Press.	
3. Hawk's Physiological Chemistry, McGraw Hill.	
4. Standard Methods of Biochemical Analysis, S.R. Thimmaiah	
5. Biochemical methods, S. Sadasivam, A .Manickam	
6. Fundamental of Analytical Chemistry,-D.A. Skoog, D.M.West and F.J. Holler.	
Online Resources: 1.NPTEL / SWAYAM lectures.	
1. https://nptel.ac.in/courses/104102113	

Syllabus Semester-IV

Course code:MCH43MML619	**Course name:**Electro-Analytical Techniques **Course category:**MM
Credits:3	**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Potentiometry passively measures the potential of a solution between two electrodes, the solution very little in the process. One electrode is called the reference electrode and potential, while the other one is an indicator electrode whose potential changes with the sample's composition.	
Course Objectives:	
1. To understand advanced level, the theories and causes behind concept with role of various electro-anyaltical aspects.	
2. To identify processes in the electrochemistry prospective.	
Course Outcomes: At the end of the course, the students will be able to -	
CO1: Describe basic and advanced concepts of electrochemistry.	
CO2: To identify the industrial processes in electroanalytical parameters.	
CO3: Understanding of Electrode/electrolyte interface for various pharmaceutical industries..	
CO4: Analytical skills for the mechanistic pathways for the electrochemical processes.	
CO5: The mobility enhancement in the battary industries for students.	

Contents –

Unit	Content	Teaching hours
1	**General Introduction** Overview of Electrodes: Electrode processes, Types and construction of Electrode, Glass electrode, Ion selective electrode, Solid state electrode, Liquid-Liquid electrode, Enzymes and gas electrode. Applications of Electrodes: Ion selective electrode, Referance electrode, Mercury electrode, etc.	09
2	**Coulometry and High frequency titrations:** Coulometry: Introduction, Principle, Technique, Coulometry at constant current and coulometry at controlled potential, Coulometric titration, Flowing stream coulometry,,Stripping analysis,Applications High frequency titration: Introduction, Theory and instrumentation, High frequency titrimetry, Types of cells, Advantages of high frequency methods, Applications.	09
3	**Polarography**: Theory and origin of polarography, Interpretation of pornographic curves, Instrumentation of polarography, Differential pulse polarography, Factors affecting on polarographic wave.	09
4	**Cyclic voltammetry**: Introduction and beginning of cyclic voltammetry, Range of cyclic voltrametric techniques. The acceptable sweep rate range, The shape of the peak in potential sweep curves, The role of non- aqueous solution in cyclic voltammetry, Crieteria of	09

	reversibility of electrochemical reactions, Quasi reversible and irreversible processes, Qualitative and quantitative analysis by cyclic voltametric techniques, Linear sweep voltammetry for reactions that include simple adsorbed intermediates, Amperometric titrations, Chronoamperometry, Chronopotentiometry and others Numericals.	
5	**Electro-Gravimetry and Electrophoresis:** **Electro-Gravimetry**: Introduction, Theory of electrogravimetry, Instrumentation,Electrogravimetric determination with constant applied voltage and constant current, Applications of electrogravimetry, Problems based on effect concentration on electrode potential, Calculation of therotical potential, Effect of pH in electrolytic separation, Numericals **Electrophoresis:** Introduction, Paper electrophoresis Principle, Experimental techniques, Factors governing migration of ions, and Applications, Numericals.	09

Text Books: 1.Vogel's textbook of quantitative chemical analysis - Mendham, Denney,etc.
Reference Books: 1. Quantitative analysis -. Alexeyev. V
2. Instrumental methods of analysis – Chatwal and Anand.
3. Introduction to instrumental analysis – R. D. Braun.
4. Instrumental methods of analysis – Willard, Meritt, Dean and Settle.
5.Electroanalytical chemistry – H. W. Neurenberg.
6. Fundamental of Analytical Chemistry,-D.A. Skoog, D.M.West and F.J. Holler.
7. Principles of Instrumental Analysis–Skoog, F. J. Holler & J. A. Nieman.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://www.youtube.com/watch?v=GPWG0Q_92Zc

Syllabus Semester-IV

Course code:MCH43MML620**Course name:**Green Chemistry & Biorefinary Techniuques **Course category:**MM
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Green Chemistry and Biorefinery concepts are two approaches helping to develop new and more sustainable processes. .
Course Objectives:
1. To understand green chemistry and sustainability related to environmental aspects.
2. To identify processes in the biorefinary techniuques.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe classification of biomass.
CO2: Describe Physical conversion methods of biomass
CO3: Apply green auxiliaries in biofuel synthesis.
CO4: Use of the studies towards bio waste to usable materials.
CO5: Enhancement of the biorefinary industries.

Contents –

Unit	Content	Teaching hours
1	**Introduction** Biomass, classification of biomass, characteristics of biomass, composition of biomass.	09
2	**Properties and Classification of Biomass**, Classification of Conversion Technologies. Waste agricultural biomass, Types and composition, moisture content, energy content.	09
3	**Physical conversion of biomass** Sizing, separation, drying, dewatering, densification, factors affecting the densification, densification technologies, torrefaction,. thermochemical conversion of biomass, combustion, stages of combustion, Industrial combustion modes.	09
4	**Activated carbon from agriculture waste** Sources of agriculture waste, Preparation of activated carbon, process, types of charcoal Kiln, factors influencing charcoal yield, surface area, BET Analysis, pore size, characterization and application of activated carbons, Gas-Phase applications, liquid-Phase applications, Treatment of textile effluents, textile dyes, classification of textile colorants.	09
5	**Biofuels from agriculture waste** Ethanol production by fermentation, sugar fermentation, starch fermentation, enzymatic hydrolysis, acid hydrolysis, factors that influence the ethanol	09

	fermentation.Production process, transesterification reaction, types of esterification, catalysts for biodiesel Production, catalytic transesterification, acid catalyzed transesterification.	

Text Books: 1.Green chemistry and the biorefinery concept, A Morais & R Bogel-Lukasik 2013, Sustainable Chemical Processes
1. Reference Books: 1. Technologies for converting waste agricultural biomass to energy- UNEP, Division ofTechnology,IndustryandEconomicsInternationalEnvironmentalTechnologyCentre, Osaka.
2. Green Chemistry-Designing Chemistry for the Environment. Paul T. Anastas & Tracy C.Williamson.
2. Green Chemistry- Environment friendly alternatives. Rashmi Sanghi & M. M. Srivastava.
3. BiodieselProduction Technology J.Van Gerpen, B.Shanks,and R. Pruszko,D. Clements,G.Knothe,K.ShaineTyson
4. Green Chemistry-Environmentally benign reactions. V. K. Ahluwalia. Ane Books India
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://onlinecourses.nptel.ac.in/noc22_ch28/preview

Syllabus Semester-IV

Course code:MCH43MEL616**Course name:**Analysis of Ores, Alloys & Minerals **Course category:**ME-IV
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Metallurgy is the process in which the extraction of the metals are done to obtain the crude metal from their ores is defined as metallurgy.
Course Objectives:
1. To develop analytical methods for identification and quantification of composition of various ores,alloys,and cosmetic material.
2. To identify the mechanistic pathways for the respective analysis of ores and alloys.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Various process in isolation, extraction and purification of metals from ores. Composition of cosmetic materials,cement and glass.
CO2: To identify the industrial applications for analysis.
CO3: Identify various process in analysis.
CO4: Checking of purity of ores and alloy products.
CO5: Ores and alloy industries mobility enhancement .

Contents –

Unit	Content	Teaching hours
1	**General Principles of Metallurgy** Introduction to metallurgy, types of metallurgy, ores and minerals, metallurgical process, concentration of ore, calcinations, rosting, smelting. Thermodynamics of metallurgy and Ellingham diagram, extraction of Zn, Fe, Cu, Al from there ores. Refining and purification techniques zone refining	09
2	**analysis of ores and Alloys** Composition , Ilminite, Zinc blend, hematite, pyrolusite andcalciteforthemajorconstituentsusingoneofthe standard methodsofanalysis. Composition, Properties, uses and analysis of: Brass,BronzeSolder, Stainless Steel,Monel-metal, gun-metal, Silver coin for their major constituents using one of the standardmethodsofanalysis	09
3	**Analysis of Coal, Cement, flux, glass and ceramics** (a) Coal analysis –proximate and ultimate analysis. (b) Chemical Analysis of cement-silica, ferric oxide, alumina, lime, magnesia. Sulphide Sulphur (H_2S/S), K_2O, Na_2O, loss on ignition (c) Analysis of fluxes & Slag- limestone and dolomite, Blast furnace slag. Introduction to glass and ceramic materials and their analysis.	09
4	**CosmeticAnalysis. -I** **Cosmetics:** Introduction, Evaluation of cosmetic material and raw material and additives. Fromulation, standards and methods of analysis. **Deodorants and antiperspirants:** Al, Zn, Zr, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea	09

5	**CosmeticAnalysis. -II** **Hair tonic**: 2,5-diaminotoluene, potassium bromates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers) **Creams and lotions**: types of emulsions, chloroform soluble material, glycerol, pH emulsion, ash analysis, non volatile matter by IR spectroscopy.	09

Text Books: 1.The Analysis of Copper and its Ores and Alloys Paperback, 2023
Reference Books: 1. D. Hutchison, P.G.Jeffery,Chemicalmethodsofrockanalysis,3rd Edition -January 1, 1981 eBook ISBN: 9780080984803
2. Marvin Balsam, Edward Sagarin, Cosmetics Science and Technology - Vol. 1, 2008, Wiley, India Edition.
3. B.C. Agarwal and S.P. Jain, Metallurgicalanalysis, 1996, 8th edition, ISBN: 978-81-7409-135-2
4. Puri, Sharma, Kalia, Princiles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co. ISBN: 978-93-82956-96-9
Online Resources: 1.NPTEL / SWAYAM lectures.
1. http://www.digimat.in/nptel/courses/video/105105170/L01.html

Syllabus Semester-IV

Course code:MCH43MEL617**Course name:**Environmental and Industrial Material Analysis **Course category:**ME-IV
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Environmental testing and analysis services are businesses specializing in evaluations that determine the composition of soil, water, and air samples.
Course Objectives:
1. To understand basic concept of environment and industrial materials in various aspects with distinct processes in the analysis of materials.
2. To identify the mechanistic pathways for the respective analysis of environmental pollutantant.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describebasic and advancedconceptsofEnvironmental Chemistry.
CO2: To identify the industrial processes via material analysis with steps.
CO3: Identify various process in analysis.
CO4: Determination of mechanistic pathways for material analysis.
CO5: Enhancement of the mobility of students in industry.

Contents –

Unit	Content	Teaching hours
1	**General Introduction** **Aim and objective**: General Introduction of Analysis, Need of Analysis. Introduction to natural fats and oils. **Analysis of oils and fats:** Analysis of oils, fats, soaps and detergents, Softning point, Titre point, cloud point, Polenske value, Elaiden test. Saponification number. Iodine number and acid number. **Analysis of Soap**: Introduction to soaps, analysis of soap (saponifiable and unsaponifiable), estimation of free alkali in soap.	09
2	**Analysis of Dyes and Paints** **Composition and analysis of paints :** Analysis of Dyes and Paints Types of dyes and their analysis, Composition and analysis of paints - determination of volatile and non-volatile constituents, flash points, separation of pigments, estimation of binders and thinners, total lead, lead chromate.	09
3	**Analysis of detergents**: Scope of and Aim of the Subject, introduction of detergent, Classification of detergents: Analysis of active ingredients from detergents, estimation of CMC, chlorides and total phosphates	09
4	**Assessment of Water Quality:** Water Quality: Sources of water, sampling procedure of water and waste water, classification of water for different uses, types of water pollutants and water quality	09

	standards for drinking water. Analysis of Water: Analytical methods for the determination of the following ions in water: Anions: CO32- , HCO3- F - ,C1- ,SO42- , PO43- ,NO3 ,NO2 - , Cations: Fe2+ ,Fe3+, Ca2+, Mg2+, Cr3+, , Determination of Dissolved Oxygen (D.O), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).	
5	**Assessment of Air Quality:** Assessment of Air Quality &soil : Composition of pure air, classification of air pollutants, sources of air pollutants, sampling of air, standards for ambient air quality. Chemical analysis: Carbon monoxide (CO), Sulphur dioxide (SO2), Hydrogen Sulfide (H2S), Nitric oxide (NO). Particulate matter - Suspended particulate matter(SPM) and Ozone Analysis of soils: Sampling, determination of moisture, total N, P, Si, CaCO3, organic carbon and alkali metal ions	09

Text Books: 1.A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
2. S. L. Chopra and J. S. kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers,
Reference Books: 1.L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi..
2. S. M. Khopkar, Environmental chemistry, Environmental pollution analysis137
3. Environmental chemistry-B.K. Sharma.Goel publishing house Meerut
4. M. S. Creos and Morr, Environmental chemical analysis, American publications.
5.R. Gopalan and Amrutha Anand, "Environmental chemistry laboratory manual Emerald.
6.Standards for water for drinking and other purposes, Beaurau of Indian Standards India.
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/103/107/103107215/

Syllabus Semester-IV

Course code:MCH43MEL618**Course name:**Polymer and Petrochemical Analysis**Course category:**ME-IV
Credits:3**Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: This course provide a generalized understanding to the polymer process engineering. First, a brief introduction about several polymers, their classification, and characterization techniques is provided.
Course Objectives:
1. To understand basic concept of polymer and petroleum products with role of polymers in various aspects.
2. To identify the applicability of polymer and petroleum products in various aspects.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describebasic and advancedconceptsofpolymer.
CO2: To identify the industrial processes via petroleum and polymer with steps.
CO3: Understanding the calorific value, flash point etc properties of fuels.
CO4: Development the polymer and petroleum products.
CO5: Enhancement of employment mobility in petroleum industries.

Contents –

Unit	Content	Teaching hours
1	**General Introduction** Aim and objective: General Introduction of Analysis, Need of Analysis. Introduction to polymer. Brief history to polymer, classification of polymer,how polymer are made.	09
2	**Analysis and testing of polymer:** Chemical analysis of polymer: X-ray diffraction analysis, thermal analysis, TGA, DTA. Physical testing of polymers: Mechanical properties, Fatigue testing, impact testing, tear resistance,hardness, abrasion resistance. Thermal properties: Softing temperature, flammability. Optical properties: Transmittance,color, gloss, haze and transparency.	09
3	**Polymer analysis-molecular weight and size measurement** Kinetics of polymerization ,Molecular mass, Number and mass average molecular mass, Molecular mass determination by osmometry, Viscometry, light scattering and Sedimentation methods, End group analysis, colligative properties measurements,solution viscosity and molecular size, Numericals	09
4	**Fuel**: Introduction: Introduction, calorific value. Determination of calorific value. Modern concept of fuels. Classifications of fuels: criterion of selection of fuels, properties of fuels. Method of processing. Solids fuels, Natural solid fuels, Artificial solid fuels, Industrial solids fuels .Formation of coal properties of coal,Classification of coal, coking and	09

	noncoking coals. pulverised coal. Role of sulphur and ash in coal, approximate analysis, Ultimate analysis, Numerical.	
5	**Petroleum:** Introduction: Occurrence, mining of petroleum. Prospecting colour and consistency. Origincomposition, classification,terms related to petroleum. .Distillation of crude petroleum. Treatment of the residual liquid, Determination of flash point. Determination of aniline point, Knocking and Anti-knocking compounds. Octane number Cetane number,Numericals.	09

Text Books: 1.Text Book of polymer science By F.W.Billmeyer, New York: Wiley.
Reference Books: 1.Physical polymer science by L.H .Sperling wiley –Interscience New York.
2. Fundamentals of polymer science & Engineering By A Kumar & S.K.Gupta,Tata mcgraw Hill
3. Introduction to polymer science,V.R.Gowarnikar, N.V.Vishwanathan & J. Industrial Chemistry, B. K. Sharma, Goel publishing House Meerut
4. Kent, Rieg's Industrial chemistry, Rain hold.
5.Handbook of Instrumental Techniques for analytical chemistry. Frank Settleeditor
6.Polymer science by Vasant Govarikar, Wiley Earstewen. New York.
7.Principle of polymer science, Behadhar and Sastri, Narosa Publishing house
Online Resources: 1.NPTEL / SWAYAM lectures.
1. https://archive.nptel.ac.in/courses/104/105/104105124/

Syllabus Semester-IV

Course code:MCH43MEP605**Course name:**Analytical Chemistry Lab-VII**Course category:**ME-VII
Credits:1**Teaching scheme:**P-2**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Prepare the theory and basic safety practices with manual of handling of instruments.
Course Objectives:
1. To prepare advanced instrumental lab practice in the industry and lab.
2. To provide hand on training on various analytical instruments and its applications in chemical analysis.
Course Outcomes: At the end of the course, the students will be able to -
LO1: The enhancement of skills on the various instrumental techniques.
LO2: To identify the industrial processes via instrumental practices with steps.
LO3: Understanding of the principles behind the experiment performed in the laboratory.
LO4: The industrial based hand on training and to develop accuracy and precision.
LO5: Awareness of pharmaceutical process and employment mobility enhancement.

Contents –

Sr.No.	Title of the Experiment
1.	Analysis of potassium/sodium by flame photometry
2.	Determination of drug impurities by HPLC
3.	Estimation of redox properties of metal ions by Cyclic volumetric techniques
4.	Determine the concentration of ascorbic acid by Linear Sweep voltametry
5.	Determination of resistance in metal/metal ion/metal complex / nanomaterials/ by Impedance spectroscopy
6.	Determination of oxidative performance of drug by cyclic voltametry
7.	Estimation of number of heavy metal ions from soil sample
8.	Analysis of milk adherents/adulterants
9.	Determination of percentage purity of methylene blue indicator.
10.	Estimation of fluoride in a tooth paste
11.	Analysis of lactose in milk
12	Determination of alcoholic beverages (Beer) for alcohol content.

Text Books: 1.Practical Pharmaceutical Chemistry by A.H. Beckett and J.B. Stenlake.
Reference Books: 1.Physical polymer science by L.H .Sperling wiley –Interscience New York.
2. Practical Electro-Chemistry, by Professor Dr. Loutfy H . Madkour
Online Resources: 1.NPTEL / SWAYAM lectures.
1. http://www.digimat.in/nptel/courses/video/103101111/L01.html

Syllabus Semester-IV

Course code:MCH43RPJ604**Course name:**Research Project **Course category:**RP
Credits:06**Teaching scheme:**P-12**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Student do research thrust area of department faculty members and undertake experimental work on chosen topic and present work in Viva-Voce examination and should submit project report which should contain.
Course Objectives:
1. To provide hands on training to understand research problem to design synthesis and analysis of target molecule.
2. To perform analysis of compounds/ materials and application in respective research area concern.
Course Outcomes: At the end of the course, the students will be able to -
JO1: Skill to searchliteratureonselectedresearchorientedproject work with identification of advances in current research area.
JO2: Interpretation of FT-IR, XRD,SEM, TEM, XPS and Mass spectrometry data of the prepared molecules by physical and spectral analysis.
JO3: The application in respective research area concern for further research development..
JO4: Submission of the thesis and publish the work in reputed journal.
JO5: Overall development of research skills and knowledge for bright research carrier

Contents –

Sr.No.	Title of the Experiment
1.	Introduction: Literature review and to Limitation of existing work , Aims and objectives of research topic, Scope of topic
2.	Experimental section and Research methods/ Techniques
3.	outcome of project work, application
4.	Report preparation/publish article in reputed journal
4.	References

Text Books: Not applicable.
Reference Books: 1.Literature servery based on topic for project.
Online Resources: 1.NPTEL / SWAYAM lectures.
International peer reviewed research journals as per the project title and area of the work undertaken.

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MML621 **Course name:** Structural elucidation by spectral methods **Course category:** Major Mandatory
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Understanding of general methods of spectroscopy for the production and analysis of a spectrum. Calculation, problems, and their solutions related to spectroscopic data.
Course Objectives:
1. The theoretical understanding of Nuclear Magnetic Resonance Spectroscopy, Mass spectrometry, Mössbauer, and Electron Spin Resonance.
2. The application of these techniques in identifying unknown molecules or compounds.
Course Outcomes: At the end of the course, the students will be able to-
CO1: Spectral and structural analysis of inorganic and organic compounds using various spectroscopic techniques.
CO2: Application of given spectroscopic methods for determination and elucidation of structure of chemical compounds.
CO3: Structure depiction of the chemical compounds through application of molar mass and various fragmentation techniques.
CO4: Learning and application of Mössbauer for the structural determination of inorganic compounds specifically Metal complexes and organometallic compounds.
CO5 Learning and application of ESR spectroscopy for the structural determination of inorganic compounds specifically Metal complexes and organometallic compounds.

Course Contents

Unit	Content	Teaching hours
I	**^{1}H Nuclear Magnetic Resonance Spectroscopy** Elementary ideas (Recapitulation); Spin-spin couplings, Different types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB, AX, ABX, AMX), Rate processes, spin decoupling, shift reagents, Nuclear Overhauser effect (NOE), INEPT and INADEQUATE.	12
II	**^{13}C Nuclear Magnetic Resonance Spectroscopy** Elementary ideas, instrumental problems, chemical shifts (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbons); Effect of substituents on chemical shifts.	8
III	**Mass Spectrometry** Introduction, ion production (EI, CI, FD and FAB), ion analysis, ion abundance, factors affecting on fragmentation, fragmentation of different functional groups, molecular ion peak, isotopic peaks, metastable peak, Nitrogen rule, McLafferty rearrangement, Retro-Diels-Alder reaction.	8
IV	**Mössbauer spectroscopy** Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds (temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes).	8

V	**Electron Spin Resonance Spectroscopy** Introduction, principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications.	9

Text Books:	○ Text book of spectroscopy by Jyotikumar, 2009, Sonali publication
Reference Books:	1. Understanding NMR-Spectroscopy (2nd Edition), Wiley Publisher by James Keeler.
	2. Spectroscopy by H. Kaur, PragatiPrakashan
	3. Analytical Spectroscopy by James Very, Pacific Book Int.
	4. NMR Spectroscopy by Harald Gunther Wiley.
	5. Handbook of Instrumental Techniques for Analytical Chemistry by F. Settle Pearso Edu.
	6. Introduction to Spectroscopy (3rdEdition) by Pavia LampmanKriz: Cengage.
	7. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Hiamalaya Publishing House.
	8. Spectroscopy of Organic Copmpounds, P.S. Kalsi, New Age International Ltd.
	9. Analytical Spectroscopy by James Vergeese.
	10. Organic Spectroscopy by William Kemp.
	11. Spectrometric Identification of Organic Compounds. (6th Edition) by Robert M. Silverstein
	12. & Francis X. Webster, Wiley.
	13. Organic Spectroscopy: Principles and Applications, 2nd Edition by Jag Mohan, Alpha
	14. Science International Ltd., Harrow U. K.
Online Resources:	1. https://nptel.ac.in/courses/104106075
	2. https://onlinecourses.nptel.ac.in/noc24_cy16/preview

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MML622 **Course name:** Solid state chemistry **Course category:** Major Mandatory
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Understanding and classification of solids and the calculations required to identify different voids through the applied formulas.
Course Objectives:
1. To understand the general principles, properties, classification and identification.
2. Various laboratory preparation methods of solids.
Course Outcomes: At the end of the course, the students will be able to-
CO1: Development, characterization, and properties of crystal structures through solid state reactions.
CO2: To understand various design and development of solid materials with pre-required properties based on the solid structures of semiconductor and conductor.
CO3: Describe and understand the importance and properties of defects generated in solids.
CO4: Describes Gibbs Phase Rule, one, two, three component systems and its applications.
CO5: Describe the free election, band theories of solids

Course Contents

Unit	Content	Teaching hours
I	**Solid State Reactions** General Principles, Classification, Wagner reaction mechanism, Laws governing nucleation, Growth of nuclei, improving reactivity of solids, co precipitation as a precursor to solid state reactions, Kinetics of solid state reactions, factors affecting the reactivity of solid state reactions. General principles of growing single crystals, General conditions for crystal growth, solvent properties and saturated solutions, methods for growing crystals, slow evaporation, slow cooling, variation on slow evaporation and slow cooling, solvent diffusion, reactant diffusion, sublimation and seed crystals.	10
II	**Semiconductors and their devices** Intrinsic and extrinsic semiconductors, semiconductors materials and their fabrication, semiconductors devices p-n junctions, properties of p-n junctions, semiconductors diode asrectifier, Filters circuits, Zener diode as a voltage stabilizer, transistors transistor as an amplifier Superconductivity: conventional super conductors, organic super conductors, fullerene, high temperature super conductors, organic charge transfer complexes Applications.	10
III	**Theories of solid state and properties of solids** Free electron theory, Conduction by free electrons, Band theory, refinement to simple band theory, band structure of metals. Insulator and semiconductors. Generation of x-rays, interaction of x-rays with matter, scattering and diffraction, Bragg's law, Miller indices, General instrumentation, Bragg's method, single crystal method, Debye-Scherrer method, Identification of unit cells from systematic absences, x-ray intensities and structure determination, , applications of x-ray diffraction.	10

IV	**Phase Equilibria** Definitions, Derivation of Gibbs Phase Rule, Applications to solid-liquid, Liquid-vapour, Solid- vapour equilibria, Phase diagram for one component systems ie water, CO_2, with applications, Liquid-vapour equilibrium for two component systems, Phase diagrams for solid-liquid equilibria .Three component systems, water-chloroform-acetic acid system, triangular plots, Determination of the solubility curve for phenol and water, Gibbs- Duhem-Margules equation and its derivation, Applications to fractional distillation of binary miscible liquids (ideal and nonideal),Azeotropes, lever rule, Partial miscibility of liquids, CST, Miscible pairs, steam distillation, Nernst distribution law: its derivation and applications, Study the distribution law of Acetic acid and benzoic acid by water and CCl_4.	8
V	**Lasers and super conductors** **Super conducting solid materials** Band theory of electrical conductivity, Bardeen-Cooper-Schriffer Theory of super conductivity,the superconducting state, High critical temperature super conductors, magnetic properties of superconductors. **Lasers in chemistry:** General principles of LASER Action-Population Inversion, cavity and mode characteristics, Q-switching, Modelocking. Practical lasers- Solid State Lasers-Ruby, neodymium, gas Lasers-He, Ne, Ar, Kr, Carbon dioxide, Chemical and exciplex Lasers, Dye lasers LED and Semiconductor Lasers. Applications of Lasers in chemistry: Spectroscopy at high photon fluxes, collimated beams, Precision specified transitions, Isotope separation, Study of fast reactions using pulsed techniques.	7

Text Books:	1. Solid-State Chemistry: A Modern Approach, 1st Edition, By Ashok Kumar Jha, 2023.
	2. Solid State Chemistry and its Applications, 2nd Edition, By Anthony R. West, 2022.
Reference Books:	1. Solid state chemistry and its applications – A. R. West (John Wiley and sons)
	2. Principles of the solid state – H. V. Keer (Wiley Eastern Limited)
	3. Material science and engineering – V. Raghavan (prentice hall of India)
	4. Principles of electronics – V. K. Mehta (S. Chand and Co.)
	5. Engineering Chemistry - P. C. Jain and M. Jain (Shanpat Rai and Sons)
	6. Industrial chemistry – B. K. Sharma (Goel Publishing House)
	7. The British Glass Website- Types of Glass: http:/wwwbritglass.org.uk.
Online Resources:	1. https://onlinecourses.nptel.ac.in/noc23_ph38/preview
	2. https://archive.nptel.ac.in/courses/104/104/104104101/

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MML623 **Course name:** Nanochemistry **Course category:** Major Mandatory
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Primary knowledge of nanomaterials, their synthesis, size, properties and application in various sectors.
Course Objectives:
1. Student will be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, nanoelectronics, biomaterials energy production, and consumer products.
2. Learning of characterization of nanomaterials via various analytic techniques.
Course Outcomes: At the end of the course, the students will be able to-
CO1: To understand the general introduction & synthesis of nanomaterials by physical methods and Synthesis of nanomaterials by chemical methods.
CO2: Synthesis and Comparison of Nanocompounds with solid state compounds.
CO3: Characterization of nanostructured material through various analyzing techniques, like SEM, TEM, XRD etc.
CO4: Describe applications of Nano chemistry and their advantages with respect to classical materials and device setups.
CO5 Describe the effects may emerge due to Nano-dimensions of particles by their modified chemical and physical properties.

Course Contents

Unit	Content	Teaching hours
I	**General introduction & synthesis of nanomaterials by physical methods** Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition with consolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter diposition, electric arc deposition, Chemical Vapour Deposition (CVD).	10
II	**Synthesis of Nanomaterials by Chemical Methods** Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.	10
III	**Analysis Technique** Introduction, microscopes, electron microscopes, SEM, TEM, Scanning probe microscope (SPM), Scanning Tunnelling microscope, Atomic force microscope, X-ray diffraction, UV- visible and IR spectroscopy.	10
IV	**Properties and types of Nanomaterials** Properties of nanomaterials – Mechanical, electrical, optical, magnetic, semiconductor.	8

	Some special nanomaterials – Carbon nanotubes, porous silicon, Arogels, Zeolites.	
V	**Application of Nanomaterials** Application – Electronic, energy automobiles, sport and toys, textile, cosmetics, domestic appliances, biotechnology, medical, space, defense & environment. Introduction, deposition by chemical reactions, deposition by electrochemical reaction, chemical vapor deposition of inorganic Thin films, chemical etching.	7

Text Books:	1. Nanochemistry, Second Edition, By G.B. Sergeev and K.J. Klabunde, 2013
Reference Books:	1. Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
	2. NANO- The next revolution –Mohan Surendra Rajan(Natioinal book Trust, India)
	3. The British Glass Website- Types of Glass://www.britiglass.org.uk.
	4. Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
	5. Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. LCushing, V. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004)
	6. Handbook of Thin film technology- H. R. Khan.
	7. Thin film phenomenon- K. N. Chopra. Mcgrawa Hill publication.
	8. Material Science deposition & structure –Milton.
Online Resources:	1. https://nptel.ac.in/courses/118102003
	2. https://archive.nptel.ac.in/courses/113/106/113106093/

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MMP613 **Course name:** Spectroscopy Laboratory **Course category:** Major Mandatory
Credits: 02 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Primary knowledge of spectroscopic methods and their principles.
Course Objectives:
1. To understand applications of Spectroscopy Laboratory course.
Course Outcomes: At the end of the course, the students will be able to-
LO1: To determine the pKa and pKb values by titration method
LO2: Get the knowledge of composition of metal complexes through polarimeter.
LO3: Determine the value of refractive index and viscosity of the given solutions.
LO4: Identification of metal ions using flamephotometry.

Course Contents

	Spectroscopy
Sr.No.	**Title of the Experiment**
1	To determine the indicator constant pK in of an indicator by using half height method (Bromo cresol purpule)
2	To determine the stability constant of metal complex between 5-SSA and Fe^{+3} with help of Job's curve and Bent and French method (for weak complex)
3	To determine the concentration of Fe(II) and Cu(II) by spectrophotometric titrationwith EDTA.
4	To investigate the reaction kinetics between $K_2S_2O_8$ and KI by spectrophotometrically
5	To determine simultaneously the dichromate and permagnate ions in the given solution.
	Polarimetry
Sr.No.	**Title of the Experiment**
1	Determine the percentage of two optically active substances in amixture
2	To investigate the complex ion formation between Fe(II) and thiocynateion
3	To study Kinetics of hydrolysis of sucrose by Hammett-Zuckerman approach.
4	Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono, di and trichloro acetic acid as catalyst.
	Refractometry
Sr.No.	**Title of the Experiment**
1	Determine the refractive indices of series of solution of a salt and determine the concentration of the salt in the given unknown solution.
2	Study the variation of refractive indices with composition of mixture of carbon tetrachloride and ethyl acetate and determine the composition and molar refraction of the given unknown mixture.
	Viscosity
Sr.No.	**Title of the Experiment**

1	Determine the variation of viscosity with composition of I) ethanol-water, II)methanol- ethylidene chloride, III) nitric acid- chloroform and and conform the formation of compound.(TKC-250)
2	Determine the molecular weight ofmacromolecules.(TKC-251)
3	Determine the iso-electric point of gelatin and examine the effect of aging byviscometric methods.(DVJ-29)
	Flame Photometry
Sr.No.	**Title of the Experiment**
1	Estimation of Na, K, Li & Ca by flamephotometry.

Reference Book:	1. Practical NMR Spectroscopy Laboratory Guide: Using Bruker Spectrometers, By by Huaping Mo, John S. Harwood, 2017.
	2. I. N. Levine, Physical Chemistry, 6th Ed. McGraw Hill, NY (2009).

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MMP614 **Course name:** Surface tension and conductometry **Course category:** Major Mandatory
Credits: 02 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Primary knowledge of potentiometry, pH metry, conductometry, and surface tension. Effect of pH, conductance and potential on the chemical substances.
Course Objectives:
1. To understand applications of Surface tension and conductometry Laboratory course.
Course Outcomes: At the end of the course, the students will be able to-
LO1: Redox titration of two metal components for the determination of oxidation state.
LO2: Determination of free energy change and equilibrium constant of chemical reaction.
LO3: Determination of various metal complexes through pH metry and conductometry analysis.
LO4: Physico-chemical analysis of compounds using surface tension.

Course Contents

	Potentiometer
Sr.No.	**Title of the Experiment**
1	Titrate ferrous ammonium sulphate with cerric sulphate and find out formal redox potential of Fe^{+2}/ Fe^{+3} and Ce^{+3}/Ce^{+4}system
2	Titrate potentiometrically phosphoric acid solution against NaOH and calculate pK_1, pK_2 and pK_3 of the acid.
3	To determine the standard free energy changes ΔG^o and equilibrium constant for reaction $Cu+2Ag^+ \rightarrow Cu^{++} + Ag$
4	Determine the activity coefficient of silver ions using a concentration cell without transference.
	pH metry
Sr.No.	**Title of the Experiment**
1	To determine the proton-ligand stability constant of an organic acid and themetal-ligand stability constant of its complex by pH measurements.
2	Determine the Hammett constant of a given substituted benzoic acid by pH measurements.
3	Determine the pH values of various mixtures of sodium acetate and acetic acid in aqueous solution and hence find out the dissociation constant of the acid.
	Conductometry
Sr.No.	**Title of the Experiment**
1	Conductometric titration of a mixture of strong acid, weak acid and a salt.
2	To determine the degree of hydrolysis and hydrolysis constant of sodium acetate. conductometrically.
3	Determine the amount of trichloroacetic acid, monoacetic acid and acetic acid in a given solution by conductometric titration against sodium hydroxide solution.
	Surface Tension
Sr.No.	**Title of the Experiment**
1	Study the effect of surfactant (n-propyl alcohol) at various concentrations on the surface tension of water and hence determine the limiting cross sectional area of

	alcohol molecule by stalagmometer.
2	To study the effect of surfactant on surface tension of water by parachor of a solid by stalagmometer.

Reference Book / Hand Books/ Lab Manual	
1.	P. W. Atkins, J. de Paula, J. Keeler, Atkins' Physical Chemistry, 11th Ed. Oxford Univ Press, Oxford, UK (2018).
2.	R. J. Silbey, R. A. Alberty and M. G. Bawendi, Physical Chemistry, 4th Ed. Sec 16. 9, Wiley, NY (2005).

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MMP615 **Course name:** Chemical Kinetics and Thermodynamics **Course category:** Major Mandatory
Credits: 02 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Basic understanding of states of chemical compounds and their change from one state to another state. Thermodynamic laws and their applications on chemical compounds
Course Objectives:
1. To understand applications of Chemical Dynamics, rate of reactions, kinetics of iodination reaction.
2. To understand applications of Phase equilibria.
3. To understand applications of Adsorption, activity coefficient.
Course Outcomes: At the end of the course, the students will be able to-
LO1: To explain the rate, rate constant order of reaction experimentally.
LO2: To describe the phase equilibria in two and three component systems.
LO3: To investigate the adsorption of gases and liquids on charcoal.
LO4: To investigate the solute -solvent interaction on the basis thermodynamic parameters.

Course Contents

	Chemical Dynamics
Sr.No.	**Title of the Experiment**
1	Investigate the influence of ionic strength on the rate constant of the reaction between $K_2S_2O_8$ and KI.(TKC-335)
2	Determine the order of a reaction by 1) substitution method, (II) fractional change method and (III) differential method.
3	Investigate the reaction between bromic acid and hydrochloricacid.(TKC-335)
4	Investigate the kinetics of iodination ofacetone.
5	calculate pK1,pK2and pK3 of theacid.
6	To determine the standard free energy changes ΔG^o and equilibrium constant forreaction $Cu+2Ag+ \rightarrow Cu++ + Ag$(TKC-167)
7	Determine the activity coefficient of silver ions using a concentration cellwithout transference.(TKC-154)
	Phase equilibria
Sr.No.	**Title of the Experiment**
1	Determine the critical solution temperature of phenol and water in presence of 1) 1% NaCl 2) 0.5% naphthalene 3) succinic acid
2	Construct the phase diagram of three-component system containing ethanol benzene and water.
3	Determine the equilibrium constant of the tri-iodide formation in aqueous solution by distribution method.
4	Determine the formula of the complex formed between cupric ion and ammonia by distribution method.
	Adsorption
Sr.No.	**Title of the Experiment**
1	Investigate the adsorption of acetic / oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir'sisotherm

	Thermodynamics
Sr.No.	**Title of the Experiment**
1	Determine the partial molar volume of ethanol and water in a given compositionby densitymeasurements.
2	To determine heat of neutralization of strong acid and heat of ionization ofweak acid calorimetrically.
3	To determine the integral heat of solution of KNO_3.
4	To determine the heat of dissociation of benzoic acid inwater.
5	To determine heat of precipitation of $BaSO_4$.

Reference Book / Hand Books/ Lab Manual
1. J. R. Taylor, An Introduction to Error analysis, 2nd Ed. University Science Books, Sausalito, CA.
2. P. R. Bevington and D. K. Robinson, Data Reduction and error analysis for the Physical Sciences, 3rd Ed. McGraw Hill, NY (2003).

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MEL619 **Course name:** Nuclear chemistry **Course category:** Major Elective
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Understanding of nuclear elements and their various reactions for the production of different nuclear elements and their application.
Course Objectives:
1. Understand the main concepts, character, reactions and applications of nuclear chemistry.
Course Outcomes: At the end of the course, the students will be able to-
CO1: Describe the nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay and also methods for measurements of radioactivity.
CO2: Explain the fundamentals of radiochemistry, radiation chemistry and the applications of these in kinetics, radical chemistry, biotechnology and materials.
CO3: Operate and measurement of radioactive material.
CO4: To Describe the radiation chemistry in details.
CO5: Applications of radiation chemistry in pharmaceuticals and agrochemicals.

Course Contents

Unit	Content	Teaching hours
I	**Nuclear particles and its properties** The fundamental particles, roll call of elementary particles, composition of the nucleus, theories of nuclear composition, nuclear properties, mass defect and binding energy, nuclear stability explained by different factors. Nuclear size and density, mechanical effects due to orbiting and spinning of nucleons, orbital angular momentum of the nucleons, Total angular momentum of the nucleons, magnetic quantum numbers, principal and radial quantum numbers, total angular momentum of nucleus, total magnetic nuclear angular momentum quantum number, magnetic properties of the nucleous, the neutron magnetic moment, the structure of nucleon the net magnetic moments, The spin of odd Z odd N nuclei, The Nordheinrule.	10
II	**Radioactivity** Historical, background, natural radioactive elements, general characteristics of α, β, γ rays, detection and measurement of radioactivity, the theory of radioactive disintegration, decay kinetics, units of radioactivity, parent daughter growth relationship- secular and transient equilibrium, theory of α decay, β decay – energetics of β decay problems of β decay, fermis theory of β decay, nuclear de-excitation – emission, numerical.	10
III	**Nuclear Reactions** Definition and Bethes notation, nuclear reaction energetic, nuclear reaction and threshold energy, characteristics of nuclear reactions, types of nuclear reactions, conservation in nuclear reactions, nuclear reactions cross section, cross section and reaction rate, the compound nucleus theory, general properties of compound nucleus, optical model, direct interaction model, specific nuclearreactions- photonuclear reactions, stripping and pickup reactions evaporation, spallation, fragmentation, direct nuclear reactions,	10

	thermonuclear reactions.	
IV	**Radiation chemistry** Introduction of radiation with matter, primary effects due to charged particle/radiation, Linear energy transfer(LET), Bethes equation for LET, Bremsstrahulung, the cerenkov radians, interactions of electron with matter, interaction of neutrons with matter, interaction of heavy charged particles with matter, interaction of rays with matter, units for measuring radiation absorption, absorption in water B. Typical reactions involved in the preparations of isotopes: the scillard-chalmers reactions, radiochemical principles in the use of tracers,	9
V	**Application of radiation chemistry** Typical application of radioisotopesastracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity.	6

Text Books:	1. Handbook of Nuclear Chemistry, By Attila Vértes, Sándor Nagy, Zoltán Klencsár, Rezső G. Lovas, Frank Rösch, 2011.
	2. Principles of Nuclear Chemistry, By Peter A C McPherson, 2017.
Reference Books:	1. An Introduction of Electrochemistry by S. Glasstone. Affiliated East West Press, New Delhi.
	2. Electrochemistry by Shipra Baluja and Falguni Karia.
	3. Electrochemistry by B. K. Sharma. Krishna Prakashan,Meerut.
	4. Modern Electrochemistry by JO'MBockri's and A. K. N. Reddy, Vol. 2, Plenum Press, New York.,1992.
	5. The Principles of Electrochemistry by Duncan A. Mac Innes Dover Publication Inc.
Online Resources:	1. https://onlinecourses.nptel.ac.in/noc23_cy21/preview
	2. https://archive.nptel.ac.in/courses/104/101/104101137/
	3. https://www.digimat.in/nptel/courses/video/104101137/L40.html

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MEL620 **Course name:** Environmental chemistry **Course category:** Major Elective
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Involvement of the study of the effects that chemicals have on the air, water and soil and how they impact the environment and human health.
Course Objectives:
1. To understand the air, water, pollution by industry diffract, pesticides, microorganism, different types of toxic substances and analyze their toxicological information.
2. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
Course Outcomes: At the end of the course, the students will be able to-
CO1: Describe the air, water, pollution by diffract industry, pesticides, microorganism.
CO2: Describe experimental methods for analysis of water and soil analysis and pollution awareness to society.
CO3: Recognize different types of toxic substances & responses and analyze toxicological information.
CO4: Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
CO5: Describe the effect of toxic elements by pesticides on environmental and biological systems.

Course Contents

Unit	Content	Teaching hours
I	**Air Pollution** General considerations: polluted air, Types of pollution and units of measurements. Air quality standards, Sampling, Monitoring, Analysis of CO, Sources and sinks of CO pollution, Effects of CO on plants and humans, Control of CO pollution, Analysis of oxides of nitrogen, NOx sources and sinks of NOx pollution, Control of NOx pollution, Hydrocarbons and photochemical smog and its control, Analysis of hydrocarbon in exhaust gasses, Petrol and air, Sulpher dioxide sources, Analysis and control, Acid rain particulates and their effects on human and climate, Control of particulates.	12
II	**Water Pollution** Aquatic environment, Water pollutants, Sampling of water and its preservation Trace metals in water, Chemical speciation with special reference to Copper, Lead, Mercury and Arsenic. Water quality standards Water quality parameters. **Oxygen Demanding Wastes:** Dissolved oxygen, Biological oxygen demand, Monitoring techniques and methodology with special reference to ammonia, Nitrates, Nitrites, Fluorides, Cyanides, Total hardness, Lead, Cadmium and Mercury. Detection and control of Detergents, oils, Pesticides, Sewage treatment.	10

III	**Chemical toxicology, Soil analysis** Toxic chemicals in environment, Impact of toxic chemicals on enzymes, Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Carbon monoxide, Sulphur dioxide, Pesticides and Carcinogens. **Soil analysis:** Sampling of soil, Determination of water holding capacity, Determination of total nitrogen, phosphorous and sulphur in soil.	8
IV	**Industrial pollution** Pollution due to cement industry, Distillery, Pharmaceutical (Drug) industries, Sugar industry, Paper and pulp industries, Thermal power plants, Nuclear power plants, Metallurgical industries, Polymer industries. Recycle, reuse, recovery, disposal, & management of solid industrial waste	8
V	**Pesticides and Environmental pollution** Types of pesticides, Insecticides and Herbicides. Effect of pesticides, Insecticides and Herbicides on environment , Physicochemical decomposition of pesticides, , Insecticides and Herbicides by soil microorganism and other living organism.	7

Text Books:	1.	Environmental Chemistry, Eleventh Edition, By Stanley E Manahan, 2022.
	2.	Environmental Chemistry Fundamentals, By Jorge G. Ibanez , Margarita Hernandez-
	3.	Esparza , Carmen Doria-Serrano , Arturo Fregoso-Infante , Mono Mohan Singh, 2017.
Reference Books:	1.	A. K. De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi.
	2.	S. L. Chopra and J. S. kanwar, Analytical, Agricultural Chemistry, Kalyani Publishers, New Delhi.
	3.	Environmental chemistry, V P Kudesia, Pragati prakashan , meerut.
	4.	R. K. Trivedy and P. K. God, Chemical and biological methods for water pollution studies, Environmental publications, co. New Delhi.
	5.	L. A. Richards, Diagnosis and improvement of saline and alkali soils. Oxford IBH publications co. New Delhi.
	6.	S. M. Khopkar, Environmentalchemistry, Environmental pollution analysis.
	7.	M. S. Creos and Morr, Environmental chemical analysis, American publications.
	8.	M. Sitting, Resources, Recovery and Recycling, Handbook of industrial waste.
	9.	Standard methods of water and waste water analysis, American public health association Washington D. C.
	10.	R. Gopalan and AmruthaAnand, “Environmental chemistry laboratory manual Emerald Publication.
Online Resources:	1.	https://onlinecourses.nptel.ac.in/noc22_ce55/preview
	2.	https://archive.nptel.ac.in/courses/122/106/122106030/
	3.	https://nptel.ac.in/courses/104103020

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MEL621 **Course name:** Advanced electrochemistry **Course category:** Major Elective
Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic knowledge of redox reactions, oxidation and reduction processes, batteries, Arrhenius equation and problems related to that.
Course Objectives:
1. Recognize the electrochemical processes.
2. Evaluate electrodes and cells.
3. Express the electrodes materials. discuss electrode potentials and cell thermodynamics.
Course Outcomes: At the end of the course, the students will be able to-
CO1: The learner should be able to apply theories in electrochemistry to analyze electrode kinetics.
CO2: To understand representing electrochemical cell and the deposition on each electrode.
CO3: Explain various over potential involved during the operation of the cell.
CO4: Understand the storage cells, fuel cells, solar cells Types of storage cells (batteries), measure of cell performance, charging and discharging.
CO5: Students will be able to determine various parameters/properties using different techniques, the knowledge of which helps them to use in different fields.

Course Contents

Unit	Content	Teaching hours
I	**Oxidation - Reduction Systems** Oxidation potentials, reversible ox-red systems, determination of standard ox-red potentials, variation of ox-red potential, ox-red equilibria, ox-red systems in analytical chemistry, ox-red indicators, two stage ox-red , semiqinone formation constant. Numericals. Donnan membrane equilibrium, membrane potential, theories of membrane potential,introduction to electrocatalysis, relative power of electrocatalysts, mechanism of electrocatalysis, bioelectro catalysis, immobilization, application of enzymes on electrodes.	12
II	**Electrodeposition** Introduction, the electrogrowth of metals on electrodes , the reaction pathway for electro deposition, surface diffusion of ions, cathodic deposition of metals from solutions, factors affecting cathodic deposition of metals, electrochemical dissolution and passivity of metals, anodic dissolution of metals, film and adsorption theories of passivity.	9
III	**Polarization and Over potentials** Polarization, concentration polarization, decomposition potentials, over voltage, hydrogen, oxygen and metal over voltages, types of over voltages, factors affecting over voltages, experimental determination of decomposition potential and over voltage, Tafels theory and Tafel equation, simultaneous deposition of metals .Numericals.	8

IV	**Conversion and storage of electrochemical energy** Introduction of storage cells, fuel cells, solar cells Types of storage cells (batteries), measure of cell performance, charging and discharging, introduction of classical batteries, modern batteries –zinc-air, nickel-metal oxide and lithium batteries. Brief history of fuel cells, efficiency of fuel cells, hydrogen-oxygen fuel cell, phosphoric acid fuel cell, direct methanol and biochemical fuel cells; Solar cells introduction, principle and working of solar cells, advantages.	10
V	**Amphoteric Electrolytes** Dipolar ions and evidences for their existence. Dissociation of amino acids, isoelectric points and neutralization curves of ampholytes. **The Migration of Ions** Transference numbers and ionic velocities, Hittorf method, moving boundary method, Transference numbers in mixtures, abnormal transference numbers. Problems. **Acids and Bases** Definitions, types of solvents, dissociation constants of acids and bases, Determination of dissociation constants, Acidity function, effect of solvent and temperature on dissociation constant and ionic product of water. Problems.	6

Text Books:	1.	Fundamentals of Electrochemistry, By V. S. Bagotsky, 2005.
	2.	Advanced Electrochemistry By Chatterjee Sananda, Discovery Publishing House Pvt Ltd, 2020.
Reference Books:	1.	Modern Electrochemistry, Vol 1,2A and 2B, John O" M Bokris
	2.	An Introduction to Electrochemistry, Samuel Glasstone.
	3.	Theoretical Electrochemistry, L.Antropov.
	4.	Advanced Physical Chemistry, Gurtu and Gurtu.
	5.	Principles of Physical Chemistry, Puri,Sharma and Pathania.
	6.	Text Book of Physical Chemistry, S. Glasstone
	7.	Physical Chemistry, Robert J. Silbey.
	8.	Physical Chemistry, G.K.Vemulapalli.
	9.	Physical Chemistry, Maron and Pruton.
	10.	Physical Chemistry, P.W. Atkins
Online Resources:	1.	https://www.freebookcentre.net/chemistry-books-download/Advanced-Electrochemistry-Lecture-Notes.html
	2.	https://archive.nptel.ac.in/courses/104/106/104106129/

Syllabus Semester-III (Physical Chemistry)

Course code: MCH43MMP616 **Course name:** Physical Chemistry Lab **Course category:** Major Elective
Credits: 02 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Primary knowledge of magnetic moment calculation, magnetisum in substances. General formulas and equations to calculate concentrations of the solutions.
Course Objectives:
1. To understand applications of Chemical Dynamics, rate of reactions, kinetics of iodination reaction.
2. To understand applications of Phase equilibria. To understand applications of Adsorption, activity coefficient.
Course Outcomes: At the end of the course, the students will be able to-
LO1: To explain the rate, rate constant order of reaction experimentally
LO2: To describe the phase equilibria in two and three component systems.
LO3: To investigate the solute -solvent interaction experimentally on the basis thermodynamic parameters

Course Contents

	Magneto chemistry
Sr.No.	**Title of the Experiment**
1	To determine the magnetic susceptibility and number of unpaired electrons ingiven compound.
2	Verification of Weidemann's law using nickel chloride solution.
	Turbidimetry
Sr.No.	**Title of the Experiment**
1	Determine the molecular weight of a given polymer byturbidimetry
	Miscellanies
Sr.No.	**Title of the Experiment**
1	Determination of dissociation contant of weak Electrolyte
2	To compute reduced mass and force constant
3	To calculate activation parmeters at a given temperature
4	To computation of normality, molarity, molality
5	Conversion of celsius to fahrenheit

Reference Book:	1. J. W. Nibler, C. W. Garland, K. J. Stine, and J. E. Kim, Experiments in Physical Chemistry, 9th Ed. McGraw Hill, NY (2014).
	2. A. M. Halpern and G. C. McBane, Experiments in Physical Chemistry, 3 rd Ed. Freeman, NY (2006).
	3. J. W. Nibler, C. W. Garland, K. J. Stine, and J. E. Kim, Experiments in Physical Chemistry, 9th Ed. McGraw Hill, NY (2014).

Course code: MCH43RPJ603 **Course name:** Minor Research Project **Course category:** Major Elective
Credits: 04 **Teaching scheme:** P-4 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Primary knowledge of working in laboratory with chemicals and solvents. Understanding of research articles and literature review of related topic.
Course Objectives:
1. To provide hands on training to understand research problems to design synthesis and analysis of targeted molecules and application in respective research area.
Course Outcomes: At the end of the course, the students will be able to-
LO1: Skill to search literature on selected research oriented project work
LO2: Identify the advances in current research.
LO3: Conduct experiments scientifically with safety.
LO4: Interpret FT-IR, NMR, Mass, SEM, TEM, XPS, XRD analysis data.
LO5: The application in respective research area concern for further research development.
LO6: To submit the thesis and publish the work in reputed journal.

Course Contents

Sr.No.	Title of the Experiment
1	Introduction, literature review and to limitation of existing work. Aims and objectives of research topic and scope of topic.
2	Experimental section and research methods/ techniques.
3	Outcome of project work and application
4	Report preparation publish article in reputed journal.
5	References.

Reference Book / Hand Books/ Lab Manual
NA

Syllabus Semester-III (Physical Chemistry)

Course code:MCH43MML623 Course name:Surface and magnetochemistry Course category: Basic Science Credits: 3Teaching scheme: L-3 Evaluation scheme: CA–60, ESE–40 Course category: Major Mandatory

Pre-requisites: Students should revise topic of 12 th Surface chemistry of everyday life.

Course objectives:

- **1.To understand significance of economic and industrial factors in modern heterogeneous catalysis**
- **2.To understand structure/activity relationships in heterogeneous catalysis.**

Course Outcomes

1. Describe the significance of economic and industrial factors in modern heterogeneous catalysis.
2. State the connections and constraints on chemisorption and catalysis bymetals.
3. State the importance of a multi-technique approach for the elucidation of reaction mechanisms.
4. Describe the kinetic isotope effect that can provide mechanistic insight for heterogeneously catalysed reaction systems.
5. **Derive and develop structure/activity relationships in heterogeneous catalysis.**

Unit	Content	Teaching hours
I	**Surface Chemistry** Adsorption, adsorption isotherms, Langmuir's unimolecular theory of adsorption statistical derivation of Langmuir's adsorption isotherm, BET theory of multilayer adsorption and its determination	9
II	**Colloidal state of Matter** Introduction to colloids, classification, properties, specific properties like,electrical properties, charge on colloidal particals, origin of charge, electrical double layer, electrokinetic properties,electrophoresis, electroosmosis, streaming potential, sedimentation potential,determination of size of colloidal particals, applications of colloids, Numericals.	9
III	**Introduction to Magnetochemistry** Definition of magetic properties, types of magnetic behaviour, sources of paramagnetism,Pascals constants and it's applications, Determination of magnetic susceptibility. Numericals.	9
IV	**Micelles**	

	Defination, Surface cative agents,its classification, micellization, hydrophobic interactions, critical micellar concentration (CMC) factors affecting the CMC of surfactants, counterion binding to micelles, thermodynamics of micellization. Solubilization, micro emulsion, reverse micelles.	9
V	**Macromolecules & Basic concept of polymer chemistry,** Basic concept of polymer chemistry,: Classification of polymers. Types of polymer chains. Stereo regular polymers. Polymer nomenclature. Functionality and polymerization concept. Chain polymerization: Free radical polymerization: Methods of initiating free radical polymerization. Chain transfer, reactions.	9

Text Books:
Title, Author, Edition, year of publication, Publisher
1.Text book of Physical Chemistry. S.Glasstone,
2.Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.

Reference Books:
Title, Author, Edition, year of publication, Publisher
1.K.J.Laidler, J.H.Meiser and B.C. Sanctuary, Physical Chemistry, Houghton MifflinCompany, New York, 2003.
2.A.W. Adamson, Physical Chemistry of Surfaces, 4 th edition, Interscience, New York,1982
3.G.K.Vemulapalli, Physical Chemistry, Printice Hall of India.
4.Gurtu and Gurtu , Advanced Physical Chemistry.
5.Gurdeep and Raj, Advanced Physical Chemistry.
6.A.R.West, Solid State Chemistry and its Applications, John Wiley and Sons, 2003(reprint 2009)
7.H.V.Keer, Principles of Solid State.
8.Earn Shaw, Introduction to Magnetochemistry, Academic Press.J.Sharma,Magnetochemistry.
R.I.Dutta and Syamal, Elements of magnetochemistry.

Semester-IV (Physical Chemistry)

Course code: MCH43MML624 Course name: Polymer chemistry **Course category: Basic Science Credits: 3 Teaching scheme: L-3 valuation scheme: CA–60, ESE–40**

Course category: Major Mandatory

Pre-requisites: Students should revise topic Polymer chemistry.

Course Objective

1. To understands the fundamentals of biological macromolecules
2. To understands the various process of polymerization reaction
3. To understands the kinetics of polymerization process

Course Outcome

1. Describe the fundamentals of biological macromolecules
2. Describe the various process of polymerization reaction.
3. Explain the kinetics of polymerization process.
4. Explain the utility of conducting polymers.
5. Explain the utility of conducting pH.

Course Contents

Unit	Content	Teaching hours
I	**Fundamentals of Biological Macromolecules** Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Properties and classification of amino acids; Structures of nucleic acids, Protein structure and function, Properties of nucleosides and nucleotides, Composition of nucleic acids, Electrophoresis, Factors affecting on Electrophoretic Mobility; Types of Electrophoresis; Free electrophoresis and Gel electrophoresis; Electrophoresis in genetic analysis; DNA Sequencing and DNA foot Printing.	9
II	**Macromolecules** Introduction, Formation of synthetic high polymers classification, Polymerization reactions:Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion.	9

III	**Chemistry of Polymerization** Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts.Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques.	9
IV	**Kinetics of Polymerization** Free radical chain polymerization, Anionic polymerization, CationicpolymerizationCo polymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation.	9
V	**Electronically Conducting Polymers** Introduction, Theories of electronic conduction; Band theory of conduction, Hoppingconduction, Super conduction, Mechanism of conduction, Doping mechanism, p-type, n-type,auto doping, Stimuli sensitive (smart) polymers, pH and temperature sensitive smart polymers,Applications: Photovoltaic devices, Sensors, LED and Solar cells, Electro chemical devices,Batteries etc.	9

Text Books:
Title, Author, Edition, year of publication, Publisher
1. **Cantor, C. R. and Schimmel Biophysical Chemistry Vols. 1-3, W. H. Freeman (1980).** Lehninger, A.L., Nelson, D. L. and M. M. Lehninger, Principles of Biochemistry 4th Ed
2. **U. Satyanarayana; Biochemistry.**
3. **Upadhyay; Biophysical Chemistry.**
4. **L. Stryer, Biochemistry, 5th Edition, (2002) Freeman and Co. New York.**
5.D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry 3rd Edition (2002)McMillan North Publication.
6.D. Voet, J. G. Voet, Biochemistry 3rd Edition (2004), Wiley International Publication. • **Polymer Science. By V. R. Gowariker, N. V. Viswnathan, Jayadev Sreedhar.**

Reference Books:
Title, Author, Edition, year of publication, Publisher

E - resources:

Semester-IV (Physical Chemistry)

Course code:MCH43MML625 Course name:Chemical dynamics and catalysis
Course category: Basic Science Credits: 3 Teaching scheme: L-3
Evaluation scheme: CA–60, ESE–40 Course category: Major Mandatory

Pre-requisites: Students should revise topic of Chemical dynamics and catalysis

Course Objective

1. To understand Laws of thermodynamics to chemical processes.
   To understand thermodynamic properties using equations of Electron transfer reactions,
   proton transfer reactions
2. To understand how to explain the microscopic picture of surfaces, fundamental basis of thermodynamics.
3. To understand how to describe the concept photocatalytic reactions, types of photocatalyticreactions.

Course Outcome

1. Explain Laws of thermodynamics to chemical processes.
2. Describe thermodynamic properties using equations of Electron transfer reactions, proton transfer reactions
3. Explain the photocatalytic reactions, types of photocatalytic reactions.
4. Describe the concept of Homogeneous Catalysis
5. Describe the concept of bimolecular surface reactions.

Course Contents

Unit	Content	Teaching hours
I	**Kinetics of Complex Reactions** Opposing or reversible reactions, parallel and competitive reactions, consecutive reactions, chain reactions, branched chain reactions and explosions, hydrogen-oxygen reactions, kinetics of polymerization-step wise and free radical polymerization Effect of temperature on rates of simple and complex reactions. Numericals	10
II	**Reactions in solution** Diffusion controlled reactions, substitution and correlation effect, Hammet equation, Taft effects, compensation effect. Electron transfer reactions, proton transfer reactions. Ion dipole and dipole-diople interactions. Influence of pressure on rate in solution. Numericals	10
III	**Photochemical Reactions** Introduction, low of photochemical equivalence, photocatalytic reactions, types of photocatalyticreactions, photooxidation, photoreduction, photosensitization, photocatalyticdegradation. Chemiluminescence, photosynthesis. Numericals	9
IV	**Homogeneous Catalysis**	9

	Introduction, mechanism of catalysis, Acid-base catalysis, effect of pH on rate constant. Micellar catalysis, enzyme catalysis, factors governing rate of enzyme reactions, kinetics of enzyme catalysed reactions. Autocatalysis and oscillatory reaction, Lotka-Volterra mechanism, the brusselator, the eregonator, bistability, chemical chaos. Numericals	
V	**Macromolecules** Unimolecular surface reactions, bimolecular surface reactions, effect of temperature on heterogeneous reactions, Preparation and characterization of catalysts, applications	7

Text Books:
1. A Textbook of Physical Chemistry - Application of Thermodynamics | Volume 3, 5th Edition Paperback – 20 March 2020

Reference Books:
1. Chemical kinetics- E.S.Laidler pearson Education
2.Chemical kinetics and Reaction dynamics -Bul Houston
3.Chemical kinetics and Reaction Mechanism -F-Wilkinson-VanNostral Reinhdd
4.Physical chemistry- Atkin and D.Paula, Oxford University press
5.Physical chemistry- Berry, Rice, Ross Oxford University press
6.Physical chemistry-principles And Appllication in Biological Sciences – Tinoco, SauerPearson Education.
7.kinetics and Mechanism Of Chemical TransformationsJ. Rajaram Macmillan India LtdJ.C.Curiacose.

Semester-IV (Physical Chemistry)

Course code:MCH43MML626 **Course name:** Statistical Thermodynamics
Course category: Basic Science
Credits: 3 Teaching scheme: L-3 **Evaluation scheme:** CA–60, ESE–40
Course category: Major Mandatory

Pre-requisites: Students should revise topic of Thermodynamics

Course objective: To inculcate skill of various wet Chemical analysis.

Course outcome:

1. Apply fundamental concepts of thermodynamics to engineering applications.
2. Estimate thermodynamic properties of substances in solid, gas and liquid states.
3. Determine thermodynamic efficiency of various energy related processes.
4. Determine Plancks distribution law and radiation.
5. Determine applicationof thermoelectric effects-Seeback and Peltier effect.

Course Contents

Unit	Content	Teaching hours
I	**Introduction** Thermodynamics probability and most probable distribution, Stirlings approximation, distribution laws, the law of equipartition of energies. Quantum statistics- Max Well-Boltzmann, Bose-Einstein and Fermi-Dirac, limit and applicability of various distribution laws.	10
II	**Molecular Partition function** Partition function, Expression for translational, rotational, vibrational and electronic partitionfunctions, Third law of thermodynamics and partition function, Numerical problems.	10
III	**Application to chemical systems** Partition function and Thermodynamic functions, Sackur-Tetrode equation (derivation), determination of equation of state of an ideal gas. Internal rotation, residual entropies, heatcapacity of solids Einstein model, Debye modification (model), characteristic temperature,statistical mechanics of solutions ideal and nonideal.	9
IV	**Applications to quantum systems** Nuclear spin statistics, ortho and para nuclear states, ortho and para hydrogen. Fermi energy, Fermi energy of electron gas in metals, Plancks distribution law and radiation, Bose-Einsteindegenerate gas (He gas).	8
V	**Applications to thermoelectric effects** Onsager's theory, microscopic reversibility and Onsager's reciprocity,stationary states	8

	and entropy production, Prigogine's principle of minimum entropy, applicationto thermoelectric effects-Seeback and Peltier effect	

Text Books:
1. Physical chemistry- Atkin and D.Paula, Oxford University press.
2. Mathews P.M., and Venkateshan K.,A Text book of Quantum Mechanics; McGraw Hill Education; 2 edition (1 July 2017)

Reference Books:
1) Statistical Thermodynamics, Donaid A. Mc Qurrie, Harper & Row, New York 1973.
2) Statistical Thermodynamics, M.C. Gupta, Wiley Eastern Ltd. New Delhi.
3) Elements of Statistical Thermodynamics, L. K. Nash Addison Wesley, Menlo Park, 1972.
4) Physical chemistry, P. W. Atkins, ELBS
5) Non Equilibrium Thermodynamics, Progogine Kalyani Publication.
6) Thermodynamics and Non Equilibrium Thermodynamics, Gurudeep & Raj.

E - resources:
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Semester-IV (Physical Chemistry)

Course code: MCH43MEL622 **Course name:** Atomic Spectroscopy and Microscopic Techniques

Course category: Basic Science **Credits: 03** **Teaching scheme:** L-3

Evaluation scheme: CA–60, ESE–40 **Course category:** Major Elective-IV

Pre-requisites: Students should revise topic of Spectroscopy and Microscopic Techniques

Course Objectives:

1. To understand the concept in Atomic Spectroscopy and Microscopic Techniques .

2. To understand Atomic absorption and Flame Emission Spectroscopy.

Course Outcomes:

1.The learner should be able to apply theory of Electron Spectroscopy.

2. The learner should be able to operate the instrument.

3. The learner should be able Explain various Luminescence Spectroscopy techniques.

4. The learner should be able to apply the knowledge to calculate Microscopic techniques – I

5.The learner should be able to apply the knowledge Quantitative analysis in TEM and SEM**.**

Course Contents

Unit	Content	Teaching hours
I	**Electron Spectroscopy** Introduction of electronic spectroscopy (PES, UPS, XPS, ESCA); Principle and theory, Instrumentation, application and problems.	9
II	**Atomic absorption and Flame Emission Spectroscopy :** Absorption of radiation by atoms, equipment, radiation sources, atomizers, detectors, interferences in atomic absorption spectroscopy, applications. Introduction to plasma, various type of emission spectroscopy,instrumentation, inductively coupled plasma spectrometer, flame photometer, applications.	9
III	**Luminescence Spectroscopy :** Atomic Fluorescence, Introduction to molecular luminescence	9

	(fluorescence, phosphorescence and chemiluminescence); Theory of luminescence, instrumentation (spectrofluorometer), applications.	
IV	**Microscopic techniques - I :** Introduction to TEM and SEM : Electron gun, electron acceleration, Condenser lenses, specimen stage, vacuum system, Operating principle, Penetration of electrons into a solid, TEM image, secondary electron images, Backscattered electron images**.**	9
V	**Microscopic techniques - II :** AEM (Analytical Electron Microscopy) : The Bohr model of the atom, X-ray emission spectroscopy, X-ray energy dispersive spectroscopy, Quantitative analysis in TEM and SEM. Scanning Tunneling Microscopy (SEM) and Atomic Force Microscopy (AFM): Basic principles and theory, instrumentation, operatingparameters and applications.	9

Text Books:
1 Introduction to Instrumental Analysis, Robert D. Braun. Pharma Med Press.
2. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Timonthy A. Nieman, Harcourt Asia – Harcourt College Publishers.

E - resources:
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Semester-IV (Physical Chemistry)

Course code: MCH43MEL623 **Course name:** Quantum Chemistry **Course category:** Basic Science

Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40

Course category: Major Elective

Pre-requisites: Understanding of basic classic quantum chemistry. Particle in one, two and three dimension and their calculations.

Course Objectives: To understand the concept of wave function, oscillators, time dependent Perturbation Theory. To understand Hertreefock theory with reference to computation aspects

Course Outcomes: At the end of the course, the students will be able to -

1. understand the origin of quantum theory and Schrodinger's time-dependent and time-independent equations
2. To explain the concept of wave function, oscillators, time dependent Perturbation Theory.
3. To explain Hertreefock theory with reference to computation aspects.
4. Describe the electronic properties of molecules by Semi-empirical method, density functional method and Configuration Interaction and its limitations and application.
5. Describe Thomas Fermi theory, Pople Nesbet equations.

Course Contents

Unit	Content	Teaching hours
I	**Introduction, Schrödinger equation and related problems** The conceptual aspect, The state vectors, Bra and Ket notations, Eigenstates and eigenvalues, The postulates of quantum mechanics, Interpretation of the wave function, Operators, Commutation relations. Equation of motion, Hamiltonian, Time dependent Schrodinger equation, Time independent Schrodinger equation, Schrodinger equation for particle in a potential well.	12
II	**Perturbation Theory** Energy and wave-function corrections to wave-function degenerate states, applications including stark effect, hydrogen atom, anharmonic, - quartic oscillators, particle in a box- ground and excited states, time dependent perturbation theory	9

III	**Hartree Fock Theory** Slater determinants, Postulate of antisymmetry, Slater- Condon rules for matrix elements, Hartree-Fock equations, Koopman and Brillouin theorems, Roothaan formulation, basis sets, computational aspects, UHF method, Pople Nesbet equations	8
IV	**Semi-empirical Theories** Recapitulation of Huckel method, extended Huckel method, ZDO approximation, CNDO/INDO methods, Molecular Properties, Computational aspects, MINDO, AM1, PM3 methods, comparison of these methods	8
V	**Density Functional Theory** Introduction, Hohenberg Kohn Theorem, N and V representablity, Levy Functional, Kohn Sham equations, Functional derivatives and local potentials, Thomas Fermi theory, The Kohn- Sham construction, Fractional occupation numbers, Janak's theorem, Slater transition state, Electronegativity, hardness, Multi-configuration wave function, full CI matrix, doubly excites CI, illustrations, Natural orbitals, Introduction to MC-SCF methods. Truncated CI and size-consistency	8

Text Books:

- Modern Quantum Chemistry, A. Szabo and N.L. Ostlund, Dover, New York (1996)
- 2.Approximate Molecular Orbital Theory, J. A. Pople and D. L. Beveridge, McGraw Hill, New York (1971)

Reference Books:

15. Density Functional Theory of Atoms and Molecules, R. G. Parr and W. Yang, Oxford University Press, Oxford (1989)
16. Molecular Modeling, A. Leach, Longman, Landon (1996)
17. Schiff L.I., Quantum Mechanics: McGraw Hill Education; 4 editions (1 July 2017)
18. Ghatak A.K., & Loknathan S. Quantum Mechanics: Theory & Applications Laxmi Publications (1 January2015).
19. Shankar R., Principles of Quantum Mechanics: Springer; 2nd ed. 1994. Corr. 14th printing 2014 edition (19 October 2011).
20. Zettili N., Quantum Mechanics: Concepts and Applications; Wiley india Pvt. Ltd; 2nd edition edition (12 October 2016).
21. Mathews P.M., and Venkateshan K.,A Text book of Quantum Mechanics; McGraw Hill Education; 2 edition (1 July 2017)

E - resources:

3. https://archive.nptel.ac.in/courses/104/101/104101124/
4. https://archive.nptel.ac.in/courses/104/105/104105128/
5. https://archive.nptel.ac.in/courses/104/108/104108057/
6. https://onlinecourses.nptel.ac.in/noc22_cy33/preview

Semester-IV (Physical Chemistry)

Course code: MCH43MEL624 **Course name:** Chemical mathematics & computer programming

Credits: 03 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40

Course category: Major Elective

Pre-requisites: Understanding of basic classic quantum chemistry. Particle in one, two and three dimension and their calculations.

Course Objectives: To Apply fundamental concepts, to understand representing, to apply the knowledge of computational theories and chemistry.

Course Outcomes: At the end of the course, the students will be able to -

1. Devise an algorithm to solve a mathematical problem numerically.
2. Analyze an algorithm's accuracy, efficiency and convergence properties.
3. Implement this algorithm and write computer code.
4. Describe classic techniques and recognize common pitfalls in numerical analysis.
5. Describe Numerical differentiation.

Course Contents

Unit	Content	Teaching hours
I	**Preliminaries of computing and Solution of non-linear equations** Errors, Types of errors, Propagation of Error, Floating point arithmetic. Approximation using Taylor's series Bisection Method, Methods of false position, Newton's method, Modified Newton's method, fixed point iterative method, Newton's and fixed point iterative method for system of nonlinear equations. Roots of polynomials, Error and convergence analysis of these methods	10
II	**Solution of system of linear equations** Direct Methods: Gauss elimination with pivoting. LU decomposition method, Cholesky decomposition method, Error analysis for direct methods. Iterative methods: Jacobi, Gauss Seidel method, SOR method, Vector and matrix norm, Convergence of iterative methods. Eigen values problems: Jacobi's and Power method.	9
III	**Interpolation** Finite difference operators, divided difference operators, Relation between difference operators, Application of difference operators. Polynomial Interpolation, Existence and uniqueness of interpolating polynomials, Lagrange and Newton's interpolation. Newton's forward and backward	10

	difference formula, Error in interpolation	
IV	**Differentiation and integration** Numerical differentiation: Methods based on interpolation, finite differences, Error in approximation, order of approximation. Numerical Integration: Quadrature formula, Newton Cotes Methods, Trapezoidal and Simpson's rules with error analysis. Gauss quadrature methods with error analysis.	8
V	**Initial value problems (ODE)** Picard's method, Taylor's series method, Euler and Runge-Kutta methods for initial value problems of order one and higher and system of first order ODEs with error analysis.	8

Text Books:

3. The Chemical Maths Book, E. Steiner, Oxford University Press (1996).
4. Maths for Chemists, Volumes 1 and 2, Martin C. R. Cockett and Graham Doggett, Royal Society of Chemistry , Cambridge (2003).

Reference Books:

8. Computers and Common Sense R. Hunt and Shelley, Prentice Hall, New Delhi (1998) Computer Programming in Fortran-90 V. Rajaraman, Prentice Hall, New Delhi (1990)
9. Computer and Chemistry: introduction to programming and numerical methods T. R. Dickson, Freeman (1968)
10. Computer programs for chemistry D. F. Detar W. A. Benjamin Inc, New York Vol. 1-3 (1968-69)
11. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill

E - resources:

3. https://nptel.ac.in/courses/104104026
4. https://archive.nptel.ac.in/courses/104/104/104104081/

Semester-IV (Physical Chemistry)

Course code: MCH43MEP607 **Course name:** Advanced Physical Chemistry Lab –II

Credits: 01 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20

Course category: Major Elective

Pre-requisites: Primary knowledge of atomic, IR, Raman spectroscopic methods and their applications.

Lab Course Objectives: To understand applications of atomic, IR, Raman spectroscopic methods.

Lab Course Outcomes: At the end of the course, the students will be able to -

Student will learn the structure determination and content determination of the given molecules or compounds through the listed experiment list.

Course Contents

List of experiments

1. **Calibration of volumetric apparatus.**
2. IR and Raman spectroscopy of solvent mixtures.
3. Computing Potential Energy Surface of molecules using Quantum Mechanics.
4. Introduction to Scanning Probe Microscopy
5. Analysis of the rotational-vibrational spectra of HCl molecules.
6. Determination of partial molal volume.
7. Determination of the isotherm for a three component system.
8. Kinetics of fast reactions by stopped-flow technique.
9. Spectrophotometric determination of the acid dissociation constant
10. The measurement of electrical conductance for the determination of the equivalent conductance at infinite dilution
11. Rate of the hydrolysis of sucrose using polarimeter.
12. Determination of pKa of poly-basic acid with the pH meter.
13. Determination of critical miceller concentration.
14. Determination of transport number by moving boundary method.
15. Polarizability from refractive index measurements.
16. Formula and stability constant of a complex by spectrophotometry.
17. Fluorescence quantum yield determination of an unknown molecule.
18. Fluorescence spectrum and stern-volmer quenching constant.

Reference Books:

1. Experimental physical chemistry, F. A. Bettelheim
2. Experimental physical chemistry, G. P. Matthews
3. Experimental physical chemistry, F. Daniels
4. Experimental physical chemistry, A. Halpern and G. McBane
5. Experimental Physical Chemistry, D. P. Shoemaker, C. W. Garland, and J. W. Nibler

Semester-IV (Physical Chemistry)

Course code: MCH43RPJ606 **Course name:** Research project (Dissertation, presentation and Seminars)

Course category: Basic Science **Teaching scheme:** Project **Evaluation scheme:** CA–60, ESE–40

Credits: 06 **Course category:** Major Elective

Pre-requisites: Primary knowledge of working in laboratory with chemicals and solvents. Understanding of research articles and literature review of related topic.

Course Objectives: To provide hands on training to understand research problems to design synthesis and analysis of targeted molecules and application in respective research area.

Course Outcomes: At the end of the course, the students will be able to -

1. Skill to search literature on selected research oriented project work
2. Identify the advances in current research.
3. Conduct experiments scientifically with safety.
4. Interpret FT-IR, NMR, Mass, SEM, TEM, XPS, XRD analysis data.
5. The application in respective research area concern for further research development.
6. To submit the thesis and publish the work in reputed journal.

Course Contents

Sr.No.	Title of the Experiment
1	Introduction, literature review and to limitation of existing work. Aims and objectives of research topic and scope of topic.
2	Experimental section and research methods/ techniques.
3	Outcome of project work and application
4	Report preparation publish article in reputed journal.
5	References.

Syllabus
Semester-III (Medicinal Chemistry)

Course code: MCH43MML627 **Course name:** Drugs Synthetic Methods **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise Organic Reaction Mechanism course of M. Sc Chemistry, II Semester.
Course Objectives:
The main objective of the course is on Drugs Synthetic Methods which is to impart an understanding of the synthetic methods and mechanism of drug action which is usually not covered at the UG level.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe the ADME properties of drugs.
CO2: Describe the Structure Activity Relationship in drug design and discovery.
CO3: Explain the various parameters requires for QSAR study.
CO4: Describe the principles and use of Combinatorial Chemistry in drug synthesis.
CO5: Understand the functions and mechanism of Tranquilizers. .

Contents

Unit	Content	Teaching Hrs
I	**Anaesthetics, antipyretic, Analgesic, Antagonist, Anti-neoplastic & Alkylating agents:** Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with possible mechanism) from following classes: Anaesthetics: Lidocaine, Thiopental, mechanism of action. Analgesic and antipyretics: Paracetamol, Meperidine, Methadone, Aminopyrine Anti-neoplastic agent Introduction, cancer chemotherapy, special problems; Role of alkylating agent, and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibiters, synthesis of some antineoplastic agent-e.g. Taxol (a)Antagonist: Fluorouracil (b) Alkylating agents: i) Chlorambucil (ii) Cis-Platin	9

II	**Antibiotics, Antimycobacterial, Antiviral, Antitubercular and anti-leprotic, Anti-inflammatory Drugs: Antibiotics:** Preparation of semi synthetic penicillin, conversion of penicillin into cephalosporin, general account of tetracycline and macaracyclic antibiotics (no synthesis) Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with Possible mechanism) from following classes: Antibiotics: (a) Chloramphenicol (b) Ampicillin (c) Amoxycillin (d) Cefepime (e) Cefpirome Antimycobacterial: Ethambutol, Antiviral: Acyclovir, Antimicrobial: Sulfamethoxazole, Trimethopim. Antitubercular and anti-leprotic:Ethanbutol, Isoniazide, Dasone, mechanism,Pathways, inhibition of cyclooxygen. Anti-inflammatory: Ibuprofen, Oxyphenbutazone, Dichlorophenac, Indomethacin, Arachidonic acid.	9
III	**Antidiabetics, Antihistamines and Anti-hypertensive drugs:** Antidiabetics, Antihistamines and Anti-hypertensive drugs Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with possible mechanism) from following classes: Anti-hypertensive Drugs: (a) Verapamil (b) Captopril (c) d-sotalol (d) Atenolol (e) Diltiazem (f) Semotiadilfumarate. Antidiuretics: (a) Troglitazone (b) Chlorpropamide (c) Tolbutamide Antihistamines; Phenobarbiton, Fenediazole, Diphenylhydramine, mechanism of action	9
IV	**Anti AIDS and Cardiovascular Drugs:** Tranquilizers, Anti AIDS and Cardiovascular Drugs: Introduction, Classification, Mechanism of action and Synthesis of the following drug molecules (at least one convenient synthetic route with Possible mechanism) from following classes	9
V	**Tranquilizers** Antacids / Antiulcer: Omeprazole, Ranitidine**:** Diazepam, Trimeprazin Anti AIDS drugs: Cause, Antimetabodies and Anti-AIDS drugs Cardiovascular Drugs: Dilliazem, Quindine, Methyldopa, Atenolol, Oxyprenol	9

Text Books:	
1.	Synthesis of Essential Drugs- R. S. Vardanyan and V. J. Hruby, 1st Edition - March 10, 2006, Elsevier.

2. Contemporary Drug Synthesis- J. J. Li, D. S. Johnson, D. R. Sliskovic, B. D. Roth, 1st Edition - June 2004, Wiley.

3. Text book of Organic medical and pharmaceutical Chemistry, Wilson, Gisvold and Dirque, 12th Edition 2010, Wilson & Gisvold's

4. Strategies for organic drug synthesis and designing - D. Lednicer, 2nd Edition 2008, Wiley.

Reference Books:

1. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham Michael Myers, Volumes 2, 6th Edition, 2003, john Wiley and Sons, Inc.
2. The Organic Chemistry of Drug Design and Drug Action, Mark W. Holladay, Richard B. Silverman, 3rd edition, 2014, Elsevier.
3. Principles of Medicinal Chemistry, Ph.D. Lemke, Thomas L. Williams, David A. Roche, Victoria F. 7th Edition, 2012, Lippincott Williams & Wilkins.
4. Medicinal Chemistry- Ashutosh Kar, 1st Edition, New Age International Private Limited.
5. Medicinal Chemistry- Balkishen Razdan, 1st Edition, 2010. CBS publication.

E - resources**:**

https://shop.elsevier.com/journals/the-american-journal-of-medicine/0002-9343

https://www.google.co.in/books/edition/Textbook_Of_Medicinal_Chemistry/lOy4OOWyjl8C?hl=en&gbpv=1&dq=Medicinal+Chemistry-+Balkishen+Razdan&printsec=frontcover

https://www.google.co.in/books/edition/Pharmaceutical_Chemistry_Ii/l9uRGg_cJTAC?hl=en&gbpv=1&dq=Medicinal+Chemistry-+Balkishen+Razdan&printsec=frontcover

Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MML628 **Course name:** Fundamentals of Medicinal Biochemistry **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise topic of 12th Science, chemistry of everyday life.
Course Objectives:
The main objective of the course is on Fundamentals of drug compounds which is to impart an understanding of the biochemical mechanism of some heterocyclic compounds which are usually not covered at the UG level.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Explain the relationship between drug's chemical structure and its therapeutic properties.
CO2: Predict drugs properties based on its structure.
CO3: Describe the factors that affect its absorption, distribution, metabolism, and excretion, and hence the considerations to be made in drug design.
CO4: Describe the common methods of spectroscopic and chromatographic analysis, and discuss how they can be applied to pharmaceuticals.
CO5: Understand chemical transformations in Bioinorganic Chemistry. .

Contents

Unit	Content	Teaching Hrs
I	**Medicinal Biochemistry:** Introduction to development of antimicrobial agents, historical development of antimicrobials, chemotherapy, use of synthetic compounds and antibiotic revolution. Mechanism of action at molecular level of selected antibiotics: inhibitors of cell wall: introduction to bacterial cell wall, peptidoglycan structure synthesis , mechanism of antibiotics inhibiting cell wall synthesis. Plasma membrane antiseptics, mechanism of antiseptics, disinfectants, cationic antibiotics, polypeptide antibiotics ionophoric and polyene antibiotics. Mechanism of inhibition of Nucleic acids synthesis: inhibitors of nucleotide synthesis, inhibitor of polymerization of nucleic acids, inhibitors of polymerases.	9
II	Antiviral, antifungal, antiprotozoal, analgesic drugs & Immunology: A] Antiviral, antifungal, antiprotozoal, analgesic drugs: mechanism of action at molecular level of some antiprotozoal: antimalarial, antiviral antiflu, anti HIV etc, analgesic drugs. Mechanism of resistance to antibiotics and other drugs: mechanism of resistance at biochemical level of some antibiotics: conversion of active drug to inactive, modification of drug sensitive site, loss of cell permeability to drug. B] Immunology	9
III	Chemistry of amino acids:	9

	Chiral Synthesis of alpha and Beta amino-acid, Difficulties involved in synthesis of peptides, Importance of peptides in drug discovery, Protection and Deprotection of amino acids General aspects, need for protection, minimal versus global protection, protection of amino group by acid and base labile groups, protection of carboxyl group, concept of orthogonal protection in peptide synthesis, importance of side-chain functional group protection and details of protective groups used for masking individual amino acids, methods used for deprotection. Coupling reactions in peptide synthesis Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over-activation and side reactions of individual amino acids	
IV	Peptides, nucleotides, nucleosides & Synthesis of Antibiotics: A] Peptides, nucleotides, nucleosides Principle of solid phase peptide synthesis, t-BOC and FMOC protocols, various solid supports and linkers: Activation procedures, peptide bond formation, deprotection and cleavage from resin, low and high HF cleavage protocols, formation of free peptides and peptide amides, purification and case studies, site-specific chemical modifications of peptides Chemistry of nucleosides and nucleotides B] Synthesis of Antibiotics	9
V	Bioinorganic Chemistry 1. Principles of coordination Chemistry related to Bioinorganic–Proteins, nucleic acids andother metal binding biomolecules. 2. Choice, uptake and assembly of metal containing units in Biology 3. Control and utilization of metal ion concentration in cells. 4. Metal ion folding and cross –linking of biomolecules. 5. Binding of metal ions and complexes to biomolecular active center	9

Text Books:

1. Biological Chemistry of the Elements: R. J. P. Williams & F.R.deSalvia, 1st Edition,1991, Oxford University, Press.
2. Bioinorganic Chemistry: Inorganic elements in the Chemistry of life: Anintroduction &guide:W. Kaim, B. Schwederski, 3rd Edition, 1991, VCH publication.
3. Synthesis of Essential Drugs- R. S. Vardanyan and V. J. Hruby, 1st Edition -March 10, 2006, Elsevier.
4. Contemporary Drug Synthesis- J. J. Li, D. S. Johnson, D. R. Sliskovic, B. D. Roth, 1st Edition - June 2004, Wiley.
5. Text book of Organic medical and pharmaceutical Chemistry, Wilson, Gisvold and Dirque, 12th Edition 2010, Wilson & Gisvold's
6. Strategies for organic drug synthesis and designing - D. Lednicer, 2nd Edition 2008, Wiley.

Text Books:

1. Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W.Kuchel
2. and G.B. Ralston. Ist. Ed. 2020, McGraw-Hill Book Co.
3. Burger's Medicinal Chemistry, Drug Discovery and Development, Donald J. Abraham Michael Myers, Volumes 2, 6th Edition, 2003, john Wiley and Sons, Inc.
4. The Organic Chemistry of Drug Design and Drug Action, Mark W. Holladay, Richard B. Silverman, 3rd edition, 2014, Elsevier.
5. Principles of Medicinal Chemistry, Ph.D. Lemke, Thomas L. Williams, David A. Roche, Victoria F. 7th Edition, 2012, Lippincott Williams & Wilkins.
6. Medicinal Chemistry- Ashutosh Kar, 1st Edition, New Age International Private Limited.
7. Medicinal Chemistry- Balkishen Razdan, 1st Edition, 2010. CBS publication.
8. Medicinal Chemistry,- Molecular and Biochemical approach – Thomas Mogardy and Donald Weaver 3rd Edition, 2015,Oxford press.

E - resources:
https://www.google.co.in/books/edition/Textbook_Of_Medicinal_Chemistry/lOy4OOWyjl8C?hl=en&gbpv=1&dq=Medicinal+Chemistry-+Balkishen+Razdan&printsec=frontcover

Semester-III Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MML629 **Course name:** Advanced Spectroscopic Methods **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise syllabus of fundamental of spectroscopy from Graduation level
Course Objectives:
The main objective of the course is to ddescribe the concept of structural elucidation by means of spectroscopic methods..
Course Outcomes: At the end of the course, the students will be able to -
CO1: Implement structure elucidation of new compound that may be natural or synthetic.
CO2: Explain the Nuclear magnetic resonance spectroscopy. Proton chemical shift, spin-spin coupling, coupling constants and applications to organic structures.
CO3: Understand the 13C Nuclear magnetic resonance spectroscopy.
CO4: Explain the Mass, ESR, etc and its applications.
CO5: Apply the knowledge of the chemistry for Advanced Spectroscopic Methods. .

Content

Unit	Content	Teaching hours
I	**^{1}H NMR Spectroscopy** Recapitulation of basic principle, Fourier Transform technique, Pulse sequence, and relaxation processes. Use of Integration in the quantative determination of isomers, Chemical Shift, Factors affecting on chemical shifts (inductive, resonance and anisotropic effect and solvent effect with examples), Chemical shift of different types of protons (alkane, alkene, alkyne and allene, aromatic protons) Spin-Spin coupling: Coupling constant and its mechanism, factors affecting coupling constants (dihedral angle, Karplus equation-graph, electronegativity, bond order, hybridization, bond angle with examples), Chemical equivalence and non-equivalence, rate processes. Different types of spin coupling, first order analysis of spectra, Ramsay mechanism of spin coupling, roofing effect with example, different spin systems with examples (AB, AM, AX, ABX/AMX etc.), calculations of line intensities and chemical shifts.	9
II	**^{13}C NMR** Elementary ideas, instrumental difficulties, FT technique advantages and disadvantages, Proton noise decoupling technique advantages and disadvantages, off-resonance technique, Chemical shifts of solvents, factors affecting on chemical shifts, analogy with 1H NMR,	9

	calculations of chemical shift of hydrocarbons, effect of substituents on chemical shifts, different types of carbons (alkene, alkyne, allene, carbonyl, nitrile, oxime and aromatic carbons and effect of substituent on chemical shifts of carbons. Chemical shifts of solvents	
III	**2D NMR techniques** Two-dimensional (2D) NMR techniques principle and pulse technique, DEPT, 1H-1H COSY, 1H-13C COSY (HETCOR, HMQC, HMBC, HSQC), interpretation of 2D spectra and examples, Spin decoupling and Nuclear Over Hauser effect (NOE) with examples.	9
IV	**Mass spectrometry** Theory, instrumentation various methods of ionization (field ionization, FAB, MALDI, californium plasma), different detectors [magnetic analyser, ion cyclotron analyser, quadruple mass filter, time of flight (TOF)]. Importance of HRMS, Rules of fragmentation of different functional groups, factors controlling fragmentation. Fragmentation of alkanes alkenes, nitriles, aromatic and carbonyl compounds etc.	9
V	**Problems on Spectral Interpretation** Problems -based on joint application of UV, IR, 1H and 13C NMR, 2D and Mass (Including reaction sequence)	9

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Spectroscopic Methods in Organic Chemistry: D. H. Williams & I. Flemming Ist Edition, 2011, McGraw Hill Education 2. Spectroscopy of Organic Compounds: V. M. Parikh, 1974, Addison-Wesley Publishing Company **3.** ^{13}C NMR Spectroscopy: G. C. Levy, R. L. Lichter, G. L. Nelson, 1980, John Wiley & Sons Ltd., New York

Reference Books:
Title, Author, Edition, year of publication, Publisher

1.	Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster,6th Ed. John Wiley.
2.	Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, 1986, Springer.
3.	Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, 2nd Edition, 1998, Oxford University Press.
4.	One and Two dimensional NMR Spectroscopy- - Atta-Ur-Rehman, Ist Edition, 1989, Elsevier.
5.	Organic structural spectroscopy- Joseph B. Lambert, Shurvell, Lightner, 1998, Ist Edition, Cooks, Prentice Hall.
6.	Spectroscopic methods in organic chemistry – D. H. Williams and I. Flemming , 6th Edition, 2007,Mc Graw Hill.

E - resources:	
1.	https://www.youtube.com/watch?v=fVcr-83hj1E
2.	https://www.youtube.com/watch?v=7jhN_6scxuo
3.	https://www.youtube.com/watch?v=clGgCyqj1Nk

Semester-III Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MMP615 **Course name:** Chemistry Lab Course-III **Course category:** Major Mandatory
Credits: 2 **Teaching scheme:** P-4 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Separation, purification and identification of two components mixtures, chemical tests derivatives etc.
Course Objectives:
The main objective of the course is to use the technique of separation, crystallization derivatization and function group detection of unknown mixture of organic compounds.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Apply techniques involved in organic synthesis.
LO2: Do separation, crystallization, derivatization and function group detection of organic compounds
LO3: Develop method for synthesis of useful compounds using named reaction.
LO4: Determine physical constant of organic compounds
LO5: Perform any one of the Chromatographic methods for structure identification.

Content

Sr.No.	Title of the Experiment
1	Separation, purification and identification of compounds of THREE components mixtures, chemical tests. derivatives etc. by micro scale technique. IR spectra to be used for functional group identification. TLC and Column Chromatography. (12 Mixtures)
2	Acid-Base Phenol
3	Acid-Base Neutral
4	Neutral-Base Phenol
5	Acid-Neutral-Phenol
6	Purification Techniques (8 Experiments): 1. Purification of two organic solids by recrystallization using solvents other than water. 2. Purification of two organic liquids by distillation technique. 3. Purification of two organic solids by Sublimation method. 4. Thin Layer Chromatography technique of two components mixtures. 5. Preparative TLC. 6. Column Chromatography technique. 7. Solvent Extraction method. 8. Vacuum distillation under pressure.
7	**Use of ChemDraw, ISIS, Marvin Sketch: (10 Experiments)** Draw the structure of organic compounds, 3D structure of compounds, reaction sequence. Get the correct IUPAC name. Prediction of NMR, CMR for organic compounds.

Reference Book / Hand Books/ Lab Manual	
1. A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India	
1.	Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
2.	A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
3.	Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
4.	Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication

Syllbaus Semester-III (Medicinal Chemistry)

Course code: MCH43MMP616 **Course name:** Chemistry Lab Course-IV **Course category:** Major Mandatory
Credits: 2 **Teaching scheme:** P-4 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Separation, purification and identification of two components mixtures, chemical tests derivatives etc.
Course Objectives:
The main objective of the course is to use the technique of separation, crystallization derivatization and function group detection of unknown mixture of organic compounds.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Perform one and two stage reactions in organic synthesis.
LO2: Do separation, crystallization, derivatization and function group detection of organic compounds
LO3: Develop method for synthesis of useful compounds using named reaction.
LO4: Determine physical constant of organic compounds
LO5: Perform any one of the Chromatographic methods for structure identification.

Content

Sr.No.	Title of the Experiment
1	Two stage and Three stage Organic preparations starting with 5g or less. (TLC Analysis is recommended)
2	Preparation of Benzanilide by Beckmann rearrangement.
3	Preparation of Antharanilic acid.
4	Preparation of Phthalimide.
5	Preparation of N- Bromosuccinamide.
6	Preparatin of p- Aminobenzoic acid.
7	Preparation of p- chloronitrobenzene by Sandmeyer reaction.
8	Preparation of p- Iodonitrobenzene by Sandmeyer reaction.
9	Pinacol- Pinacolone rearrangement.
10	Preparation of Acetophenones by Fries rearrangement
11	Preparation of aromatic aldehydes by Vilsmer Hack reaction or R. T.
12	Wittig reaction.
13	Preparation of Benzopyrazole (Other suitable experiments may be added)

Reference Book / Hand Books/ Lab Manual	
1.	A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India
2.	Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
3.	A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
4.	Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
5.	Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication

Semester-III Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MMP617 **Course name:** Chemistry Lab Course-V **Course category:** Major Mandatory
Credits: 2 **Teaching scheme:** P-4 **Evaluation scheme:** CA–30 ESE–20
Pre-requisites: Separation, purification and identification of two components mixtures, chemical tests derivatives etc.
Course Objectives:
The main objective of the course is to use the technique of separation, crystallization derivatization and function group detection of unknown mixture of organic compounds.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Perform one and two stage reactions in organic synthesis.
LO2: Do Structure elucidation of organic compounds by spectral analyses
LO3: Develop method for synthesis of useful compounds using Microwave Assisted Synthesis
LO4: Use reusable catalysts in organic synthesis.
LO5: Perform Ultrasound assisted synthesis.

Content

Sr.No.	Title of the Experiment
1	Preparations involving one stage synthesis based upon the green synthetic protocols as covered in theory syllabus (Minimum Five Chemical reactions)
2	Structure elucidation of organic compounds by spectral analyses. (Synthesized compounds will be elucidated by FTIR, UV, ^{1}H NMR/^{13}C NMR and Physical constant.)
3	Microwave Assisted Synthesis
4	Ultrasound assisted synthesis
5	Neat reaction
6	Use of Greener solvents
7	Use of reusable catalysts

Reference Book / Hand Books/ Lab Manual
1. A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India.
2 Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
1. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
2. Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
3. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication
4. http://journal.chemistrycentral.com/content/7/1/95

Semester-III Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MEL625 **Course name:** Chemical Industries **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should study the unit processes and unit operations carried out in the chemical Industry
Course Objectives:
The main objective of the course is to create awareness about the various chemical industries utilities and to kip emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis, toxicology and personal proactive equipment.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understanding of Safety principles.
CO2: Analyze Hazard chemicals in the Cement and Glass industry
CO3: Understand application of the Paints and Pigments
CO4: Explain the Agrochemicals with their optimum usage and side effects.
CO5: Apply the knowledge of the Petrochemicals in concern with environment. .

Contents

Unit	Content	Teaching hours
I	**Metallurgy Industry Extraction and applications of metal alloys:** Metallurgy Industry Extraction and applications of metal alloys: Metallurgy Industry Extraction and applications of metal alloys a) Iron and steel: Iron, steel alloy, tool steel, stainless steel. b) Aluminum	9
II	**Cement and Glass Industry**: Introduction; Classification and Manufacturing processes of Cement and Lime; Setting and Hardening process. Glass Industry Introduction; Physical and Chemical properties; Characteristicsof glass; Raw material Manufacturing process of glass; Ceramic- Raw material, Manufacturing process of White ware, Glazing.	9
III	**Paints and Pigments Industries Paints:** A) Paints and Pigments Industries Paints- Introduction; Classification of paints; Constituents of paints; Formulation of paints;Mixing of paints; Manufacturing processes of paints ; Failure of paints; Varnishes, Enamals, Emulsion paints- Constituents. Pigment- Manufacturing processes of zinc oxide and titanium dioxide, properties and application Special paints- Luminescentspaints,Heat resistant paints, cellulose paints. B) Dyes Classification of dyes according to the mode of applications and according to the chemical constitution; Methods of preparation of commercial dyes of different classes with suitable examples; Typical manufacturing processes of dyes; Fluorescent brightening agents.	9

IV	**Agrochemicals:** a) Organo chlorine pesticides: BHC, Aldrin, Dialdrin, Endosulphan, b) Organo phosphorus pesticides: Malathion, monocrotophos, Dimethoate, chloropyriphos. c) Carbamates: Carbaryl, Bygon, Ziram, Zineb, Maneb. d) Insect pheromones and Repellants: Pheromone, general introduction and application in integrated pest management (no synthesis), Repellant: Survey and synthesis of following repellants: N,N Diethyl-3-methyl benzamide, N,N, Diethylenebenzamide, 2-ethyl-1,3, hexanediol, Butopytranexyl, Dimethylcarbamate, Dimethylpthalate	9
V	**Petrochemicals:** Petrochemicals Crude oil, Natural gas, Petroleum hydrocarbons- Types and source of crude oil; Refining various petroleum fractions- Thermal cracking, Recycle cracking, Thermal cracking of fuel; outline of chemicals derived from natural gases/ paraffin hydrocarbon-Ethylene, Propylene Butylenes, Benzene, Toluene.	9

Text Books:
1.Engineering Chemistry by by Jain PC and Jain M, 17th Edition. 2020, Dhanpat Rai Publication
2. A Textbook of Engineering Chemistry by S. S. Dara, S. 1986, Chand Publication.
3. Handbook of Chemical Industries, by P. Vishwanathan, Ist edition, 2016, Medtech Publication.

Reference Books:
1. *Process Engineering: Addressing the Gap between Study and Chemical Industry Michael Kleiber, IInd edition, 2016, De Gruyter.*
2. *Safety In chemical plants /Industry & its Management B.K.B.Rao R.K.Jain , Vinit Kumar, 2010, Khanna Publishers.*
3. *Chemical process industries inorganic chemicals and allied industries vol 1, W. Smith, 2019, CBS publication.*
4. *The Structure of Scientific Revolutions" by Thomas S. Kuhn, 4th edition, 2012, The University of Cicago Press.*
5. *Agrochemicals Desk Reference, John H. Montgomery, 2nd edition, 1997, CRC Press.*
6. *The Large International Firm in Developing Countries: The International Petroleum Industry. By Edith T. Penrose, 1968, Cambridge: The M.I.T. Press*

E - resources:
1. https://www.google.co.in/books/edition/The_Structure_of_Scientific_Revolutions/3eP5Y_OOuzwC?hl=en&gbpv=1&printsec=frontcover

Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MEL626 **Course name:** Food ,Fertilizers & Pesticide Analysis **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should study the ingredients in food, fertilizers and pesticide and revise the analytical techniques from B. Sc. Lab course.
Course Objectives:
The main objective of the course is to develop understanding of analytical methods for industrial applications of Food Fertilizers & Pesticide
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe basic and advanced concepts of analysis and its applications in food industries.
CO2: Analyze Hazard chemicals as Food Contaminants and adultrations
CO3: Understand application of the Fertilizers
CO4: Explain the Agrochemicals with their optimum usage and side effects.
CO5: Apply the knowledge of the pesticides in concern with environment. .

Contents

Unit	Content	Teaching hours
I	**Food and importance of food nutrients** Food:Food and importance of food nutrients,Energy of food, physical and chemical constituents of food, Food safety considerations. Food Additives: General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers,texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour.	9
II	**Food Contaminants and adultrations**: Proximate composition of food and its analysis, Legislation to food. General Considerations Analysis of Milk Fat content, proteins, acidity, bacteriological quality and milk adulterants. Control of food adultrations.	9
III	**Fertilizers** Introduction to Fertilizers: Introduction, classification of fertilizers, NPK value, Chemical composition of super phosphates, Lime and potash, Analysis of commercially available fertilizers for NPK.	9
IV	**Analysis of Fertilizer** Legislation to Pesticides: Legislation and recent amendment to pesticide materials and formulations. Analysis of Fertilizer: Names of pesticide and their structures. Analysis of specific pesticides. Analytical methods to analyze pesticides. Applications of dosage of different pesticides.	9

V	**Herbicides**-Major classes-Synthesis and properties of 2,4-D,atrazine,glyphosate, butachlor and benthiocarb.- Fungicides- Majior classes-synthesis and properties of carbendazim, carboxin, captantridemorph and copper oxy chloride- Insectides act and plant growth regulators.	9

Text Books:	
1.	Chemical Analysis of Foods And Food Products, 3rd edition, JACOBS M. B, CBS Publishers & Distributors Pvt Ltd, India.
2.	Chemical Analysis of Food, Techniques and Applications, Yolanda Pico, 2nd edition, 2020.
3.	Selected Formulary Book on Cosmetics, Drugs, Cleaners, Soaps and Detergents, 2nd edition, 2016, NIIR Project Consultancy Services.

Reference Books:	
1.	The Complete Technology Book on Herbal Beauty Products (Cosmetic Industry) with Formulations, Manufacturing Process, Machinery Equipment Details & Plant Layout, Dr. Himadri Panda, 2nd Edition, Asia Pacific Business Press Inc.
2.	Fundamentals Of Analytical Chemistry, Douglas A. Skoog, 2nd edituion, 1969, Wiley.
3.	Electrochemical Methods: Fundamentals and Applications; Bard, A. J.; Faulkner, L. R. 2nd edition, 1980, Wiley: New York,
4.	Introduction to Modern Liquid Chromatography; Snyder, L. R.; Kirkland, J. J 1979.,Wiley: New York,

E - resources:
1. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://pubs.acs.org/doi/pdf/10.1021/ac012633h

Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MML609 **Course name:** Chemistry of Nanomaterials **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Basic understanding of solid state chemistry and properties of matter.
Course Objectives:
To understand basic and advanced level concepts in design, preparation and properties and applications of Nanomaterials
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe: Types of nanomaterials and emerge due to nano-dimensions of particles.
CO2: Describe and Interpret: Methods for synthesis of nanomaterials and characterization data
CO3: Understand: Advanced biological/chemical methods for industries.
CO4: Identify: Solution for the energy crises and environmental pollution and mechanistic pathways during electrochemical conversion.
CO5: Describe: application of nanomaterials in medicine and its toxicity.

- Contents

Unit	Content	Teaching hours
I	**General Introduction** **Introduction to Nanomaterials**: Size Effects - difference between bulk and Nanomaterials - Definition of Nanomaterial. **Classification Nanomaterials**: Nanoparticles, Nanocrystal, 0-D Quantum dots, Nanostructured material (1-D Wire and rods, 2-D thin film, 3-D structures) - Carbon nanotubes (CNTs) : Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs) - Graphene. **Proprieties of Nanomaterials**: optical, electronic, magnetic and chemical etc.	09
II	**Synthesis of Nanomaterials** **Synthesis of Nanomaterials**: Synthesis of Nanomaterials: Bottom Up and Top Down Approach - Gas Phase synthesis of Nanomaterials - Wet chemical synthesis - Chemical Vapour Deposition (CVD). **Characterisation of Nanomaterials**: using UV-Visible Spectroscopy, Fluorescence Spectroscopy, Powder XRD, Particle size analysis by Dynamic Light Scattering (DLS), SEM, TEM, AFM techniques.	09
III	**Optical luminescence Nanomaterials**: Optical luminescence and fluorescence from direct, bandgap semiconductor nanoparticles - White LEDs - LEDs based on nanowires - LEDs based on nanotubes- LEDs based on nanorods - High Efficiency Materials for OLEDs - High Efficiency Materials for OLEDs.	09
IV	**Energy Applications**	09

	Renewable Energy Technology: Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies. **Nanomaterials for Storage:** and devices for energy transport, conversion and storage.	
V	**Nanomedicine Application** **Nanomaterials in Medicine**: Introduction to Nanocarriers, Interactions of nanocarriers with blood stream, cellular targeting, Biological and chemical reagents for cell-specific targeting - Biodistribution of liposomes, dendrimers and Nanoparticles, **Toxicity of Nanomaterials:** drug delivery, tissue regeneration, cancer detection, Luminescent nanoparticle probes for bio-imaging and diagnostics.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Nanotechnology: Principal and practice, Sulabha Kulkarni ISBN 978-9381891261 2. Fundamentals of Nanotechnology –Gabor L Hornyak, John J Moore, 2009, 786 pages, eBook ISBN9781315222561.
Reference Books:
1. NANO- The next revolution- Mohan Surendra Rajan, 2009, pages:179 ISBN: 812374305X
E - resources:
1. Nano structured materials-synthesis, properties, self assembly and applications, IIT Delhi Prof. A.K. Ganguli, NPTEL Course https://nptel.ac.in/courses/118102003

Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43MEP608 **Course name:** Chemistry Lab-VI **Course category:** Major Elective
Credits: 1 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Students should obtain the skills for Separation, purification and synthesis of derivatives ets. from Ist year M. Sc. Chemistry.
Course Objectives:
The main objective of the course is to demonstrate/apply the green chemistry protocols for the synthetic routes followed by the technique of separation, crystallization and derivatization of organic compounds.
Course Outcomes: At the end of the course, the students will be able to,
CO1: Apply techniques involved in organic synthesis
CO2: Do separation, crystallization derivatization and function group detection of organic compounds
CO3: Develop method for synthesis of useful compounds using named reaction.
CO4: Perform the methods for the preparation of useful compounds using named reaction.
CO5: Apply the technique of separation, crystallization derivatization and function group detection

Content

Sr.No.	Title of the Experiment
1	Advanced Preparations Preparations involving at least two stages based on name reactions, condensations, cyclocondensations, reagents and rearrangements (as covered under the theory). Separation purification of the product by column is desired.

Reference Book / Hand Books/ Lab Manual
1. A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India.
3 Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
5. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
6. Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
7. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication
8. http://journal.chemistrycentral.com/content/7/1/95

Syllabus Semester-III (Medicinal Chemistry)

Course code: MCH43RPJ607 **Course name:** Research Project **Course category:** Research Project
Credits: 4 **Teaching scheme:** P-8 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should obtain the skills for Separation, purification and synthesis of derivatives ets. from Ist year M. Sc. Chemistry.
Course Objectives:
The main objective of the course is to identify/search the recent advances in current research, design research oriented project on particular context followed by literature survey
Course Outcomes: At the end of the course, the students will be able to,
CO1: Conduct experiment scientifically with safety.
CO2: Characterize the prepared material by using microscopic, spectroscopic, diffraction, adsorption and thermal techniques.
CO3: Demonstrate the skill to write dissertation , communication skill in presentation.
CO4: Perform the methods for the preparation of useful compounds using named reaction.
CO5: Interpret observed data statistically.

Content

Sr.No.	Title of the Experiment
1	**Department Faculty will give project to the students.** After successful completion of project Dissertation/ presentation/ Seminars will be conducted at department in the presence of external expert. (At least one research paper publication is desired based on research project completed.)

Reference Book / Hand Books/ Lab Manual	
1.	A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India.
2.	Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
3.	A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
4.	Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
5.	Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication
6.	http://journal.chemistrycentral.com/content/7/1/95

Semester-IV (Medicinal Chemistry)

Course code: MCH43MML630 **Course name:** Medicinal Chemistry **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise Organic Reaction Mechanism course of M. Sc Chemistry, II Semester.
Course Objectives:
The main objective of the course medicinal chemistry is to impart an understanding of the computational tools for drug designing and the mechanism of drug action which is usually not covered at the UG level
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand the significance of advanced techniques in drug design and discovery
CO2: Describe the factors affecting on absorption, distribution, metabolism, and excretion (ADME) properties of drugs
CO3: Explain the relationship between a drug's chemical structure and its therapeutic properties
CO5: Describe the principles and role of computational chemistry in medicinal chemistry

Contents

Unit	Content	Teaching Hrs
I	**General Introduction:** Introduction to Medicinal Chemistry, History and development of medicinal chemistry, Physicochemical properties concerning biological action, Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism. **Drugs:** Essential Drugs, Nomenclature of Drugs, Routes of Drug Administration, Adverse effects of Drugs, IUPAC Naming of Drugs.	9
II	**Drug discovery process:** A brief introduction to bioinformatics and chemoinformatics, Molecular modeling: Energy minimization, geometry optimization, conformational analysis. Computer Aided Drug Design (CADD), Development of New Drugs, Factors Affecting development of New Drugs. Concept of prodrugs and soft drugs, Drug Receptors.	9
III	**Pharmacokinetics:** Introductions, Drug Absorption, Distribution, Metabolism (Phase I and Phase II), Excretion and Toxicity (ADMET).	9

	Pharmacodynamics: Introduction, Drug- receptor interaction, Types of Interactions, Enzyme Stimulation, Enzyme Inhibition, Membrane Active Drugs, QSAR- 2D QSAR and 3D-QSAR.	
IV	**Drug Action:** Theories of Drug Action, Molecular Recognition in Drug-Receptor Binding, Enzyme Inhibitors (Modes of inhibition). Antibacterial, Antifungal, Antiviral, and Anticancer drugs (Major drug classes, mechanism of drug action, Drug resistance). Analgesic Drugs, anesthetics (general, local), Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Steroids	9
V	Molecular docking: Rigid docking, flexible docking, manual docking. Autodock and Dock software with examples	9

Text Books:

1. The Organic Chemistry of Drug Design and Drug Action- Richard B. Silverman, 2nd Edition, 2004, Elsevier Academic Press

2. Foye's Principles of Medicinal Chemistry, 5th Edition–David A. Williams and Thomas L. Lemke, 2002, Lippincott Williams & Wilkins.

3.Medicinal Chemistry: A Molecular and Biochemical Approach, Thomas Nogrady and Donald F. Weaver, 3rd Edition, 2005, UK: Oxford University Press.

4. Medicinal Chemistry: An Introduction–Gareth Thomas, 2011, Germany: Wiley.

5. The Practice of Medicinal Chemistry, ed. Camille Wemuth, 1996, Academic Press.

Reference Books:

1. Chemoinformatics and Bioinformatics in the Pharmaceutical Sciences– ed. Himanshu Ojha, Navneet Sharma, Pawan Raghav, Ramesh K. Goyal, 1st edition, 21 May 2021, United Kingdom: Elsevier Science.

2. Drug Delivery Approaches: Perspectives from Pharmacokinetics and Pharmacodynamics, ed. Bret Berner, Heather A. E. Benson, Michael S. Roberts, Toufigh Gordi,1st edition, 4 August

2021, United States, Wiley.

3. Principles The Organic Chemistry of Drug Design and Drug Action, Mark W. Holladay, Richard B. Silverman, 3rd edition, 2014, Elsevier.
4. A Primer of Drug Action: A Concise Nontechnical Guide to the Actions, Uses, and Side Effects of Psychoactive Drugs, revised and updated –Robert M. Julien, 10th edition, 6 August 2013, United Kingdom: Henry Holt and Company.
5. Molecular Docking for Computer-Aided Drug Design: Fundamentals, Techniques, Resources and Applications– Mohane S. Coumar, 1st edition, 17 Feb 2021, Netherlands, Elsevier Science.

E - resources:

1. https://sites.ualberta.ca/~pwinter/Molecular_Docking_Tutorial.pdf
2. https://www.youtube.com/watch?v=NLrjHq89fYM
3. https://www.youtube.com/watch?v=GvZq67dcHXs
4. https://www.sciencedirect.com/book/9780123820303/the-organic-chemistry-of-drug-design-and-drug-action

Semester-IV(Medicinal Chemistry)

Course code: MCH43MML6310 **Course name:** Stereochemistry **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise Stereochemistry course knowledge from UG level.
Course Objectives:
The main objective of the course stereochemistry focuses on the stereoisomers of different compounds, reactivity, and methods for asymmetric synthesis
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand the conformation and reactivity of cyclic and acyclic compounds
CO2: The nomenclature and reactivity of various bicyclic ring systems
CO3: Newer methods of stereo-selective synthesis
CO4: Use of suitable chiral auxiliaries as catalysts for asymmetric synthesis
CO5: Stereochemistry of Allenes, Spiranes, and biphenyls ring systems

Contents

Unit	Content	Teaching Hrs
I	**Conformation and reactivity in acyclic compounds and of cyclohexanes:** Stability and reactivity of diastereoisomers. Curtin- Hammett principle. The shapes of the rings including six-membered, five, seven, and eight-membered rings, Reactivity of the six-member ring system Conformational effects in medium-sized rings, Concept of I strain	9
II	**Fused and Bridged rings:** Fused bicyclic ring systems: Cis- and trans- decalins and nine methyl decalines and perhydraphenanthrene, perhydroanthracene. Bridged rings, Nomenclature stereo chemical restrictions. The Bredts rule, Reactivities. Stereochemistry of Allenes, spiranes and biphenyls	9
III	**Newer methods of stereo-selective synthesis:** Introduction and Stereoselective and stereospecific reactions. Enantioselective synthesis (Chiral approach) reactions with hydride donors, catalytic hydrogenation via chiral hydrazones and oxazolines, enatiotopic and diastereotopic atoms, groups and faces. Use of calculations of optical purity and enantiomeric excess.	9

IV	**Asymmetric Synthesis:** Chiral pool, Chiral auxiliary, Enantio- & Diastereoselective synthesis, Chiral reagent and chiral catalyst including CBS reagent, NADH, Asymmetric hydrogenation including BINAP, Hydroboration-Ipc_2BH, $IpcBH_2$, Asymmetric epoxidation- (+) DET & (-) DET, Sharpless, Jacobson, Asymmetric dihydroxylation-$(DHQD)_2PHAL$ & $(DHQ)_2PHAL$, Felkin-Anh model, Zimmermann-Traxler transition state model.	9
V	**Pericyclic Reactions:** Characteristics of Pericyclic Reactions, Types of Pericyclic Reactions; Electrocyclic reactions, Cycloaddition reactions, Sigmatropic reactions, Cheletropic reactions, Group transfer reactions, Reaction profile for a concerted reaction, Background of Molecular Orbitals, Symmetry in pi molecular orbitals, Ethylene, 1, 3-butadiene, Allyl system.	9

Text Books:

Title, Author, Edition, year of publication, Publisher

6. An Introduction to Medicinal Chemistry, G. L. Patrick, 2023, United Kingdom: Oxford University Press.

7. Stereochemistry of Organic Compounds: Principles and Applications – D. Nasipuri, 2nd Edition, 1994, India: Wiley Eastern.

8. Stereochemistry Conformation and Mechanism – P.S. Kalsi, 7th edition, 2008, New Age International (P) Limited, India.

9. Organic Chemistry, R. T. Morrison, and R. N. Boyd, 3rd edition, 1973, Allyn and Bacon, Boston.

10. Stereochemistry of Organic Compounds, Ernest L. Eliel, and Samuel H. Wilen, 2008, India, Wiley India Pvt. Limited.

11. Organic Synthesis– Smith, Michael, 4th edition, 2016, United Kingdom, Elsevier Science.

12. Stereochemistry of Carbon Compounds– Eliel, Ernest Ludwig, 1st edition, 1962, Japan, McGraw-Hill.

13. Stereochemistry of Organic Compounds–Ahluwalia, V.K., 2022, India: Springer International Publishing.

Reference Books:

Title, Author, Edition, year of publication, Publisher

6. Advanced Organic Chemistry: Part A: Structure and Mechanisms. Richard J. Carey, Francis A. Sundberg, 5th edition, 13 June 2007, Germany: Springer.

7. Advanced Organic Chemistry: Part B: Reaction and Synthesis. Carey, Francis A. Sundberg, Richard J., 5th edition, 24 Nov 2007, Germany: Springer US.

8. Organic Chemistry–Clayden, Jonathan., Greeves, Nick., Warren, Stuart, 2nd edition, 15 March 2012, United Kingdom: OUP Oxford.

9. Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products, 5/E, I. L. Finar, 5th edition, 1956, India: Pearson Education.

10. Dynamic Stereochemistry of Chiral Compounds: Principles and Applications– Wolf, Christian, 2008, United Kingdom: RSC Publishing.

11. Stereochemistry and Stereoselective Synthesis: An Introduction– Poppe, László., Nagy, József., Hornyánszky, Gábor., Boros, Zoltán., 1st edition, 2016, Germany: Wiley.

E - resources:

1. https://www.youtube.com/watch?v=_RXRBYkwzyI
2. https://www.chem.ucalgary.ca/courses/351/WebContent/orgnom/index.html
3. http://publications.iupac.org/pac/1998/pdf/7001x0143.pdf
4. https://www.slideshare.net/Madankumar159/effect-of-conformation-on-reactivity
5. https://www.sciencedirect.com/science/article/abs/pii/B9780128210628000120

Semester-IV (Medicinal Chemistry)

Course code: MCH43MML632 **Course name:** Drug Discovery **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise fundamental of drug chemistry from 12th std .
Course Objectives:
The main objective of the course Drug Discovery focuses on the various stages of the development of drugs, their different forms, and regulatory guidelines
Course Outcomes: At the end of the course, the students will be able to -
CO1: Explain the relationship between the drug's chemical structure and its therapeutic properties.
CO2: Complete stages of drug development and delivery systems
CO3: Develop Methods for drug screening and dosage forms of drug
CO4: Use quality attributes, guidelines for development, and clinical trials during drug development
CO5: Apply Mechanism of drug delivery system in physiological conditions

Contents

Unit	Content	Teaching Hrs
I	**Introduction to drug discovery and dosage forms:** Introduction, drug discovery, and design: A historical outline, sources of drugs and lead compounds, classification of drugs, brief discussion on methods of drug administration, introduction of drug action and bioavailability	9
II	**Drug screening methods:** General principles of screening of drugs, general screening methods, clinical trials, experimental animals used in pharmacological assays, invitro, invivo studies, tissue experiments, and whole animal experiments. Bioassay, scope, principals involved, and general methods. Bioassay of acetylcholine, insulin, and atropine. Screening method for evaluation of analgesic, anti-inflammatory, antiulcer, anticonvulsants, hepatoprotective, antidiabetic, and antifertility activities. Methodology for microbial assay of penicillin and miconazole. Enzyme inhibition studies: inhibition of acetylcholine esterase activity in rat striatum, Cox inhibition studies.	9
III	**GMP and Drug Regulations:** Introduction, requirements of good manufacturing practice and quality	9

	management, guidelines to manufacturing practice for medicinal products, premises and equipment, documentation, production, and quality control. GCP guidelines and related management, Principles of ICH and GCP, and ethical principles related to GCP. Regulations for obtaining permission for a clinical trial, application for permission, report: clinical trial report, trial management, data monitoring committee (DMC).	
IV	**Drug delivery systems:** Fundamental of novel drug delivery: Rationale of sustained release, controlled release dosage forms. Physicochemical and biological factors influencing design, performance of CR products, Pharmacokinetics, and pharmacodynamic basis of NDDS. Bioavailability assessment of CR systems, Regulatory requirements, Theory of mass transfer, Fick`s law and its application in NDDS, Polymers in CR- classification, properties of biocompatible and biodegradable polymers. Modeling of drug release from porous polymer, drug release from nonporous and hydrophobic polymers, Oral controlled drug delivery systems, mucosal drug delivery systems, ocular drug delivery systems, parenteral drug delivery systems, transdermal drug delivery systems	9
V	**Dosage forms:** oral solids, oral liquids, solution properties, suspensions, emulsions, parenteral, aerosols, inhalation products, topical semisolids, typical lipids and powders, ophthalmic products, rectal and vaginal products. Oral solids: tablets, types of tablets, methods of tablet production- wet granulation, coating of tablets. Quality control methods and measurement of tablet properties, Oral liquids: introduction, type, oral suspensions and oral emulsions.	9

Text Books:

Title, Author, Edition, year of publication, Publisher

1. Introduction to Medicinal Chemistry: How Drugs Act and Why, A. Gringauz, 1997, Germany: Wiley.
2. Synthesis of Essential Drugs, R. H. Vardanyan and V. J. Hruby, 1st edition, 2006, Netherlands: Elsevier Science.
3. Contemporary Drug Synthesis, J. J., D. S. Johnson, D.R. Sliskovic, B.D. Roth, 1st edition, 2004, Germany: Wiley.
4. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, 2012, United Kingdom: Elsevier Science.

5. Pharmacology and Pharmacotherapeutics–Satoskar, R.S., Rege, Nirmala., Bhandarkar, S.D., 26th edition, 2021, India: Elsevier Health Sciences.
6. Basic Pharmacology–R W Foster, 3rd edition, 11 May 2015, Netherlands: Elsevier Science.
7. Drug Discovery and Evaluation: Pharmacological Assays, H. G. Vogel, 3rd edition, 30 Oct 2007, Germany: Springer.
8. Pharmaceutics and Pharmacokinetics – G.R. Chatwal, 2nd edition, 2010, Himalaya Publication House, New Delhi
9. Biopharmaceuticals, Jogdand, S. N., 2006, India. Himalaya Publishing House, New Delhi

Reference Books:

Title, Author, Edition, year of publication, Publisher

1. Strategies for Organic Drug Synthesis and Design, D. Lednicer, 2nd edition, 2009, Germany: Wiley.
2. Medicinal Chemistry, A. Kar, 2007, India: New Age International (P) Limited.
3. Biopharmaceutics and Clinical Pharmacokinetics–Gibaldi, Milo, 1991, United Kingdom, Lippincott Williams & Wilkins.
4. The Pharmaceutical CODEX: Principles & Practice of Pharmaceutics, Lund, Walter, 12th edition, 2009, India, CBS Publishers & Distributors.
5. GMP in Practice: Regulatory Expectations for the Pharmaceutical Industry. Vesper, James L., 2nd edition, 2011, United States, Parenteral Drug Association.
6. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Allen, Loyd, 10th edition, 2014, United States: Wolters Kluwer Health.
7. Drug Delivery Systems, Ranade, Vasant V.., Hollinger, Mannfred A.., Cannon, John B., 2nd edition, 2003, United States: CRC Press.

E - resources:

1. https://www.sciencedirect.com/science/article/abs/pii/B9780128198698000197
2. https://www.youtube.com/watch?v=oKBt-Noejxs
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6117650/

Semester-IV(Medicinal Chemistry)

Course code: MCH43MML612 **Course name:** Chemistry of Natural Products **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise fundamentals of organic chemistry from UG level.
Course Objectives:
The main objective of the course is to create awareness about the various classes of natural products, their structural features, and biosynthesis.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Recognize various classes of natural products
CO2: The nomenclature and stereochemistry of each class
CO3: Describe the structural feature and biosynthesis of representative examples of each class
CO4: Apply the various isolation techniques
CO5: Flavonoids and their biosynthesis

Contents

Unit	Content	Teaching Hrs
I	**Biogenesis:** The building blocks and construction mechanism of Terpenoids – Mono, Sesqui, Di and Triterpenoids and cholesterol, Alkaloids derived from ornithine, lysine, nicotinic acid, tyrosine and tryptophan., The Shikimate pathway – cinnamic acids, lignans and lignin, coumarins, flavonoids, and stilbenes, isoflavonoids and terpenoid quinones (Ref. 8, 9, 10), Arachidonic acid – Prostaglandins & thromboxanes.	9
II	**Terpenoids and Carotenoids** **Terpenoids**: Introduction, biological importance, classification, occurrence and isolation, isoprene rule, structure determination and biosynthesis of Citral, Geraniol, α-Terpineol, Menthol, Farnesol, Zingiberene **Carotenoids:** Methods of isolation. structural relationship of α-, β- and γ-carotenes. structure elucidation and synthesis of β-carotene.	9
III	**Alkaloids** Definition, nomenclature, occurrence, isolation, classification, role of alkaloids in	9

	plants, General methods of structure elucidation, Structure, stereochemistry, and synthesis of the following: Ephedrine, (+)-coniine, nicotine, atropine, Quinine, and Morphine.	
IV	**Steroids:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, structure determination, and synthesis of Bile acids, Androsterone, Testosterone, Estrone, and Progesterone, biosynthesis of steroids	9
V	**Plant Pigments, Porphyrins & Prostaglandins** **Plant Pigments:** Occurrence nomenclature and general methods of structure determinations, isolation, and synthesis, Quercetin, Quercetin-3-Glucoside, Cyanidin-7-arabinoside cyanidine, Hirsutidin Biosynthesis of Flavonoids: Acetate pathway and shikimic acid pathway. **Porphyrins**: Structure and synthesis of Haemoglobin and chlorophyll **Prostaglandins:** Occurrence, nomenclature, classification, biogenesis, and physiological effects Synthesis of PGE2 and PGF 2	9

Text Books/Research articles:
Title, Author, Edition, year of publication, Publisher
1. The Total Synthesis of Natural Products, John ApSimon, Volume 1 and 6, 2009, Germany: Wiley. 2. Medicinal Natural Products: A Biosynthetic Approach, P. M. Dewick, 2nd edition, 2002, United Kingdom: Wiley. 3. Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products, 5/E, I. L. Finar, 5th edition, 1956, India: Pearson Education. 4. Natural Products. Their Chemistry and Biological Significance, Mann, J., Davidson, R.S., Hobbs, J.B., Banthorpe, D.V., and Harborne, J.B., 1st edition, 1994, Addison Wesley Longman, Harlow, UK. 5. Chemistry of Natural Products, Bhat, S. V., Nagasampagi, B., Sivakumar, M., 1st edition, 2005, Germany: Narosa. 6. Medicinal Natural Products: A Biosynthetic Approach, Paul M. Dewick, 2nd edition, 2002, United Kingdom: Wiley.

7. Secondary metabolism, J. Mann, 1987, United Kingdom: Clarendon Press.
8. Chemical aspects of biosynthesis, J. Mann, 1994, Japan: Oxford University Press.

Reference Books:

Title, Author, Edition, year of publication, Publisher

1. Chemistry of Natural Products, O. P. Agarwal, Vol- 1 &Vol-2, 2006, Goel Publishing House, India
2. Biogenesis of Natural Products, Kumar, B., Chopra, H. K., 2005, United Kingdom: Alpha Science.
3. Chemistry of Natural Products: A Unified Approach, N. R. Krishnaswamy, 1999, India, Universities Press, India.
4. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M. I. Choudhary, 1998, Harwood Academic publishers
5. The Total Synthesis of Natural Products, John ApSimon, Volume 9, 2009 Germany,Wiley.
6. The Alkaloids: Chemistry and Physiology, H. L. Holmes, R. H. F. Manske, Volume 1, 2014,United States, Elsevier Science.
7. Chemistry of Terpenes and Terpenoids, A. A. Newman, 1972, United Kingdom: Academic Press.
8. Aspects of Terpenoid Chemistry and Biochemistry: Proceedings of the Phytochemical Society Symposium, Liverpool, Trevor Walworth Goodwin, April 1971. India: Academic Press.
9. Natural Products Chemistry, Koji Nakanishi, Shô Itô, Toshio Goto, Volume 1, 2013, Japan: Elsevier Science.

E - resources:

9. https://www.google.com/search?client=firefox-b-d&sca_esv=ebabc885052a0758&q=chemistry+of+natural+products&tbm=vid&source=lnms&sa=X&ved=2ahUKEwjwv-_gureEAxVQsVYBHd6oBjMQ0pQJegQIDhAB&biw=1472&bih=705&dpr=1.3#fpstate=ive&vld=cid:9c80535e,vid:s-SoJpQB4mA,st:0

10. https://chemnote.weebly.com/uploads/2/5/8/6/25864552/alkaloids.pdf

Semester-IV(Medicinal Chemistry)

Course code: MCH43MEL611 **Course name:** Chemoinformatics **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should learn the fundamentals of Computer applications and biochemistry.
Course Objectives:
The main objective of the course is to create awareness about cheminformatics, basic principles of stereochemistry, and apply the biological databases for drug synthesis
Course Outcomes: At the end of the course, the students will be able to -
CO1: Recognize the various software of chemoinformatics and apply them in drug design.
CO2: Predict the stoichiometric ratio of the precursors
CO3: Perform molecular docking study using computer-aided programs
CO4: Analyze biological database
CO5:Preduct the Properties of Amino acids and Proteins

Contents

Unit	Content	Teaching Hrs
I	**Mathematics Process** Graph theory and molecular numerology; Logic, sets and functions; Algorithms, integers, and matrices; Mathematical reasoning, induction and recursion; Counting; graphs, trees and sets, basic probability and statistics; Markov processes	9
II	**Basics of Biomolecules** Basic Stereochemistry, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures.	9
III	**Chem Information** History of scientific information communication-chemical literature-chemical information chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources	9
IV	**Biological Databases** Introduction; Experimental sources of biological data; Publicly available	9

	databases; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualisation of sequence data; Visualization of structures using Rasmol or SPDB Viewer or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics.	
V	**Drug Design** Introduction to drugs, structure-based drug design. QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and De Novo Drug Design Virtual screening/docking of ligands. Protein structure, Drug action & enzymes. Drug action & receptors. Prediction of Binding Modes, Protein– Ligand binding free energies, Fragment-Based Drug Design, ADMET prediction.	9

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Trends in Bioinformatics, P. Shanmughavel, 2006, India: Pointer Publishers. 2.Advanced Organic Chemistry-Part A & B, Francis A. Carey and Richard J. Sundberg, 3rd edition, 1990, Plenum Press. 3.Principle of Bioinformatics, P. Shanmughavel, 2005, India: Pointer Publishers. 4.Stereochemistry of Organic Compounds, E. L. Eliel, , S. H. Wilen, 2008, India: Wiley India Pvt. Limited. 5.Bioinformatics Database Systems, Byron, K., Herbert, K. G., Wang, J. T. L., 2016Unite, d States: CRC Press.

Reference Books:
Title, Author, Edition, year of publication, Publisher
1.An Introduction to Chemoinformatics, A.R. Leach, V. Gillet, 2007, Netherlands: Springer Netherlands. 2.Chemoinformatics and Bioinformatics in the Pharmaceutical Sciences– ed. Himanshu Ojha, Navneet Sharma, Pawan Raghav, Ramesh K. Goyal, 1st edition, 21 May 2021, United Kingdom: Elsevier Science.

3.Drug Delivery Approaches: Perspectives from Pharmacokinetics and Pharmacodynamics, ed. Bret Berner, Heather A. E. Benson, Michael S. Roberts, Toufigh Gordi,1st edition, 4 August 2021, United States, Wiley.

4.Principles The Organic Chemistry of Drug Design and Drug Action, Mark W. Holladay, Richard B. Silverman, 3rd edition, 2014, Elsevier.

5.Genomics and Proteomics: Principles, Technologies, and Applications, Devarajan Thangadurai, Jeyabalan Sangeetha, 2015, Canada: Apple Academic Press.

E - resources:

1.https://www.slideshare.net/DHARMENDRABARIA1/basic-aspects-of-stereochemistry

2.https://mgcub.ac.in/pdf/material/20200406015739416c3962e5.pdf

Semester-IV(Medicinal Chemistry)

Course code: MCH43MEL627 **Course name:** Organic Synthesis **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should learn the fundamentals of organic chemistry and reagents for organic synthesis from UG level.
Course Objectives:
The main objective of the course is to impart understanding about retrosynthetic approaches, important functional group interconversion and information related to protecting groups
Course Outcomes: At the end of the course, the students will be able to -
CO1: Describe ring synthesis via a retrosynthetic approach.
CO2: Predict the mechanism of retrosynthesis in complex molecules and natural products
CO3: Describe protective groups in organic synthesis; with special emphasis on the protection and deprotection of hydroxyl, carbonyl, carboxylic acid, and amines.
CO4: Understand the concepts of one-, two-group C-C bond disconnections
CO5: Synthesis of 3, 4, 5 and 6 membered rings

Contents

Unit	Content	Teaching Hrs
I	**Disconnection Approach** Disconnection Approach:Introduction to: (i) Grounding of organic chemistry for understanding retrosynthesis; (i) Retrosynthetic analysis and designing of the synthesis; (ii) Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions, importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations: chemoselectivity, regioselectivity, stereoselectivity, enentioselectivity, Reversal of polarity, cyclization reactions, amine synthesis.	9
II	**Protecting Groups** Protecting Groups: Protection and deprotection of hydroxyl, carbonyls in aldehydes and ketones, amines, carboxylic acids, alkenes, and alkynes.	9
III	**C-C Disconnections** C-C Disconnections: (i) One group C-C Disconnections: Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. (ii) Two group C-C Disconnections: Diels-Alder reactions, 1,3 difunctionalized compounds and α, β-unsaturated compounds, control in carbonyl condensations, 1,5 difunctionalized	9

	compounds, Michael addition and Robinson annelation.	
IV	**Ring Synthesis** Ring Synthesis: Introduction to ring synthesis, saturated heterocycles, synthesis of 3, 4, 5 and 6 membered rings, rearrangements and photochemistry in synthesis, aromatic heterocycles.	9
V	**Illogical' two group disconnections:** The 1,2-Dioxygenation Pattern, α-Hydroxy Carbonyl Compounds, 1,2-Diols, Illogical' Electrophiles, eview Problems, The 1,4-Dioxygenation Pattern, 1,4-Dicarbonyl Compounds.	9

Text Books:

1. Advanced Organic Chemistry: Part A: Structure and Mechanisms, Carey, F. A., Sundberg, R. J., 5th edition, 2007, Germany: Springer US.
2. Stereochemistry of Organic Compounds: Principles and Applications, Nasipuri, D., 2nd edition, 1994, India: Wiley Eastern.
3. Stereochemistry of Organic Compounds, Eliel, E. L., Wilen, S. H., 2008, India: Wiley India Pvt. Limited.
4. Modern Methods of Organic Synthesis South Asia Edition, Carruthers, W., Coldham, I., 4th edition, 2015, United States: Cambridge University Press.
5. Fieser and Fieser's Reagents for Organic Synthesis, Volume 16, Fieser, M., 1992, India: Wiley.

Reference Books:

1. Organic Synthesis, Smith, M., 4th edition, 2016, United Kingdom: Elsevier Science.
2. Advanced Organic Chemistry: Part B: Reaction and Synthesis, Carey, F. A., Sundberg, R. J., 4th edition, 2007, Germany: Springer US.
3. Organic Synthesis: The disconnection approach, Stuart Warren, 2007, India: Wiley India Pvt. Limited.
4. Designing organic syntheses: a programmed introduction to the synthon approach, Warren, S., 1978, United Kingdom: Wiley.
5. The logic of chemical synthesis. Sweden, E.J. Corey, 1991, Nobel Foundation [Nobelstiftelsen].

E - resources:
11. https://doi.org/10.1002/chem.201702235
12. https://www.youtube.com/watch?v=iFnLkCa7HbQ

Semester-IV(Medicinal Chemistry)

Course code: MCH43MEL628 **Course name:** Bioactive Heterocyclic Chemistry **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should learn the fundamentals of heterocyclic chemistry and reagents for organic synthesis from UG level.
Course Objectives:
The main objective of the course is to classify simple heterocyclic aromatic compounds as electron-deficient or electron-rich and explain their reactivity based on these properties.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Apply organometallic reactions that are applied in heterocyclic chemistry.
CO2: Synthesize of important electron-deficient nitrogen-containing heterocycles; pyridines, diazines, and their benzo-condensed analogs.
CO3: Synthesize of important electron Rich heterocycles; furans, pyrroles and thiophenes and 1,3-azoles, and benzo-condensed analogs.
CO4: Describe the structures of classes of heterocyclic aromatic organic compounds.
CO5: Synthesis of bicyclic heterocyclic compounds

Contents

Unit	Content	Teaching Hrs
I	**3 & 4-membered rings:** 3-membered rings: Aziridines, Oxiranes, Thiiranes, 4-membered rings: Azetidines, Oxitanes and Thietanes	9
II	**5-membered rings:** Five-membered rings with one heteroatom: Pyrrolidine, Furan, Pyrrole and Thiophene Five-membered rings with two heteroatoms: Imidazole, Pyrazole, Oxazole, Isoxazole, Thiazole, Isothiazole.	9
III	**6-membered rings:** Six-membered rings with one heteroatom: Pyran, Pyridine Six-membered rings with two heteroatoms: Piperazine, Morphine, Thiomorphine, Pyridazines, pyrimidines, pyrazines, Six-membered rings with three heteroatoms: Hexahydro-1,3,5-triazine Six-membered rings with three heteroatoms: Tetrazine	9
IV	**Benzofused heterocycles:** Benzopyrroles, Benzofuran, Indole, Benzothiophene, Benzoxazole, benzthiazole, Benzimidazole, Quinolines, Isoquinoline, Quinazolines, Coumarins and	9

	Chromones, Purines and Pteridines.	
V	**Heterocyclic Chemistry** IUPAC Nomenclature of heterocyclic rings [3-10 membered] containing O,S, & N atoms. Nomenclature of above rings containing mono-, di-, &multiple [same or different] heteroatoms should also be covered. Nomenclature of 2 & 3 fused rings containing mono-, di-, & multipleheteroatoms [same or different] should also be covered. Syntheses &reactions of three to six-membered rings in detail.	9

Text Books:

1.An Introduction to the Chemistry of Heterocyclic Compounds, Acheson, R. M.,1967, United Kingdom: Interscience Publishers.

2.Heterocyclic Chemistry, Joule, J. A., Mills, K., 5th edition, 2013, Germany: Wiley.

3.The Organic Chemistry of Drug Design and Drug Action, Silverman, R. B., 2012, United Kingdom: Elsevier Science.

4.The Chemistry of Heterocycles: Structure, Reactions, Syntheses and Applications, Eicher, T., Hauptmann, S., Suschitzky, H., Suschitzky, J., 2002, Germany: Wiley.

5.Heterocyclic chemistry, Gilchrist, T. L., 1992, United Kingdom: Longman Scientific & Technical.

Reference Books:

1.Organic Chemistry, Clayden, J., Greeves, N., Warren, S., 2nd edition, 2012, United Kingdom: OUP Oxford.

2.Heterocyclic Chemistry, R.K. Bansal, 3rd edition, 2020, New Age International.

3.Strategies for Organic Drug Synthesis and Design, Lednicer, D., 2nd edition, 2009, Germany: Wiley.

4.Heterocyclic Chemistry: Volume II: Five-Membered Heterocycles, Gupta, R. R., Kumar, M., Gupta, V., 2013, Germany: Springer Berlin Heidelberg.

5.Synthesis of Saturated Oxygenated Heterocycles I: 5- and 6-Membered Rings, Janine Cossy, 2014, Germany: Springer Berlin Heidelberg.

E - resources:
1.https://www.google.co.in/books/edition/Heterocyclic_Chemistry/41nmCAAAQBAJ?hl=en&gbpv=
2.https://www.google.co.in/search?q=Benzofused+heterocycles:&sca_esv=15e84c835f9706f1&sca_upv=1&hl=en&gl=in&tbm=vid&source=lnms&sa=X&ved=2ahUKEwi1o52s_reEAxU3ja8BHZTlAt0Q0pQJegQIAxAG&biw=1472&bih=705&dpr=1.3#fpstate=ive&vld=cid:7dff6f97,vid:S16g6O84

Semester-IV(Medicinal Chemistry)

Course code: MCH43MEP609 **Course name:** Chemistry Lab-VII **Course category:** Major Elective
Credits: 1 **Teaching scheme:** P-2 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Separation, purification and synthesis of derivatives ets. from Ist year M. Sc. Chemistry.
Course Objectives:
The main objective of the course is to demonstrate/apply the isolation and purification processes for organic compounds.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Apply knowledge of Filtration techniques.
LO2: Perform Recrystallisation in aqueous and organic solvents.
LO3: Perform Solvent extraction in aqueous and organic solvents.
LO4: Perform the methods for the preparation of useful compounds using named reaction.
LO5: Apply the technique of separation, crystallization and purification techniques.

Content

Sr.No.	Title of the Experiment
1	• **General considerations.**
2	• **Filtration techniques.**
3	• **Recrystallisation techniques.**
4	• **Sublimation techniques - freeze drying.**
5	• **Solvent extraction.**
6	• **Drying of liquids or of solutions of organic compounds in Organic**
7	• **Distillation under diminished pressure ("vacuum' distillation)**
8	• **Distillation at atmospheric pressure**
9	• **Steam distillation**
10	• **Ffractional distillation at atmospheric pressure**

Reference Book / Hand Books/ Lab Manual
1. A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India
2. Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
4. Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
5. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication

Semester-IV(Medicinal Chemistry)

Course code: MCH43RPJ608 **Course name:** Research Project **Course category:** Research Project
Credits: 6 **Teaching scheme:** P-12 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Separation, purification and synthesis of derivatives ets. from Ist year M. Sc. Chemistry.
Course Objectives:
To design and complete research-oriented project in a particular context related to recent advances in current research.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Apply knowledge of Filtration techniques.
LO2: Perform Recrystallisation in aqueous and organic solvents.
LO3: Perform Solvent extraction in aqueous and organic solvents.
LO4: Perform the methods for the preparation of useful compounds using named reaction.
LO5: Interpret observed data statistically

Contents

Sr.No.	Title of the Experiment
1	**Respective Department Faculty will give the project to the students.** After the successful completion of the project, Dissertation/ presentation/ Seminars will be conducted at the department in the presence of an external expert. (At least one research paper publication is desired based on the research project completed.)

Reference Book / Hand Books/ Lab Manual
1. A Textbook of Practical Organic Chemistry - A. I. Vogel, 5th Edition, 2003, Pearson India
2. Practical Organic Chemistry - Mann & Saunders. 4th edition, 200, Pearson Education India
3. A Handbook of Quantitative & Qualitative Analysis- H. T. Clarke.4th edition 200, CBS publishers and distributors pvt ltd.
4. Reagents in Organic Synthesis by Fieser and Fieser. Ist Edition,
5. Systematic Lab Experiments in Organic Chemistry by Arun Sethi. , Ist edition, 20003, New Age. Int. Pubication

Syllabus
Semester-III (Polymer Chemistry)

Course code: MCH43MML633 **Course name:** Principles of Polymer Chemistry **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should revise basic concept of polymer
Course Objectives:
To study the fundamental concepts of polymer chemistry including the structure of monomers, functionality, and classification of polymers based on source, composition, conditions, molecular weight, geometry, and Nomenclature of polymers.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Distinguish the basic concept of polymerization reactions involved in the Macro molecules and micro molecular reactions.
CO2: Become fully aware of the stereo chemistry and physical status of polymer molecules, molecular weight, stereo specificity and stability of polymer compounds.
CO3: Understand the study of methods of polymerization reaction and their properties, advantages, disadvantages, modifications and applications.
CO4: Describe the method of polymerization
CO5: Depict the mechanism of polymerization .

Contents

Unit	Content	Teaching Hrs
I	**General introduction to polymers** General introduction to polymers with emphasis on important concepts such as monomers, precuations and synthesis of some monomers, functionality and physical state (amorphous and crystalline), classification of polymers on the basis of source, elemental composition, heat, pressure, chemical reactivity, Chemical/monomer composition, geometry and stereo regularity. Concept of molecular weight, Nomenclature of Polymers.	9

II	**Chemistry and mechanism of Polymerization** Chemistry and mechanism of Polymerization - Definition of polymerization, Factors affecting on polymerization, Addition polymerization (free radical, ionic and co-ordination polymerizations), Condensation polymerization-molecular weight in step growth polymerization, Ring opening polymerization. Redox Polymerization, Living radical polymerization, Co-polymerization, Co-polycondensation (with Examples). Plasma polymerization, Photo polymerization, Electro chemical Polymerization, Metathesis polymerization, Group transfer polymerization- synthesis and applications.	9
III	**Reactions of synthetic polymers** Reactions of synthetic polymers -chemical modification; preparation of polymer derivatives, ATRP, Macromers in polymer synthesis. Isolation and purification of Polymers, Polymer fractionation: Fractional precipitation technique, Partial Dissolution (extraction) technique.	9
IV	**Methods of Polymerization** Methods of Polymerization – Bulk, solution, precipitation polymerization, Suspensions, emulsion, melt polycondensation, interfacial polymerization, solution Polycondensation, solid phase, gas phase and (formulation, mechanism, properties of the polymer produced advantages and disadvantages of each technique)	9
V	**Step Polymerizations** Reactivity of functional groups, kinetics of step polymerization, molecular weight control in linear polymerization, process conditions, multi-chain polymerization, cross-linking, step copolymerization	9

Text Books:

1. Principles of Polymerization: G. Odian, 2001 John Wiley & Sons, Singapore, .
2. Polymer Chemistry: M. P. Stevens, 2nd Ed., 2011 Oxford Univ. Press., Indian Edition,
3. Principles of Polymer Chemistry, A. Ravve, 1995. Plenum Press, New York and London,
4. Principles of Polymerisation, P. Bahadur, N. V. Sastry, 2002. Narosa Publishing House, New Delhi,
5. Principles of Polymer Systems, F. Rodriguez, C. Cohen, C. Ober, L. A. Archer, 5th edn., 2003. Taylor & Francis, New York,

Reference Books:

1. Introduction to polymer chemistry, G.S. Mishra, Wiley Eastern Ltd., 1993, New Delhi. Newage publishers.
2. Principle of polymer science-P Bahadur, N.V Sastry 2nd edition 2002, Narosa PublishingHouse..
3. Preparation methods of polymer chemistry-Wayne. R. Sorenson, Fred Sweeny, Tod. W. Campbell. 2001, A John Wiley & son, INC., Publication..
4. F.W. Billmeyer, Text Book of Polymer Science, 3rd edition, 2002, John Wiley and sons, NewYork,.

E - resources:

https://www.youtube.com/live/KMVWEIOzKJY?si=_vVOq2iW5CZB5Fnb

https://youtu.be/hLQM0XJiYKQ?si=D1itFxIu07hkOWbB

Semester-III(Polymer Chemistry)

Course code: MCH43MML634	**Course name:** Polymer Compounding **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Student should learn the processing methods of polymer	
Course Objectives:	
To study the Polymer compounding or blending of polymers and additives by using state of the art strategies to incorporate the required properties in the polymers.	
Course Outcomes: At the end of the course, the students will be able to -	
CO1: Differentiate various methods of compounding.	
CO2: Utilize tools, equipment, machines, and instruments of polymer compounding.	
CO3: Apply the knowledge of compounding and mixing processes for the polymers.	
CO4: Understand various mixing devices from the point of view of optimization of mixing time and power consumption.	
CO5: Learn the working principle of compounding machineries and parameters.	

Contents

Unit	Content	Teaching Hrs
I	**General introduction to Compounding** Introduction - Limitations of raw polymer (plastics and elastomers) materials needfor compounding. Properties and technical requirements of additives. Compounding additives Classification, role, mechanism, suitability and examples of following additives. Additives which assist processing stabilizers, lubricants-properties, mode of action of lubricants and, their application in the processing. The technical and economic significance of lubricants and processing aids. Additives which modify mechanical properties plasticizers-definition of term, solvency and Gelation properties, effects on hardness, tensile strength, elongation, low temperature resistance and electrical resistance. Reinforcing fillers, toughening agents or impact modifiers-impact modifiers for PVC.	9

II	**Processing additives-I** Function of processing additives, History of processing additives, Classification of processing additives, processing with plasticizer. Additives which reduced formulation costs – fillers-theory of the action of fillers and reinforcements, properties of filled andreinforced plastic, application criteria for fillers in thermoplastics, extenders .Additives, which modify surface properties – anti-static agents-chemical structure of anti-static agents, application, measurements of the anti-static agents, anti wear additives, adhesion promoters, anti-slip additives.	9
III	**Processing additives-II** Additives which modify optical properties – colorants-white pigments, black colorants, carbon blacks, lamp blacks, pigments, oxidic black pigments ,organic color pigments, optical brighteners. Anti-aging additives, antioxidants, autoxidation and mechanisms of anti-oxidation action, testing of antioxidants, mechanisms of U.V stabilization- UV absorbers, quenches, hydroperoxide decomposers, free redical scavengers, Other additives,light stabilizer testing, accelerated weathering, outdoor weathering, influence of pigments on light stabilizer performance, blowing agents, flame retardant, specialty additives.Vulcanizing agents, vulcanization and its effects, vulcanization reaction stages, determination of state of vulcanization, vulcanization systems.	9
IV	**Compounding – criterion and costing** Compounding – criterion, costs- quality balancing, analysis of quality costs, quality cost elements, prevention cost, appraisal costs, internal costs, external failure cost. Compounding procedures for different polymers and products. Curing characteristics	9
V	**Compounding machineries and parameters – Mixing technology:** Compounding machineries and parameters Mixing technology principle of mixing, quality control. Different types of mixing role mills, Internal mixers and solution mixers, mixing sequence on a two roll mill, mixing sequence in the internal mixer. Testing and evaluation of compounds, Mould cleaning compounds.	9

Text Books:

1. Rubbery materials and their compounds – Brydson.1988 Elsevior Applied Science.
2. Rubber technology and manufacture – C.M. Blow.-1971 Institution of Rubber Industry.
3. Rubber technology – Morice Morton.-1973 Springer-Science

Reference Books:

1. Handbook of plastic materials and technology – I I Rubin.- 1990, Wiley Inter Science
2. PVC technology 4th Edition, 1985, Titow W. V. Elsevier Applied Science.
3. Plastic additives and modifiers hand book, 1992, Van Nostrand Reinhold.-Springer.
4. Design Formulas for Plastics Engineers- NattS,Rao- 2004, Hanser publishers. NY.

E - resources:

https://youtu.be/BA0-P2jLM7s?si=YCOCHx5jccNTgnNj
https://youtu.be/daHgxi0S6BM?si=w7YyJWNKByL6vq-8

Semester-III (Polymer Chemistry)

Course code: MCH43MML635 **Course name:** Polymeric materials **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Student should learn the various polymer materials.
Course Objectives:
To study the polymers as materials by comparison of plastics with conventional materials like metals, alloys, ceramics wood etc.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand the properties of plastics and conventional materials like metals, alloys, ceramics wood etc.
CO2: Become fully aware of the structural properties of materials by theory and
CO3: Experimental analysis by XRD, FT-IR, SEM, Molecular weight by viscosity method.
CO4: Realize the mechanical properties such as tensile strength, elongation break, impact strength, Young's modulus, flexural, tear strength.
CO5: Syntheses/fabricate these materials in lab scale and studied their properties and applications.

Contents

Unit	Content	Teaching Hrs
I	**General introduction** Introduction- polymers as materials, comparison of plastics with conventional materials like metals alloys ceramics etc. Classification of polymers / plastics, structural aspects, manufacture properties and applications	9
II	**Thermoplastics** Thermoplastics- Polyolefins and allied polymers, Vinyl polymers Styrene and itscopolymers, Acrylics. Polyamides, Polyesters, PU, Fluoropolymers, Cellulose and its derivatives, Polycarbonates, Polyacetals, PES, PEI, PEEK, Polyacrylic acid, PVA, Polyvinylacetals.	9
III	**Thermosets** Thermosets- PF, MF, UF, Epoxy resins, Unsaturated polyester, Vinyl esters, Cyanateesters, Furan resins and silicone polymers.	9

IV	**Elastomers -I** Elastomers- Natural Rubber, isoprene rubber, butyl rubber, Nitrile rubber, chloroprene Rubber and Styrene-butadiene Rubber, EPDM, Vulcanization, Rubber chemicals.	9
V	**Elastomers -II** Polybutadiene rubber, butyl and neoprene/ chloroprene rubber, silicone rubber, etc. and their properties and applications Use of carbon black in rubbers, Manufacture of tyres	9

Text Books:
1. Plastic materials 7th Edition, 1965, Brydson.-Elsevier . 2. Rubbery materials and their compounds.1988, Brydson.- Elsevior Applied Science 3. Rubber technology and manufacture 2011, C.M. Blow. .- Institution of Rubber Industry. 4. High performance polymers, their origin and development- R.B. Seymour and G.S. Krishenbaum. 1986, Elsevier .

Reference Books:
1. Hand book of plastics materials and technology. Rubin, 1990, Wiley-Inter Science. 2. Plastics in Packaging – A.S.Athalye 1992 (Tata McGraw - Hill Publishing company, New Delhi). 3. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann - 6th Ed., 1995, Oxford. 4. Feldman.D and Barbalata.A, “Synthetic Polymers” 1996, Chapman Hall.
E - resources:
https://youtu.be/rXSPHseX5kk?si=pe1zHgH27YEqAuhY
https://youtu.be/rSpCM150SOw?si=Ej4aftwpQ-qeT5zo

Semester-III (Polymer Chemistry)

Course code: MCH43MML636 **Course name:** Inorganic & Natural Polymers **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Importance of natural and biopolymer
Course Objectives:
To study the Mineralogical type and inorganic polymers structure, properties and applications
Course Outcomes: At the end of the course, the students will be able to -
CO1: Realize the importance of inorganic and natural polymers and bio-polymers properties and applications.
CO2: Understand the isolation, characterization of natural and bio-polymers.
CO3: Understands proteins, nucleic acids, polysaccharides, macromolecular structures, biologicalfunctions, biological information, enzymatic activity, bio-polymers-viruses and phages-living macromolecules.
CO4: Analyze various structures of bio-polymers.
CO5: Understand the Structure, properties and applications of bio-polymers.

Contents

Unit	Content	Teaching Hrs
I	**General introduction** Introduction. Mineralogical type inorganic polymers. Covalent inorganic polymers. Polymeric sulfur,Silicone polymers,Phosphonate polymers. Polyphosphozenes: History, critical account of preparation, properties, structure and applications, co-ordination polymers (phthalocyanines).	9
II	**General survey** General survey of inorganic polymers, comparision of organic polymers with inorganic polymers, inorganic chains, rings and cages, fluorocarbons, carbides, borazenes, isopoly and heteropoly acids and their salts, silicates, zeolites.	9
III	**Natural polymers -I** Natural polymers: Classification, bio-polymers - introduction functions Cellulose, cotton, wool, silk, paper, rubber, collagen, hyaluroran melanin, lignin applications. Polymer from renewable resource	9

IV	**Natural polymers -II** Introduction Monomers and polymers from renewable resource materials: castor oil, natural gums, oleo chemicals, cashew nut shell liquid, carbohydrate derived monomers, furfural as a raw material for monomers and polymers.	9
V	**Structure of bio-polymers** Structure of bio-polymers: Proteins, nucleic acids and polysaccharides the Macromolecular structure and biological functions of polymers primary, secondary, tertiary and quaternary structures structure maintenance and transmission of the biological informations structure and enzymatic activity – mechano structural function of bio-polymers-viruses and	9

Text Books:

1. Inorganic Polymers – by J. E. Mark, H. R. Alcock and R. West, 2005, Prentice Hall Publishers.
2. Contemporary Polymer Chemistry- By J. E. Mark, H. R. Alcock and F. W. Lampe, 3rd Edition; 2005. Prentice Hall Publishers
3. Introduction to Polymer Chemistry-by Charles E. CarroherJr, 2010, CRC Press, Taylor & Francis, Boca Raton,.
4. Introduction to Biological Chemistry, by Awapara. 1968, Prentice Hall.
6 Contemporary Polymer Chemistry by H. R. Allcock and F. W. Lampe, 2003, Prentice-Hall Inc.

Reference Books:

1. Organic Polymer Chemistry – by K.J.Saunders, 2nd Edition, 1973, Chapman & Hall.
2. Polymeric Materials from Renewable Resources – RAPR Technology Ltd., 4 (7)
1991.J.M.Methven, Pergamon Press, New York.
3. Polymer Applications of Renewable Resource Materials by E.D. Carrahar and L.H. Sperling, 1981, Plenum Press, New York.
4. Principles of Polymer Science-P. Bahadur, N V Sastry-2002, Narosa Publishing House.

E - resources:

https://youtu.be/8jaxr0RhYPU?si=rQU5L3klQjRoHVnS

https://youtu.be/vzJvaFX_pkQ?si=rOgHryESuQs-IUXj

Semester-III(Polymer Chemistry)

Course code: MCH43MMP619 **Course name:** Polymer Chemistry Lab-III **Course category:** Major Mandatory
Credits: 2 **Teaching scheme:** P-4 **Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Students should acquire practical skills for Polymerization Process.
Course Objectives:
To study the thermodynamic behaviors of polymers in solutions at low concentrations, study the solubility and solubility parameters, nature of crystalline, effects of radiation on polymers and cross-linking of polymers.
Course Outcomes: At the end of the course, the students will be able to -
LO1: Realize the structure and properties of polymer molecules and micro molecular compounds.
LO2: Estimate the Iodine values, Acid values, DBP values and hydroxyl value by PVA and Cyclohexanol of various polymers.
LO3: Determine saponification value of oil, epoxy equivalent weight of the epoxy resin.
LO4: Study of three component system
LO5: Prepare thermosetting and thermoplastics.

Content

Sr.No.	Title of the Experiment
1	Estimation of Iodine value of Castor oil.
2	Acid value of maleic acid
3	Determination of DBP value and sieve analysis of Carbon black.
4	Estimation of acid value of oxalic acid.
5	Acid value of acrylic acid
6	Estimation of hydroxyl value by PVA and Cyclohexanol
7	Determination of epoxy equivalent weight of the epoxy resin.
8	Determination of saponification value of oil.
9	Study of three component system.
10	Determination of percentage of carbon black present in polymer.
11	Preparation of poly (glycerylphthalate) and determination of its acid value.
12	Preparation of polyethylene tetrasulphide and analysis by chemical methods.

13	Kinetics of polymerization of polyesterification reaction between ethylene glycol and phthalicacid.
14	Preparation of nylon 6, 10/6, 6 salt using HMDA- sebasic acid/ adipic acid
15	Solution and bulk preparation of a polyester/ polyether based polyurethane.
16	Preparation of cross- linked polymers:
17	Poly acrylic acid- co-polyacrylamide
18	Sodiumalginate and poly(vinylalcohol).
19	Preparation of acid catalysed phenol formaldehyde resin.
20	Synthesis of adipic acid from cyclohexanol using Conc. HNO3.
21	Estimation of carbohydrate by phenol sulphuric acid.
22	Estimation of lactose.

Text Books:

1. Practical physical chemistry-A. Findlay.2018

2. Experiments in physical chemistry- James and Pritchard.

3. Selected experiments in physical chemistry-Latham

4. Experimental inorganic/physical chemistry-M. A. Malathi, 1999, Horwood publishing chichester,England.

5. Preparative method in polymer science- Wayne R. Sorenson, Tod W. Campbell.

Reference Books:

1. Expermintals in polymer science -D.G. Hundiwale, V.D.Athawale, U. R. Kapadi,

2. V.V.Gite.,2009, NewageInternational(P) Limited, Pubilishers.

3. Systematic Lab experimentas in organic chemistry- ArunSethi, 2006, Newage International

4. Practical organic chemistry, S. Viswanathan, 1993Dey&Sitaraman, Publisher.

E - resources:

https://youtu.be/1IXvcf7rDXM?si=WLd-sHz15TACHb9u

https://youtu.be/uqRvJUamyuA?si=-4HZB217sqYfB9Yo

Semester-III (Polymer Chemistry)

Course code: MCH43MEL629 **Course name:** Physical chemistry of polymers **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Importance of natural and biopolymer
Course Objectives:
To study the thermodynamic behaviors of polymers in solutions at low concentrations, study the solubility and solubility parameters, nature of crystalline, effects of radiation on polymers and cross-linking of polymers.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Realize the structure and properties of polymer molecules and micro molecular compounds.
CO2: Understanding the thermodynamic properties of polymers in low concentration solution compared to conventional chemical moieties.
CO3: Become fully aware of the difference between polymers and conventional micro molecular structure, size, molecular weight and thermodynamic behaviors.
CO4: Study structure-properties relationships between various polymers.
CO5: Understand the properties of Biocomposites.

Contents

Unit	Content	Teaching Hrs
I	**Thermodynamics of polymers solutions** Thermodynamics of polymers solutions: introduction to thermodynamics,Thermodynamics solubility of the systems, Vanthoff's equation. Change in Volume ondissolution of polymers. Thermodynamics of dissolution of polymers and their structures. Partialmolar quantities, methods of calculation. Ideal and non-ideal solutions. Thermodynamic criteriaof polymer solubility, solubility parameter.	9
II	**Flory - Huggins theory** Flory - Huggins theory. Entropy of mixing, enthalpy of mixing, Change in Gibbs freeenergy of dissolution of polymers. Dilute solution theory based on excluded molar volume.Thermodynamic properties. Perturbation theory and closed expressions. Second virial co-efficients, real polymer chains, Third Virial coefficients, lattices theories.	9

III	**Natural polymers** Phase equalibra: thermodynamic derivation of phase rule. Theory of binary system.Solid liquid equilibria. Thermal analysis.Crystalizability of polymers, melting temperature of polymers. Three compound systems. Brownian plots. Systems involving two solids and a liquid. Partially miscible three liquid systems. Theory of polymer fractionation. The nature of the crystallinity state in polymers.	9
IV	**Structure of bio-polymer** Radiation chemistry of polymers, effect of radiation on polymers, structure and Properties, theory of polymer swelling, swelling of non-ionic network system. Swelling of ionic network system, IPN's: networks, sequential, simultaneous, full and semi IPN's, thermoplastic IPN's.	9
V	**Biocomposites** Definition classification natural bio, fibre and nano fillers as reinforcement, biodegradable/ bio-based resins as matrices. Properties of biocomposites. Applications in automobile &buildings.	9

Text Books:
1. Principles of polymer chemistry – P.J. Flory. 1995, Encyclopedias- 672 pages.
Reference Books:
1. Principles of polymerization – G. Odian. 2004, John Wiley & sons, Inc. 2. Polymer colloids, A comprehensive Introduction: Rober M. Fitch 1971, Springer ademic Press

E - resources:
https://youtu.be/rsztOS62rSU?si=gK0enQD3gGWx5ClP

Semester-III (Polymer Chemistry)

Course code: MCH43MEL630 **Course name:** Polymers Blends & Composites **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Importance of natural and biopolymer
Course Objectives:
1. A polymer blend is a mixture of two or more polymers that have been blended together to createa new material with different physical properties.
2. Polymer blends and composites are the physical mixture of two or more homo-polymers.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Realize and synthesis and fabricate new polymer blends and composites
CO2: Understand the standard test specimen preparation like mouldings for films, specimens for mechanical properties
CO3: Understand the different blending processes.
CO4: Study structure-properties relationships between various blending processes.
CO5: Describe the Preparation & Application of polymer Nanocomposites .

Contents

Unit	Content	Teaching Hrs
I	**Polymer Blends** Polymer Blends: Definition, difference between polymer blends and alloys,classification of polymer blends and alloys, principle of polymer compatibility, miscibility effectof molecular structure on polymer-polymer interaction, thermodynamics of polymer-polymermixing, Blend morphology & characterization. Techniques for determination of polymer-polymer miscibility, preparation and manufacture of polymer blends, characterization of blendsand applications.	9
II	**Polymer composite systems** Polymer composite systems: Definition, reason for composites, chemistry, properties& applications. Types of composites, reinforced thermoplastic, thermoset, elastomers – Resins(polyesters, epoxide, vinyl ester, phenol formaldehyde, polyimide, semi crystalline andamorphous polymers - PEEK, PP, PEK, PBT, PC, ABC, nylon etc.) additives, reinforcements(particulate, fibrous, gaseous). Factors affecting the performance of composites	9

III	**Processing techniques** Processing techniques: Open mould, hand layup and spray layup, vacuum bag moulding, pressure bag moulding, autoclave moulding, closed mould, SMC, DMC, RTM. Continuous manufacturing process- Pultrusion, filament winding, centrifugal casting,Application.	9
IV	**Structure of bio-polymers-I** Mechanical behavior of composites: Analysis of continuous fiber composites and Shortfiber composites. Deformation behavior of single ply and laminates. Creep, fatigue impact. Lectricaland thermal properties.	9
V	**Preparation & Application of polymer Nanocomposites** Preparations of polymer nanocompositesmelt blending, solution blending, latex coagulation, in-situ polymerization, characterization, properties and application. Polymers in nanoelectronics, Magnetic polymer nanocomposites, Wear resisting polymer nanocomposites, Packaging, Bio-medical, surface coatings, etc.	9

Text Books:

1. Paul D.A., and Newman S., "Polymer Blends", 1978, Academic press. Elsevier.

2. Dyson, R.W., "Engineering Polymers", Blackie, 1990. Champam& Hall, NY.

3. Crawford, R.J., Plastics Engineering 2nd edition, 1987, Pergamon Press.

4. Richardson, T., Composites 1987, a design guide industrial press Inc., New York,.

5. Polymer engineering composites. Ed.M.O.W.Richardson, 1977, Applied science publishers,London.

Reference Books:
1. Hand book of composites- G.lubin,VanNostrand,New York,1982. 2. Mohar J.G et al SPI Hand book of technology and engineering of Reinforced plastic composites, 3. Van Nostrand,New York. Polymer blends, Paul D.R and Newman S. Academic.2nd edition 1973 4. Polymer Blends and Alloys- R.P. Singh, C.K. Das, S. K. Mustafi- Asian Book Private Limited.2002 9. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt.Ltd., New Delhi, 2003

E - resources:
https://youtu.be/yFE9ZlytGlk?si=XAsGVSQ2xqgGLO9k
https://youtu.be/nsWkP8QmmAA?si=Erbe9MaX-E1Ykkbb

Semester-III (Polymer Chemistry)

Course code: MCH43MEL631	**Course name:** Flocculants and dispersants **Course category:** Major Elective
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Flocculants and dispersants	
Course Objectives:	
1. To study the introduction, classification, mechanism and uses of flocculants or clarificationagents and their legal and Economicalaspects.	
2. To study the modern trends in purification of water, juice clarification of sugarcane juice in sugar industry to improve the quality and yield of sugar products.	
Course Outcomes: At the end of the course, the students will be able to -	
CO1: Realize the structure properties and applications of flocculating and dispersant polymers	
CO2: Understand the standard test specimen preparation like mouldings for films, specimens for mechanical properties	
CO3: Understand the synthesis and mechanism of flocculating and dispersant polymeric materials	
CO4: Classify flocculating and dispersant polymeric materials	
CO5: Realize the structure properties and applications of bio-polymers.	

Contents

Unit	Content	Teaching Hrs
I	**Flocculants Introduction** Flocculants Introduction, Classification, Flocculation mechanism, Uses, Choice ofoptimum flocculants, Legal aspects, and Economic aspects.	9
II	**Dispersants and Disperse systems** Dispersants and Disperse systems Production of disperse systems, Stabilization ofdisperse systems, Stabilizers, Uses of dispersants.	9
III	**Surfactants Properties** Surfactants Properties and mode of action, Classification, Applications, Comparison of surfactants Vs dispersants, Chelants and precipitation inhibitors, Dispersants, Flocculants Vs dispersants. Emulsions, CMC and its importance in polymer chemistry.	9

IV	**Structure of bio-polymers-II** Polymer colloids: lyophilic and lyophobic colloids, Dispersion, coagulation, kineticsof coagulation, practical applications, adsorption, polymer adsorption of macromolecularmaterials. Stability of colloidal latex. Kineticstabililityof electrically charged hydrophobiccolloids, kinetic stability of electrically neutral hyderphobic colloids, electrostatic stabilization.	9
V	**Polymer degradation** Polymer degradation and stability, thermal degradation, chain scission, non-chainscission, oxidative and UV stability, chemical and hydrolytic stability, radiationeffect, mechano degradation, biodegradation biodegradable polymers (PLA) andstarch additives.	9

Text Books:
1. Ionic Polymers-Edited by L.Holiday, 1975, Applied Science Publishers.
2. Principles of polymer chemistry, P.J. Flory. 1953, Cornell university press.
3. Macromolecules in solutionH.merawetz. Interscience. N.Y. 1965Intersciencepubl

Reference Books:
1.Principles of polymer science, G. Odian. 2004, Johnwiley& sons.
2. Polymer colloids, A comprehensive Introduction: Rober M. Fiteh 1971 (Academic Press)

E - resources:
https://youtu.be/JkpMWjW3wbE?si=P5UVP9n2GCC-Fk_p
https://youtu.be/5uuQ77vAV_U?si=tZQ_fS2utphQ7cPR

Semester-III (Polymer Chemistry)

Course code: MCH43MEP610	**Course name:** Polymer Chemistry Lab-I **Course category:** Major Elective
Credits: 1 **Teaching scheme:** P-2	**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Students should acquire practical skills for Polymerization Process.	
Course Objectives:	
1. Prepare the graduate with practical hands-on different polymerization techniques.	
2. Prepare the graduate with hands on training pertaining to preparing polymers by chain andstep growth polymerisations.	
3. Provide hands on training to estimate various end groups of polymers andthus molecular weight and its application in further formulations as well.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1: Convert monomer to polymer.	
LO2: Select various polymerization techniques in polymer synthesis.	
LO3: Explain the polymerization mechanisms.	
LO4: Classify flocculating and dispersant polymeric materials	
LO5: Evaluate the end group values and apply this knowledge for further applications	

List of Experiments

1. Preparation of polymethyl methacrylate by emulsion polymerisation.
2. Radical copolymerization of styrene and methylmethacrylate.
3. Bulk polymerization of MMA with 2, 2-azo-bis-butyronitrile.
4. Copolymerization of styrene with MMA by free radical solution technique.
5. Preparation of cellulose acetate.
6. Grafting of starch/cellulose with methylmethacrylate by redox initiator.
7. Chlorination/chlorosulphonation of PE.
8. Film casting from polymer solution
   (1) PU (2) cellophane (3) cellulose acetate.
9. Bulk polymerization of styrene with benzoyl peroxide.
10. Preparations of DGEBA epoxy resin using Bisphenol-A and Epichlorohydrin.
11. Preparation of diglycidyl aniline epoxy resin.
12. Preparation of cellulose secondary acetate.
13. Preparation of polyester resin using Ethyleneglycol and maleic acid by polycondensation method.
14. Preparation of melamine- formaldehyde resin.

Text Books:
1. Practical physical chemistry-A. Findlay.2018 2. Experiments in physical chemistry- James and Pritchard. 3. Selected experiments in physical chemistry-Latham 4. Experimental inorganic/physical chemistry-M. A. Malathi, 1999, Horwood publishing chichester,England. 5. Preparative method in polymer science- Wayne R. Sorenson, Tod W. Campbell.

Reference Books:
1. Expermintals in polymer science -D.G. Hundiwale, V.D.Athawale, U. R. Kapadi, 2. V.V.Gite.,2009, NewageInternational(P) Limited, Pubilishers. 3. Systematic Lab experimentas in organic chemistry- ArunSethi, 2006, Newage International 4. Practical organic chemistry, S. Viswanathan, 1993Dey&Sitaraman, Publisher.

E - resources:
https://youtu.be/1IXvcf7rDXM?si=WLd-sHz15TACHb9u
https://youtu.be/uqRvJUamyuA?si=-4HZB217sqYfB9Yo

Semester-III (Polymer Chemistry)

Course code: MCH43RPJ609	**Course name:** Research Project **Course category:** Research Project
Credits: 4 **Teaching scheme:** P-8	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should acquire practical skills for Polymerization Process.	
Course Objectives:	
1. To design research oriented project on particular polymer.	
2. To search literature on selected polymeric material for project work.	
3. To identify/search the recent advances in polymeric technology.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1: Conduct experiment scientifically with safety for the preparation of polymers.	
LO2: To characterize the prepared material by using microscopic, spectroscopic, diffraction, adsorption and thermal techniques.	
LO3: Explain the polymerization mechanisms.	
LO4: Demonstrate the skill to write dissertation , communication skill in presentation	
To interpret observed data statistically.	
LO5: Analyze and differentiate various polymeric materials.	

Contents

1	**Respective Department Faculty will give project to the students.** After successful completion of project Dissertation/ presentation/ Seminars will be conducted at department in the presence of external expert. (At least one research paper publication is desired based on research project completed.)

Semester-IV (Polymer Chemistry)

Course code: MCH43MML637 **Course name:** Chemistry of High Polymers **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Molecular weight of polymer
Course Objectives:
1. To study the structure of polymers, Molecular weight and their types, polymer dispersity, degreeof polymerization, chain length and polymerization techniques.
2. To study the synthesis of polymer- support reagents or polymer-bound reagents it includes/avails both chemical reagent and polymer reagents.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Realize the concept of difference between chemical moieties(low molecular weight compounds) and polymer compounds.
CO2: Understand low molecular weight compounds have specific /sharp molecular weight and their properties and applications are also narrow and specific.
CO3: Understand the study of methods of polymerization reaction and their properties, advantages, disadvantages, modifications and applications.
CO4: Describe the method of polymerization
CO5: Depict the mechanism of polymerization .

Contents

Unit	Content	Teaching Hrs
I	**Basic Principles of molecular weight :** Importance of molecular weight control.Arithmetic mean-molecular weight average Mw, Mn, and Mv. Molecular weight distribution and itsimportance from the point of applications, Polydispersity index, determination of molecular weight-Theory, procedure and problems.	9
II	**Polymerization techniques:** Design criteria, polymer reactors, gas phase polymerization, comparison of the above. Batch and continuous processes, kinetics of cross-linking reactionsin thermosets and influence of additives. Kinetics of Polymerization, addition, condensation, redoxpolymerization and CFR polymerization.	9

III	**Fictionalization and reagents in polymer synthesis** Introduction: Polymer-Support materials, styrene based polymers, functionalizations of styrene based polymers via chloromethylation and other methods, determination of functionalizations in polymer supports. Polymer bound reagents. Introduction: polymeric oxidizing reagents, oxidation-reduction reagents, polymeric reducing agents, polymeric group transfer reagents, polymeric coupling agents, miscellaneous reagents, retardation inhibition, chain transfer branching effect, control of molecular weight, kinetic chain length, regulation and control, MWD, Carothers equation.	9
IV	**Polypeptide synthesis on polymer support** Introduction, principles of Merrifield'ssolid-Phase peptide synthesis, supports for solid phase peptide synthesis, linkage of first amino acid,protecting groups coupling of successive amino acids, cleavage of the resin- Peptide bond,purification, Peptides synthesis using polymeric active esters, basics of oligonucleotide synthesis,oligosaccharide synthesis, sequencing of peptides and proteins.	9
V	**Determination of molecular weight** End group analysis, cryoscopic method, ebulliometricmethods, membrane osmometry, vapour phase osmometry, light scattering, ultra centrifugation&viscometry	9

Text Books:
1. Textbook of polymer science – F.W. Bilmeyer. 1957, Wiley- India edition. 2. Polymer science – V.R. Gowarikar, N V viswanathan, Jayaadevsreedhar1986, New age international Publishers. 3. Plastic materials and processing , brydson.1965, Elsevier 4. Manufacture of plastics –Vol. I and Vol. II W. Mayo and Smith, van Nostrandreinhold 1964

Reference Books:
1.Chemical process industries, Shreve R. Norris, 1945, McGraw Hill education. 2. Rubber technology and manufacture, C.M. Blow. 1971, Institution of Rubber Industry. 3. Organic Chemistry and Synthetic Polymers by Lenz, 1968, Journal of chemical Education. 4. Polymers as Aides in Organic Chemistry. N.K.Mathur, C.K.Narang, R.E.Williams, 1980, AcademicPress, NY,.-Elsevier

E - resources:
https://youtu.be/LMSTMBX_2F4?si=kdZ048wWLolB28b7
https://youtu.be/p-yXd7Tks3c?si=VGjpp9hg7hUkjiq-

Semester-IV (Polymer Chemistry)

Course code: MCH43MML638 **Course name:** Structure Property relationship in polymers **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Structure Property relationship in polymers
Course Objectives:
1. To study the basic concept of structure of the polymer molecules /compounds or materials.
2. To study the molecular structure, properties and applications are depending on structure.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand the concept of synthesis of homo polymers, co -polymers, ter-polymers, block co-polymers, etc
CO2: Realize the structural modification by synthesis of various polymerization techniques, co-polymerization, blending, grafting depending on customer specifications.
CO3: Become fully aware of the importance of structural modifications like chemical and physical modification the properties and applications changes
CO4: Realize molecular weight can be altered by using inhibitors and activators, and chain extenders
CO5: Understand the Thermodynamic and transition properties of polymers. .

Contents

Unit	Content	Teaching Hrs
I	**Polymer properties** Approach and the concept. Chemical structure of polymers –Introduction: Shapes and energy consideration, co-polymers, hetero-atomic polymers. Physicalstructure of polymers– introduction: Melt viscosity, inter-chain and intra-chain forces; Glasstransition temperature; Crystallinity Elastomers, fibers, plastics and their correlation with Tgand Tm (structural features). Physical properties of polymers in relation to chemical structure Volumetric properties– Volume and density, thermal expansion.	9

II	**Calorimetric properties** Heat capacity, enthalpy and entropy; transitiontemperatures – Tg, Tm, and relationship between Tg and Tm of polymers; Solubility– Thesolubility parameter, solubility limits. The crystallinity of polymers,Molecular aggregation,molecular arrangement in crystallites, Polyethylene, syndiotactic vinyl polymers,PTFE, PVA,polyesters, polyamides, polydienes. The principles of crystallite structure, single crystals ofpolymers, determination, mechanism and kinetic treatment of crystalisation. Properties ofpolymers in fields of force.	9
III	**Mechanical (visco-elastic) properties** Mechanical (visco-elastic) properties, effect of shape and structure on material properties like modulus of elasticity, tensile properties, fracture toughness, impact strength, crazing, ductile-brittle transition. Influence of molecular structure on electrical and optical properties. Influence of the process variables, orientation, measurement, quantitative relationships for some physical quantities after orientation, generalized stress-strain relationship for polymers.	9
IV	**Diffusion in Polymer** Diffusion of gasses and vapors in polymers, influence of molecular structure topredict the properties of specialty polymers- Water soluble polymers, oil soluble polymers, oilinsoluble polymers, flame retardant polymers, flexible polymers, water repellant polymers, heatesistant polymers, transparent polymers.	9
V	**Thermodynamic and transition properties** Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm other transitions like β-transitions, upper and lower glass transition, Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy – Calculation of heat capacities of polymers.	9

Text Books:
1. Properties of polymers : correlation's with chemical structure by Van Krevelen, - Elsevier.4th Edition1972 2. Polymers: structure and bulk properties – Patrick Mearos. Journal of chemical education,1966 3. Structure properties relationships in polymers – Raymond B. Soymour and Charles E. Carraher, Plenum Press Newyork.1984 4. Plastics: how structure determines properties – Gruenwald 1993. Hanser publishers 5. Injection moulding theory and practice – I Rubin 1973.

Reference Books:
1. Handbook of engineering Polymeric materials by Nicholas P. Chermisinoff.1997 2. Injection moulding hand book by Rosato, 1985, Springer. 3. Properties and behaviour of polymer science-vol 2-A 2011, John Wiley & sons, INC.,Publication. 4. Property of polymers- D W Van Krevelen, K.teNijenhuis1972, Elsevier. 5. Edward Miller, "Plastics Products Design Hand Book", Marcel Dekker.

E - resources:
https://youtu.be/M_okW3vOtt4?si=EDA_sB6WpxoRfpIf
https://youtu.be/jUDyjFXOb8s?si=8mmg0Qmd0JJQ34Gc

Semester-IV (Polymer Chemistry)

Course code: MCH43MML639	**Course name:** Polymer Characterization **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Characterization techniques in polymers	
Course Objectives:	
1. To study the instrumentation theory, principle and applications of DSC and TGA for thermalanalysis and thermal stability of Polymers.	
Course Outcomes: At the end of the course, the students will be able to -	
CO1: Realize the theory, principle and instrumentation technique of DSC and TGA.	
CO2: Understand the Theoretical and instrumentation technique on various types chromatography.	
CO3: Cognize the theory and experimental method to determine molecular weight of polymers (by viscosity method).	
CO4: Students visit industries to understand the concepts of above techniques.	
CO5: Describe Polymer Morphology .	

Contents

Unit	Content	Teaching Hrs
I	**Differential Scanning Calorimeter (DSC)** Instrumentation, theory, practice and applications of thermal analysis :DSC:Physicaltransitions, melting thermograms, heat of fusion and degree of crystalanity or isotacticity. Randomcopolymer structure. Block co-polymer structure. Polymer mixture melting point depression bydiluents, crystallization, melts crystalisation, cold crystalisation. Glass transition- Crystal-crystaltransition. Chemical reactions-Curing, polymerisation. Kinetics of Curing (Broido's Method,Kissinger's Method), plasticizer effect.	9

II	**Thermal Gravimetric Analysis(TGA)** Determination of degradation kinetic parameters. Method of Freeman and Carrolmethods involving maximization rates. Method of multiple heating rates.Method of variable heatingrate for a single thermogram. Estimation of thermal stability from TGA curves. Quantitativemethods- Semi-quatitative and qualitative methods, thermal degradation behavior of some polymersby TG methods. Kinetics of thermal degradation, IPDT, OI, purity, fiber content, composition ofcompounded rubber.	9
III	**Chromatography Methods** GC, GPC and HPLC – Analysis of the purity of monomers, additives, principle's of GPC, mechanism of separation, theory and technique, instrumentation. Molecular weight distribution (MWD), purity and composition.	9
IV	**Polymer Morphology** Optical microscopy, TEM. SEM, AFM, X-ray diffraction analysis: Wide angle X-ray scattering (WAXS) and small angle X-ray scattering (SAXS), analysis ofmolecular structure of simple polymers, chain conformation, chain packing, disorder in crystals,degree of crystalinity, micro- structural parameters, degree of orientation. Basic principles of TMAand DMA.	9
V	**UV-visible spectroscopy** principle &theory Applications-qualitative and quantitative analysis, purity, cis-trans-conformation, molecular weight determination. Polymer degradation analysis.	9

Text Books:
1 Thermal charactrisation of polymeric materials – E.A. Turi.-Jornal of Polymer Science.1981 2. Analysis of polymers an introduction- T. R. Crompton, 1971, Springer. 3. Instrumental methods of analysis – Willard, dean and merit. 1975, Journal of chemical Education.

Reference Books:
1. Polymer charactrisation – D. Cambell and J.R. White.2nd edition 2000, CRC Press, 2. Experimental methods in polymer chemistry – J.F. Rabek.- 1980, Wiley Online Library. 3. NMR Frank A.Bcovey, 2nd edition 1988, Academic Press. 4. Nano Technology-Fundamentals and Applications-ManasiKarakare- I. K. International.2010.

E - resources:
https://youtu.be/P3-81C5mOuk?si=3GQ8madah_B5WYwE
https://youtu.be/2MRt2k8UZcw?si=rEyRXiikl1hG2n2H

Semester-IV (Polymer Chemistry)

Course code: MCH43MML640 **Course name:** Polymer Membrane & Drug Delivery **Course category:** Major Mandatory
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn Characterization techniques in polymers
Course Objectives:
1. To study the instrumentation theory, principle and applications of DSC and TGA for thermalanalysis and thermal stability of Polymers.
Course Outcomes: At the end of the course, the students will be able to -
CO1: Understand the concept of preparation membranes, used for various applications like separation techniques such as separation of toxic gases , bacteria, viruses
CO2: Realize the different techniques such as controlled drug delivery and muco adhesive polymers.
CO3: Become fully aware of the various applications of membranes such as micro filtrations, ultrafiltrations, nanofiltrations, reverse osmosis, Dialysis- elctrodialysis.
CO4: Visit industries to understand the concepts of Membrane techniques.
CO5: Understand Role of Polymers in controlled release of drug delivery.

Contents

Unit	Content	Teaching Hrs
I	**Fundamentals of Membranes** Introduction to membranes, definition, classification ofmembranes,. Homogenous dense membranes, Heterogeneous asymmetric membranes, Thin filmcomposite membranes, Liquid membranes-ion exchange membranes, Polymer selection fordevelopment of membranes, Polymer selection for development of membranes polymer property,Strength, Viscosity, Chemical resistance, Processing temperature, Factors membrane performance**.**	9
II	**Development and characterization of membranes-I** Development of polymer membranes,Modification, Blending, Cross linking,. Grafting- Copolymerization, Characterization ofmembranes, Solution techniques; Viscosity, Density, Ultrasonic velocity, Thermal methods; TGA,DSC, TMA,	9

III	**Development and characterization of membranes-II**Spectroscopy methods UV, FT-IR, NMR, Optical methods SEM, TEM and XRD.Application of Membranes, Various applications and uses of membranes; Micro filtration, Ultrafiltration, Reverse osmosis-Gas permeation, Pervaporation, Nano filtration, Dialysis, Electrodialysis.	9
IV	**Self-assemblies as promising Vehicles For Drug Delivery** Introduction, Various selfassembled aggregates as carriers, Surfactants micelles, Liposomes, polymeric aggregates, Polymeric micelles, Polyion, functional properties of polymeric carriers, Morphological criteria,solubility and stability- Biocompatibility, drug loading and releasing characteristics, Biological aspects, Pharmacokinetics at the systemic level, Cellular uptake , Release of drugs in the cell.	9
V	**Role of Polymers in controlled release of drug delivery** Introduction, Currentlyavailable polymers; Diffusion- Controlled systems- Solvent- Activated systems– Chemicallycontrolled systems, Magnetically controlled systems, Soluble polymers as drug carriers: Pinocytosis,Ideal soluble polymers, Biodegradable or bioerodible polymers: Drug release by matrixsolubilization, Erodible diffusional systems, Monolithic systems , Mucoadhesivepolymers,Polymer containing pendent bioactive substituents, Matrix systems.	9

Text Books:
1. Pervaporation membrane separation processes, RYM.Huang, 1991, Elsevier Publications. 2. Introduction to Molecular Science, Second Edition , Petrmunk and Tejraj M. Aminabhavi.1989, Wiley Online international, 3. Drug delivery systems (second edition)–VasantV.Ranade, A. 2003, Mannfred Hollinger.CRCPress,

Reference Books:
1. Polymer charactrisation – D. Cambell and J.R. White.2nd edition 2000, CRC Press. 2. Experimental methods in polymer chemistry, J. F. Rabek. 1980, Wiley Online Library. 3. NMR Frank A.Bcovey, 2nd edition 1988, Academic Press. 4. Nano Technology-Fundamentals and Applications-ManasiKarakare- I. K. International.2010

E - resources:
https://youtu.be/S4Rcn6ceAZk?si=SGhNQFc3_BAme-z7
https://youtu.be/b5PhiT0C6h0?si=WxW851YNAOUNl3B9

Semester-IV (Polymer Chemistry)

Course code: MCH43MEL632	**Course name:** Rubbery Technology **Course category:** Major Electives
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should Learn the basics in Rubbery Technology	
Course Objectives:	
1.	To promote and protect the interest, growth and development of the rubber industry.
2.	To foster Co-operation among individuals and units engaged in the manufacture of rubber goods with a view to advancing and safeguarding the interest of the industry.
Course Outcomes: At the end of the course, the students will be able to -	
CO1: Understand the fundamental concept of rubber and its properties and applications.	
CO2: Realize the specialty rubbers, high performance rubber.	
CO3: Become fully aware of the processing of rubbers.	
CO4: Understand the Synthesis, Properties and applications of rubbers.	
CO5: Visit industries to understand the concepts of Membrane techniques.	

Contents

Unit	Content	Teaching Hrs
I	**Fundamentals of Rubbers** Fundamentals of Rubber - Criteria for a polymer to behave as a rubber, Structure vsTg,chemical, mechanical and electrical properties, Polymerization types and techniques involved inproduction of general purpose rubbers , Ozone attack on rubbers, Protection against oxidation,Antioxidants, Network bound antioxidants, Vulcanization, Effect of cross linking density onproperties, Role of accelerators, Activators, Non–sulphur vulcanization systems.	9
II	**Synthesis Properties and applications of rubbers** Specialty rubbers heat resistant rubbers, Polyisobutylene, butyl and EPDM rubbers,Solvent/oil resistant rubbers, Nitrile, neoprene and chloroprene rubbers, EMA, ACM, EVA,Hypalon and chlorinated PE, High performance, specialty and modified rubbers, Fluorinecontaining and silicone rubbers, polyurethanes, polyethers, polysulphide, polyalkenomers andthermoplastic elastomers, Reclaim, liquid and powdered rubbers, ebonites.	9

III	**Processing of rubbers** Processing of rubber rubber processing – Mixing operations – Composition,Concentration, stabilization, coagulation, open mill mixing, internal and continuous mixers, Forming operations,Calendaring, Extrusion –Spreading and moulding operations.	9
IV	**Fundamentals of Rubbers-I** Manufacture of tyres and tubes rubber product manufacture, Tyres, Functions,requirements, Basic design reinforcing systems, Construction, Manufacture, Testing, Tubemanufacture, Compounding for tyre and tube. Belting, hoses and footwear, belting and hoses,	9
V	**Fundamentals of Rubbers-I** Conveyor, transmission (V and flat) belting. Trough ingmoulded, braided and hand–builthoses, Compounding, Footwear and ports goods, Hot air vulcanized, Compression moulded, Direct moulded process for shoe bottoming, Injection moulded sole and heel units , Safety and antistatic foot wear, Micro and macrocellular rubbers, expanding rubber by nitrogen gassing and chemical blowing agents, Tennicoit rings.	9

Text Books:

1. Rubber Technology- M.Morton, Van Nostrand Reinhold, 1987.

2. Developments in Rubber Technology, Vol. 1 – 4, A. Whelan and K.S.Lee, Applied 1981Science Publishers, London.

3. Hand Book of Elastomers- A.K. Bhowmick and H.L.Stephens, Marcel Dekker, 1988, NewYork,.

4. Rubbery Material and their Compound- J. A. Brydson, Kluwer 2001, Academic PublishersGroup,

Reference Books:

1. Injection Moulding Machine- A. Whelan1989, Elsevier Publications, London,.

2. A.K. Bhowmick and H.L.Stephens, Hand Book of Elastomers, Marcel Dekker, 1988, NewYork,.

3. B. Kothandaraman, Rubber Materials, 2008, Ane Books Pvt. Ltd., New Delhi,.

4. C.M.Blow and C.Hepburn, “Rubber Technology and Manufacture”, 2nd Edn., 1982, Butterworths, London,.

E - resources:
https://youtu.be/LG_DJIkXN0I?si=9k0ljElLR9ECh9NX
https://youtu.be/5uEYvyCFQgI?si=n_7SKE4a3bRjIyb0

Semester-IV (Polymer Chemistry)

Course code: MCH43MEL633 **Course name:** Surface Coatings & Adhesion **Course category:** Major Electives
Credits: 3 **Teaching scheme:** L-3 **Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should know the purpose of applying the coating may be decorative, functional, or both.
Course Objectives:
To provide basic information about Application of surface chemistry,
Course Outcomes: At the end of the course, the students will be able to –
CO1: Realize the basic concept of industrial coating resin synthesis, formulations and applications as coatings.
CO2: Understand the manufacturing and properties of organic and inorganic pigments and their dispersions.
CO3: Become fully aware of the surface preparation and coating applications and also testing and evaluation of coatings.
CO4: Understand the properties and application of coating material,
CO5: Describe the properties of Pigments & the process of dispersion.

Contents

Unit	Content	Teaching Hrs
I	**Industrial coating resins** Industrial coating resins- Synthesis, properties, formulations and applications as coatingsof the following resins to be discussed. Alkyds and polyesters, phenol formaldehyde, silicon resin,epoxy resin, chlorinated rubber, polyurethanes and acrylic resins.	9
II	**Pigments & their dispersion** Pigments & their dispersion - Manufacturing and properties of organic and Inorganicpigments. Factors affecting dispersions, preparation of pigment dispersion, grinding equipment.	9

III	**Coating processes** A: Surface preparation: Mechanical cleaning, solvent cleaning, alkali cleaning and acidpickling. Chemical conversion treatment. B: Coating application: Mechanism of film formation a. Applying processes: Brushing, dip coating and flow coating, curtain coating, rollercoating and spray coating b. Fixation c. Curing: Physical, chemical and oxidative C: Factors affecting coating properties.	9
IV	**Testing and evaluation of coatings** Testing and evaluation of coatings – Physico- mechanical, optical, and environmental.Application of paints- Appliance finishes, automotive finishes, coil coating, can coating, marinecoating, Curtain coatings and aircraft coating.	9
V	**Mechanical properties:** Tensile properties, compression properties, flexural properties, shearproperties, impact resistance, toughness, tear resistance, abrasion resistance and hardness, creep, stress relaxation, fatigue properties, flexing and resilience.	9

Text Books:
1. Organic coatings- Science and Technology, Swaraj Paul, 1985, WILEY. 2. Handbook of Plastics- Elastomers and Composites - Charles A Happer, 1968, McGraw-Hill, 3. Formulation of organic coatings- Norman I. Geynes, Glenn N. Danziger, Frederick C. KinslerVan 1967, Nonstrand Co. 4. The technology of paints- Varnishes and lacquers-Ed., by Morgan & Martens, Reinhold,1968

Reference Books:
1. Hand book of Adhesive technology, Pizzi, A. (ed); Mittal, K.L. (ed), Marcel Dekker, 1996, NewYork, 2. Adhesion and adhesives technology: an introduction, A.V. Pocius, Hanser/Gardner, Munich,1997. 3. Adhesion and Adhesives - Science and Technology, Kinloch, A.J., 1987, Chapman and Hall,

E - resources:
https://youtu.be/Zp2fNHCoYqk?si=l4jI1z9sgkaeFmv6
https://youtu.be/FGv0PL04PK4?si=LlgA7vUqbR1Y8a-B

Semester-IV (Polymer Chemistry)

Course code: MCH43MEL634	**Course name:** Latex and foam technology **Course category:** Major Electives
Credits: 3 **Teaching scheme:** L-3	**Evaluation scheme:** CA–60, ESE–40
Pre-requisites: Students should know the fundamentals of Latex and foam technology.	
Course Objectives:	
To provide basic information about Latex and foam technology	
Course Outcomes: At the end of the course, the students will be able to –	
CO1: Understand the synthesis of latex foam, laminated paper, latex coated with natural fibers	
CO2: Realize the concept of compounding by visiting the rubber industries.	
CO3: Become fully aware of the Latex materials.	
CO4: Understand the properties and application of foam technology.	
CO5: Know the technique for Production of latex extruded product	

Contents

Unit	Content	Teaching Hrs
I	**Introduction to NR & amp; synthetic lattices** Introduction to NR & amp synthetic lattices: Molecular and physical structure; Methods ofmanufacture and machineries and stabilization of dispersion. Artificial dispersion, vulcanized latex. Compounding of latex Micro and nano fillers, vulcanizing ingredients, Dispersing agents,stabilizing agents.	9
II	**Testing on latex mechanical stability** Testing on latex mechanical stability, pH, particle size of dispersion and size distribution.Manufacture of latex based products. Latex thread, dipped goods, casting, spraying, spreading,adhesives, rubberized coir, rubberized hair, micro-porous ebonite, can sealing, latex cements.	9
III	**Latex foam** Latex foam, latex laminated paper & boards, latex coated fabrics & cords. SBR,nitrile, neoprene, thiokol, high styrene resin, PVAc, PVC, acrylic, carboxylated SBR & vinylpyridine latex.	9

IV	**Compounding Methods.** Compounding for neoprene latex, neoprene latex coated paper, latex mixed with cement,emulsion paints, electro deposition of latex, urethane foam, cold foam, integral skin foam, semirigid foam, rigid PU foam etc. Foam testing, concepts of micro-cellular structure, closed and opencell structures. Industrial uses of latex and foam technologies.	9
V	**Production of latex extruded product** adhesives and latex spreading Latex extrusion-principle formulation-equipments-process products-equality control .latex thread, latex tubing. Latex adhesives formulation-preparation-compare with solvent based adhesives.different types of adhesives latex spreading formulation-impregnation-machinery-for latex spreading different products .	9

Text Books:
1. Latex Foam Rubber- E.W. Madge, 1962, .MacLaren and Sons Ltd., London, 2. Polymeric Foams and Foam Technology, 2 nd Ed.- Daniel Klempner and Vahid Sendijarevic(eds.), 2004, Hanser Gardner,.

Reference Books:
1. Basic Elastomer Technology- Edited by K.C. Baranwal and H.L. Stephens, Rubber Division, 2001, Published by American Chemical Society.
E - resources:
https://youtu.be/xsUHvfrJJDw?si=Hu2758iZYSexyT19
https://youtu.be/UjdiOZPMLQc?si=kHW0Bkp0nD9-itvY

Semester-IV (Polymer Chemistry)

Course code: MCH43MEP611	**Course name:** Polymer Chemistry Lab-II **Course category:** Major Elective
Credits: 1 **Teaching scheme:** P-2	**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Students should acquire practical skills for Polymerization Process.	
Course Objectives:	
1. Prepare the graduate with practical hands-on different polymerization techniques.	
2. Prepare the graduate with hands on training pertaining to preparing polymers by chain andstep growth polymerisations.	
3. Provide hands on training to estimate various end groups of polymers andthus molecular weight and its application in further formulations as well.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1: Convert monomer to polymer.	
LO2: Select various polymerization techniques in polymer synthesis.	
LO3: Explain the polymerization mechanisms.	
LO4: Classify flocculating and dispersant polymeric materials	
LO5: Evaluate the end group values and apply this knowledge for further applications	

Contents

1. Study of various polymerization techniques Bulk, Solution, Suspension, emulsion polymerization.
2. Synthesis of polyesters.
3. Kinetics of catalysed and uncatalyzedpolyesterification reaction
4. Preparation of Urea formaldehyde resin
5. Preparation of Phenol formaldehyde resin novolak and resol
6. Preparation of Melamine formaldehyde resin
7. Preparation of alkyd resin
8. Preparation of epoxy resin
9. Preparation of varnish, distemper, primer, undercoat, and topcoat
10. Characterization of surface coating viscosity, gloss, impact resistance, crosscut adhesion, scratch

Text Books:
1. Practical physical chemistry-A. Findlay.2018 2. Experiments in physical chemistry- James and Pritchard. 3. Selected experiments in physical chemistry-Latham 4. Experimental inorganic/physical chemistry-M. A. Malathi, 1999, Horwood publishing chichester,England. 5. Preparative method in polymer science- Wayne R. Sorenson, Tod W. Campbell.

Reference Books:
1. Expermintals in polymer science -D.G. Hundiwale, V.D.Athawale, U. R. Kapadi, 2. V.V.Gite.,2009, NewageInternational(P) Limited, Pubilishers. 3. Systematic Lab experimentas in organic chemistry- ArunSethi, 2006, Newage International 4. Practical organic chemistry, S. Viswanathan, 1993Dey&Sitaraman, Publisher.

E - resources:
https://youtu.be/1IXvcf7rDXM?si=WLd-sHz15TACHb9u
https://youtu.be/uqRvJUamyuA?si=-4HZB217sqYfB9Yo

Semester-IV (Polymer Chemistry)

Course code: MCH43RPJ610	**Course name:** Research Project **Course category:** Research Project
Credits: 6 **Teaching scheme:** P-12	**Evaluation scheme:** CA–30, ESE–20
Pre-requisites: Students should acquire practical skills for Polymerization Process.	
Course Objectives:	
1. To design research oriented project on particular polymer.	
2. To search literature on selected polymeric material for project work.	
3. Provide To identify/search the recent advances in polymeric technology.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1: Conduct experiment scientifically with safety for the preparation of polymers.	
LO2: To characterize the prepared material by using microscopic, spectroscopic, diffraction,	
adsorption and thermal techniques.	
LO3: Demonstrate the skill to write dissertation, communication skill in presentation	
To interpret observed data statistically.	
LO4: Analyze and differentiate various polymeric materials.	

Contents

1	**Respective Department Faculty will give project to the students.** After successful completion of project Dissertation/ presentation/ Seminars will be conducted at department in the presence of external expert. (At least one research paper publication is desired based on research project completed.)

Text Books:

1. Practical physical chemistry-A. Findlay.2018

2. Experiments in physical chemistry- James and Pritchard.

3. Selected experiments in physical chemistry-Latham

4. Experimental inorganic/physical chemistry-M. A. Malathi, 1999, Horwood publishing chichester,England.

5. Preparative method in polymer science- Wayne R. Sorenson, Tod W. Campbell.

Reference Books:
1. Experimental in polymer science -D.G. Hundiwale, V.D.Athawale, U. R. Kapadi, 2. V.V.Gite.,2009, NewageInternational(P) Limited, Pubilishers. 3. Systematic Lab experimentas in organic chemistry- ArunSethi, 2006, Newage International 4. Practical organic chemistry, S. Viswanathan, 1993Dey&Sitaraman, Publisher.

E - resources:
https://youtu.be/1IXvcf7rDXM?si=WLd-sHz15TACHb9u
https://youtu.be/uqRvJUamyuA?si=-4HZB217sqYfB9Yo

Semester-III M. Sc. Industrial Chemistry

Name of Faculty: Basic and Applied Science	
Course name: Applications of Spectroscopy	**Course code:** MCH43MML607
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of principle of spectroscopy, interaction of electromagnetic radiation with matter, molecular orbital theory and structure and bonding.	
Course Objectives: To learn basic principles of NMR, IR, UV-Vis spectroscopy and mass spectrometry and to use these spectroscopic methods for organic structure elucidation	
Course Outcomes: At the end of the course, the students will be able to -	
CO1 Describe: electronic transition, law of absorption, role of solvent, terminology used in UV-Vis spectroscopic techniques	
CO2 Interpret: IR spectra for identification of functional groups	
CO3 Deduce : Number and types of hydrognen atom for structural elucidation from ^{1}H-NMR spectrum	
CO4 Identify: Number and types of carbon atoms present in organic molecules	
CO5 Apply NMR, IR, MS, UV-Vis spectroscopic techniques in solving structure of organic molecules and in determination of their stereochemistry.	

Unit	Content	Teaching hours
I	**Ultraviolet- Visible Spectroscopy** Principles of absorption spectroscopy, Electronic transitions, presentation of electronic spectra.chromophores, Auxochromers, Bathochromic and Hypochromic Shifts, Effect of solvent and conjugation on electronic transitions, calculation of absorption maximum(λ_{max}) on the basis of Woodward-Fieser rules for dienes, enones and aromatic compounds, study of UV spectra of some organic compounds. Applications of UV-Visible Spectroscopy.	09
II	**Infrared Spectroscopy** Fundamental principle, Modes of vibration in polyatomic molecules, overtone and combination bands, Bond properties and absorption trends, Hooke's Law, Infrared spectrometer. Vibrational frequency for various functional groups, factors influencing vibrational frequency, interpretation of IR spectra of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds. Problems based on structural elucidation from FT-IR	09

	spectrum.	
III	**NMR Spectroscopy** NMR phenomenon, spin ½ nuclei, (^{1}H, ^{13}C, ^{31}P and ^{19}F), **^{1}H NMR**, Zeeman splitting, effect of magnetic field strength on sensitivity and resolution, chemical shift and shielding, magnetic anisotropy, factors affecting on chemical shift, chemical and magnetic equivalence of spins, spin-spin coupling, types of couplings, factors affecting on coupling constants, Karplus equation, Spin systems (AB,AX,ABX,AMX) spin decoupling, shift reagents, Nuclear Overhauser effect (NOE) **^{13}C NMR Spectroscopy:** Elementary ideas, chemical shifts (aliphatic, olefinic, alkyne, aromatic, hetero aromatic and carbonyl carbons); Effect of substituent on chemical shifts.	**09**
IV	**Mass spectrometry** Basic principles, ionization techniques, isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution MS, soft ionization methods, ESI-MS and MALDI-MS, basic principle of ionization and ion analysis, illustrative examples from simple organic molecules to macromolecules and supramolecules. Structural elucidation problems using the above spectroscopic techniques.	**09**
V	**ESR and Mossbauer Spectroscopy** Mossbauer spectroscopy: Principle, factors affecting the line position and shape, isomer effect and Quadrupole splitting iron salt like compounds, complexes, carbonyl compounds temperature dependence of isomer shift and Quadrupole splitting in simple compound and coordination, polynuclear complexes), Numericals. **Electron Spin Resonance Spectroscopy:** Principle of ESR spectroscopy, presentation of spectrum, hyperfine splitting in various structures, hyperfine splitting diagram of representative examples, factors affecting the magnitude of 'g' values, Zero field splitting, Kramer's degeneracy, Anisotropy in the hyperfine coupling constant, electron delocalization, instrumentation and applications	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, Spectroscopy, 9th Indian Edition Cengage Learning, 2011 2. Spectroscopy of Organic Compounds, P. S. Kalsi, 9th Edition, 2022, New Age Publisher.

Reference Books:
Title, Author, Edition, year of publication, Publisher
1. Organic Chemistry, Clayden, 2nd Edition, 2023, Oxford University Press India 2. Spectrometric Identification of Organic Compounds , David J. Kiemle, David L. Bryce, Francis X. Webster, Robert M. Silverstein, 8th edition, John Wiley and Sons Inc. 2014

E - resources:
1. Principles and Applications of 1H NMR Spectroscopy , NPTEL Course; https://nptel.ac.in/courses/104108078 2. Fundamentals of Spectroscopy, NPTEL Course; https://nptel.ac.in/courses/104106122

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Applied Inorganic Chemistry	**Course code: MCH43MML641**
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of stoichiometric calculations, main group chemistry principle of spectroscopy, and structure and bonding.	
Course Objectives: To learn basic principles of chemical calculations and structural and catalytic properties of zeolites and molecular sieves and their applications in industrial process	
Course Outcomes: At the end of the course, the students will be able to –	
CO1 Solve problems based on chemical calculations, material balance, percent composition, concentration yield of reaction and atom economy.	
CO2 Apply principles of green chemistry and catalysis and synthesis of porous catalytic materials	
CO3 **Describe** structure and composition of natural and synthetic zeolites	
Use: knowledge of methods of synthesis and its optimization for efficient synthesis of industrial catalysts.	
Interpret: Spectroscopic characterization data of zeolites, molecular sieves, and other catalytic materials.	

Course Contents

Unit	Content	Teaching hours
I	**Basic Chemical Calculations** Moles, Mole fraction, percent composition, weight and volume percent analysis of solid in composition, Material balance involving chemical reaction: Introduction, material balances, Concept of Selectivity, Conversion, and problem solving on material balance. Principles of green chemistry, atom economy numerical.	09
II	**Fundamentals of catalysis** Catalysis, types of catalysis, catalyst, properties of catalyst, classification of catalysts, Sabtier's principle, classification of solid catalysis, fundamentals of heterogeneous catalysis, factor affecting the catalyst performance, promoters, types of promoters, inhibitors, catalyst poisoning, overview on heterogeneously catalyzed process in industry	09
III	**Basic concepts of zeolites and molecular sieves** Introduction, definition, classifications on the basis of morphological appearance, SBU, substitution of other iso-electronic metal ions, types of pore size. Lowenstein's rule. pore and channels, channel dimensions, shape of the pore opening, nomenclature of zeolites, structural aspect of zeolites, acidity of zeolite, identification of acidic sites, nature of activesites,	09

	synergetic effects, shape selectivity. Industrial applications of zeolites and molecular sieves.	
IV	**Synthesis and characterization of zeolites** Synthesis of zeolites: General methods for synthesis of zeolite, hydrothermal treatment, mechanism of aluminosilicate formation during Sol-Gel, coprecipitation process, factors affecting the zeolite formation. Modification of zeolites, Oswald's rules of successive transformation, crystallization and its identification, factors affecting crystallization, template theory, organic additives, crystallizing zeolites, ZSM-5from an organic free solvent system, synthesis in non aqueous solvents.	**09**
V	**Characterization of zeolites:** FTIR, Pyridine adsorbed-IR analysis, XRD analysis, Temperature programmed desorption (TPD), probe molecules for TPD analysis, NH_3-TPD andCO_2-TPD. BET Surface area analysis.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Industrial Inorganic Chemistry, by Mark Anthony Benvenuto (Author) 1st edition, 2015, De Gruyter. 2. Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong , 4th edition, W H Freeman & Co. 2006. 3. Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey, Ellen A. Keiter, Richard L. Keiter,4th edition, Person, 1997.
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. Molecular Sieves: Principles of Synthesis and Identification, R. Szostak, 1st edition, 2013 Springer Dordrecht. 2. Atlas of zeolite framework type;Ch. Barlocher, W M. Meier , D. H. Olson; 5th rev. Ed. Elsevier Amsterdam 2000. 3. Industrial Catalysis: A Practical Approach, 3rd Jens Hagen 2015, Wiley-VCH. 4. Green chemistry and catalysis, Roger A. Sheldon, Isabel Arends, Ulf Hanefeld, 2007, WileyVCH, ISBN:978-3-527-36715-9
E - resources:
1. Heterogeneous Catalysis and Catalytic Process, NPTEL Course; https://nptel.ac.in/courses/103102012

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Chemistry of Nanomaterials	**Course code:** MCH43MML642
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of solid state chemistry and properties of matter	
Course Objectives: To understand basic and advanced level concepts in design, preparation and properties and applications of Nanomaterials.	
Course Outcomes: At the end of the course, the students will be able to-	
CO1 Describe: Types of nanomaterials and emerge due to nano-dimensions of particles.	
CO2Describe and Interpret: Methods for synthesis of nanomaterials and characterization data.	
CO3 Understand: Advanced biological/chemical methods for industries.	
CO4 Identify: Solution for the energy crises and environmental pollution and mechanistic pathways during electrochemical conversion.	
CO5 Describe: application of nanomaterials in medicine and its toxicity.	

Course Contents

Unit	Content	Teaching hours
I	**General Introduction** **Introduction to Nanomaterials**: Size Effects - difference between bulk and Nanomaterials - Definition of Nanomaterial. **Classification Nanomaterials**: Nanoparticles, Nanocrystal, 0-D Quantum dots, Nanostructured material (1-D Wire and rods, 2-D thin film, 3-D structures) - Carbon nanotubes (CNTs) : Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs) - Graphene. **Proprieties of Nanomaterials**: optical, electronic, magnetic and chemical etc.	09
II	**Synthesis of Nanomaterials** **Synthesis of Nanomaterials**: Synthesis of Nanomaterials: Bottom Up and Top Down Approach - Gas Phase synthesis of Nanomaterials - Wet chemical synthesis - Chemical Vapour Deposition (CVD). **Characterisation of Nanomaterials**: using UV-Visible Spectroscopy, Fluorescence Spectroscopy, Powder XRD, Particle size analysis by Dynamic Light Scattering (DLS), SEM, TEM, AFM techniques.	09
III	**Optical luminescence Nanomaterials**: Optical luminescence and fluorescence from direct, bandgap semiconductor nanoparticles - White LEDs - LEDs based on nanowires - LEDs based on nanotubes- LEDs based on nanorods - High Efficiency Materials for OLEDs - High Efficiency Materials for OLEDs.	09
IV	**Energy Applications**	09

	Renewable Energy Technology: Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies. **Nanomaterials for Storage:** and devices for energy transport, conversion and storage.	
V	**Nanomedicine Application** **Nanomaterials in Medicine**: Introduction to Nanocarriers, Interactions of nanocarriers with blood stream, cellular targeting, Biological and chemical reagents for cell-specific targeting - Biodistribution of liposomes, dendrimers and Nanoparticles, **Toxicity of Nanomaterials:** drug delivery, tissue regeneration, cancer detection, Luminescent nanoparticle probes for bio-imaging and diagnostics.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
3. Nanotechnology: Principal and practice, Sulabha Kulkarni ISBN 978-9381891261 4. Fundamentals of Nanotechnology –Gabor L Hornyak, John J Moore, 2009, 786 pages, eBook ISBN9781315222561.
Reference Books:
Title, Author, Edition, year of publication, Publisher
NANO- The next revolution- Mohan Surendra Rajan, 2009, pages:179 ISBN: 812374305X
E - resources:
Nano structured materials-synthesis, properties, self assembly and applications, IIT Delhi Prof. A.K. Ganguli, NPTEL Course https://nptel.ac.in/courses/118102003

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Reagent in organic Synthesis	**Course code: MCH43MML608**
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of reaction mechanism and organic chemistry.	
Course Objectives: To understand the mechanism of oxidation. 1. To understand role of reducing agents in organic synthesis. 2. To understand the mechanism of reaction by organomettalic and other reagents. 3. To develop understanding of various name reactions and rearrangenents.	
Course Outcomes: At the end of the course, the students will be able to-	
CO1 Depict the mechanism of oxidation reactions and its applications in organic synthesis.	
CO2 Depict the mechanism of reduction reactions and its applications in organic synthesis.	
CO3 Perform organic reaction using organomettalic reagents	
CO4 Describetheroleofauxiliariesinorganic reaction.	
CO5 Apply green reaction protocol in organic synthesis	

Course Contents

Unit	Content	Teaching hours
I	**Oxidation** (a) Oxidation of alcohol to aldehyde, ketone or acid: Jones reagent, Swern oxidation, Collins reagent, Fetizones reagent, PCC, PDC, PFC, IBX, Activated MnO_2, Chromyl chloride (Etard reaction), TEMPO, CAN, NMO, Moffatt oxidation (b) Oxidative cleavage of Carbon-Carbon double bonds: $KMnO_4$, Ozonolysis. (c) Oxidations using SeO_2, PhSeBr. (d) Selective cleavages at functional groups: Cleavage of glycols, IO-4, $Pb(OAc)_4$.	09
II	**Reduction** (a) Catalytic Hydrogenation; (b) Reduction of nitriles, oximes and nitro compounds; (c) Reduction of acids and Esters; (d) Reduction with metal hydride-Sodium cyanoborohydride, Diborane, L- & K-Selectrides, $LiBH_4$, DIBAL-H; (e) Birch reduction and related reactions, (h) Luche reagent, Wolf-Kishner reduction, Clemmenson reduction, Wilkinson catalyst, TBTH.	09
III	**Organometallic and Other Reagent** Synthesis and applications of organo Lithium, Magnesium, Titanium, Cerium, Copper, Chromium, Zinc, Boron, Silicon and Cadmium DCC, EDC, DDQ, 1,3 Dithiane, LDA, DMDO, OsO_4, RuO_4, SmI_2, Dess-Martin Periodinane, Diazomethane, Lawesson's reagent.	09
IV	**Unit-IV:Name reactions and Rearrangements** Pummerer, Payne, Eschenmoser fragmentation, Brook, Wagner-Meerwein, Wolf, Semipinacol, Epoxide rearrangement with lewis acid, Dienone-Phenol rearrangement, Tiffeneau-Demjanov, Favorskii, von Richter, Wittig, Neber, Smiles,	09

	Fries, Curtius, Lossen, Schmidt, Steven, Hofmann, Iodolactonisation	
V	**Green Synthesis** (iii) bio (enzyme) catalysis, (iv) catalysis with non-toxic metals (Ca, Fe, Co, etc.), (v) solid supported catalysis (vi) metal free/organo catalysis(vii) Visible light catalysis(viii) phase transfer catalysis. Alternative/Green Solvents for Organic Synthesis (i) Water, ii) Ionic liquids, iii) Supercritical liquids (SCL), iv) Poly(ethylene glycol) (PEG)	09

Text Books:

Title, Author, Edition, year of publication, Publisher

1. Stereochemistry of Organic Compounds (Principle and application): D. Nasipuri
2. Stereochemistry of Organic compounds: Ernest L. Eliel / Samuel H. Wilen
3. Organic Synthesis: W. Carruthers
4. Organic Reagents: Fieser&Fieser
5. Organic Synthesis: M. B. Smith
6. Modern Organic Synthesis: An Introduction: G. S. Zweifel& M. H. Nantz
7. Organic Synthesis Concepts, Methods, Starting Materials: J. Fuhrhop, G. Penzlin
8. Organic Chemistry: An Intermediate Text: Robert V. Hoffmann
9. A dvanced OrganicChemistry:JerryMarch 6th edition 2007 Willey-Interscience
10. O rganic Synthesis: R. O. C. Norman and Coxan

Reference Books:

Title, Author, Edition, year of publication, Publisher

11. Organic Chemistry: Clayden, Greeves, Warren &wother 2nd edition, Oxford University press ISBN 978-0-19-927029-3.
12. Advanced Organic Chemistry Part A & Part B: F. A. Carey & R. J. SundbergAdvancedOrganicChemistryPart A &Part B: F.A.Carey&R.J.Sundberg, 5th edition, Springer, ISBN13;978-0387-68346

E - resources:

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Inorganic Chemistry Lab-III	**Course code:** MCH43MMP620
Course category: MM	**Credits:** 02
Teaching scheme: P-4	**Evaluation scheme:** CA-30, ESE-20
Pre-requisites: Skills of handling of laboratory chemicals and glassware stoichiometric chemical calculations and should be performed experiments of various lab courses of M.Sc. Part-first	
Course Objectives: To Provide hands on traning of wet chemical analysis and inorganic syntheisis.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1 Perform: Synthesis of metal complexes, inorganic pigments, separation and estimation of metal ion content by ion exchange resin.	
LO2 Demonstrate: Analysis of chemicals by conductometry, potentiometry and pH metric techniques	
LO3 Interprete: UV-Visible spectra of metal complexes	

List of Experiments

Section-A: Inorganic Preparations			
Prepare and estimate the percentage of metal ion in the metal complex and their spectral studies			
1	Tris(thiourea)Copper(II)Sulphate	2	Bis (thiourea) Zinc (II) sulphate
3	$NH4[(Cr(III)(C_2O_4)_3]$	4	$[Ni(II)(Salicyldoxime)_2]$
Preparation of Inorganic Pigments			
1	Lithopone, $ZnS+BaSO_4$	2	Prussian Blue, $Fe_4[Fe(CN)_6]_3$
3	Stronsium Yellow, $SrCrO_4$	4	Chrome Green, Cr_2O_3
Section-B: Inorganic Estimation (Any Two)			
	Separation and estimation		
1	Separation and estimation of Zn(II) and Cd(II) from given mixture using Amberlite IRA400anion exchange resin		
2	Separation and estimation of Zn(II) and Mg(II) from given mixture using Amberlite IRA400 anion exchange resin		
3	Determine the total hardness of water by using EDTA		
4	Determine the percentage of chlorine from bleaching powder using Volhard method		
5	Determination of iron content from given sample by using8-hydroxyquinoline as extractant		

Reference Book / Hand Books/ Lab Manual
1. Systematic Experimental Physical Chemistry, S. W. Rajbhoj, T. K. Chondekar, 3rd edition, 2013, Anjali Publication.
2. Advanced Practical Inorganic Chemistry, Gurudeep Raj, 20th edition, 2008 Goel Publishing House
3. Vogel's Qualitative Inorganic Anlysis, 7th edition, 2009, Person Education.
4. Inorganic Chemistry Lab Manual, G. T. Pawar, 2021.

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Chemistry of Paint, Pigment and Polymers	**Course code:** MCH43MEL635
Course category: ME	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of inorganic chemistry, physical properties of matter and organic reaction mechanism.	
Course Objectives: To learn chemistry of paint, pigment and polymers there synthesis and industrial applications.	
Course Outcomes: At the end of the course, the students will be able to –	
CO1 Describe : composition and properties of paint	
CO2 Explain: process in pigmentation of pain and various types of pigments	
CO3 Use: The knowledge of synthesizing industrial polymers paint and pigments and applications	
CO4 Describe: steps in polymerization, difference between thermoplastic and termosets and types of polymers. Properties of paints and pigments	
CO5 Apply: principles of polymerization and manufacturing of paints and pigments for establishment of small scale unit	

Course Contents

Unit	Content	Teaching hours
I	**Introduction to Paints** **Paints**-Introduction of paint - Wet paint, constituents of paints, classification of paints, applications of paints, Dry film properties of paints-adhesion, hardness, toughness and durability, flexibility, loss of decorative properties due to weathering, ease of repair and surface renovation-solvent resistance, how paints dry-drying without chemical reaction, drying by chemical reaction	09
II	**Pigmentation of paints:** pigment properties, tinting strength, light fastness,bleeding characteristics, hiding power, refractive index, particle size, particle shape, specific gravity, chemical resistivity, and thermal stability, Types of pigments (classification)- natural/ synthetic pigments, organic/inorganic pigments, Inorganic pigments; TiO_2, lithopone, ZnS, ZnO and Fe_2O_3; Corrosion protection pigments; Luminescent and magnetic pigments.	09
III	**Unit-III Manufacturing of Paints** Principles, source of added value, production strategy, manufacturing	09

	process for varnishes/paints/coating powers, equipment for pigment dispersion-high speed disperser, sand or bead mill, triple roll mill, ball mill, titrator. **Important Resins or Modifications of Resins for Paints and Coatings**: (i) Epoxy Resins (BPA based resin, curing agents & flame-retardant epoxy resins) (ii) Unsaturated polyester resins	
IV	**Basic Concepts of Polymers** History, Trends, and General Polymer Background, Concept of functionality andreactivity, Degree of polymerization, Classification of polymersHomopolymers, co-polymers, linear polymers, branched polymers, cross linked orthree dimensional polymers, block co-polymers, organic- inorganic polymers,natural and synthetic polymers, chain and step growth polymers, thermoplastic andthermoset, based on applications - fibers, foams, adhesives and elastomers, based on performance - commodity and engineering polymers, isotactic polymer,syndiotactic polymer, atacti polymer	**09**
V	**General Chemistry, Technology Of Production, Properties And Applications Of Chain Growth and Step Growth Polymers** **Chain growth polymer:** (i) Polyethylene (HDPE, MDPE, LDPE, LLDPE, HMWPE, UHMWPE, EVA, crosslinked PE, chlorinated PE), (ii) Polypropylene (PP), (iii) Polyisobutylene (PIB), (iv) Acrylics (PMMA & PAN) (v) Polyvinyles (PVC, PVDC & CPVC), (vi) Polystyrene & copolymer (HIPS, SBR, SAN & ABS) (vii) Poly(vinyl acetate). **Step growth polymers:** (i) Phenol formaldehyde (PF- novolak and resol) **(ii)** Urea formaldehyde **(**UF) (iii) Melamine formaldehyde (MF) **(**iv) Polyamides:- Nylon-6, Nylon-12, Nylon-46, Nylon-66, Nylon-612	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Industrial Inorganic Chemistry, by Mark Anthony Benvenuto (Author) 1st edition, 2015, De Gruyter. 2. Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong , 4th edition, W H Freeman & Co. 2006. 3. Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey, Ellen A. Keiter, Richard L. Keiter,4th edition, Person, 1997. 4. Industrial Inorganic Chemistry, H.C. mult. Karl Heinz Büchel, Hans-Heinrich Moretto, Peter Woditsch, Ist edition 2000, Print ISBN:9783527298495

5. WILEY-VCH Verlag GmbH
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. Polymer Chemistry - M. P. Stevens, 2nd Ed., Oxford University Press, NewYork, 1999. **2.** Poly. Synthesis - Stanley R. Sandler, Wolf Karo, Vol. 1, Academic Press, Inc.,California, 1994. **3.** Introduction to Polymer Chemistry - R.B. Seymour, Marcel Dekker, 6th Ed.,Florida, 2003. **4.** Polymer Science and Technology of Plastics and Rubbers, PremamoyGhosh,Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1996. **5.** Outlines of Paint Technology, W. M Morgan 3rd edn CBS Publishers, 2000.
E - resources:
Introduction to polymer science, Professor Dibakar Dhara, IIT Kharagpur, https://archive.nptel.ac.in/courses/104/105/104105124/

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Chemistry of Glass, Ceramics and Semiconductors **Course code:** MCH43MEL636	
Course category: ME	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of inorganic and solid state chemistry.	
Course Objectives: To learn technology and chemistry of ceramics, glass and semiconducting material there synthesis and applications.	
Course Outcome: At the end of the course, the students will be able to-	
CO1 Describe: The properties of glass ceramics and semiconductor	
CO2 Use: The knowledge of synthesizing industrial ceramics, glass and semiconducting material and its applications.	
CO3 Describe: Properties applications of ceramics in electronic industry.	
CO4 Explain: types of glass material and its composition and applications.	
CO5 Apply: principles of ceramics glass and semiconducting material for industrial applications	

Course Contents

Unit	Content	Teaching hours
I	**Introduction to Ceramics: (15 Hrs)** Introduction to ceramics, various types of ceramics, Polycrystalline ceramics, phase diagrams, raw materials, fabrications science of ceramics, principles of main fabrication techniques, drying, firing sintering, reaction sintering, control of nanostructures in Ceramics.	**09**
II	**Unit-II: Ceramics Processing** Powder processing – precipitation, spray drying, freeze drying, sol-gel, CVD – milling techniques- forming-die pressing, slip casting, injection moulding, doctor blade processing – sintering techniques –standard pressure sintering, hot pressing, HIP, reaction bonded sintering, microwavesintering – surface finishing techniques.	**09**
III	**Unit-II: Electronic Ceramics (15 Hrs)** Ceramic insulators and capacitors – ferroelectric ceramics – barium titanate, PZT, PLZT materials– properties and applications of electronic ceramics – magnetic ceramics – spinel ferrites, zinc ferrites – applications – garnets – superconducting ceramics – varistors – oxides and non-oxidevaristors and fuel cells.	**09**
IV	**Glass** **Glass and ceramics Industries:** Introduction, raw materials, soda glass,	**09**

	borosilicate glass, lead glass, coloredglass, ceramic raw materials, clays, pottery, zeolites, fly ash, ceramic tiles. Glass forming processes – Glass transition – Glass transformation range – Heat treatment schedule, crystal nucleation in glass, nucleation agent – high purity silica glass, laser glasses, fiber glasses, optical glasses and non-oxide glasses.	
V	**Semiconductors** Introduction, types of semiconductor, band theory, synthesis of metal oxide, metal chalcogenides semiconducting materials, polymer doped semiconductor, properties of semiconductor, 0D, 1D, 2D Materials, Photolithography, Semiconductor Devices, Optical and Photonic Devices, Materials for Energy Generation and Storage, Membranes, Surface Science, Biomedical Materials, Miniaturization in Materials Science	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Fundamental of Ceramics by Michel W. Barsoum, McGraw Hill International edition,(1997) 2. Introduction to Materials Chemistry, 2nd Edition, Harry R. Allcock, ISBN:978-1-119- 34725-5, October 2019, Wiley Publishers. 3. Industrial Inorganic Chemistry, by Mark Anthony Benvenuto (Author) 1st edition, 2015, De Gruyter. 4. Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong , 4th edition, W H Freeman & Co. 2006. 5. Industrial Inorganic Chemistry, H.C. mult. Karl Heinz Büchel, Hans-Heinrich Moretto, Peter Woditsch, Ist edition 2000, Print ISBN:9783527298495 WILEY-VCH Verlag GmbH
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. D. W. Richerson& W. E. Lee. Modern Ceramic Engineering: Properties, Processing andUse in design. CRC Press, (2018). 2. J. S. Reed. Principles of Ceramic Processing. Wiley-Interscience, (2008). 3. M. H. Lewis. Glasses and Glass Ceramics. Springer, (2011). 4. M. Cable and J. M. Parker. High Performance Glasses. Chapman and Hall, London, (1992).
E - resources:
Industrial Inorganic Chemistry, Prof. Debashis Ray , IIT Kharagpur NPTEL Course https://onlinecourses.nptel.ac.in/noc23_cy27/preview

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Industrial Organic Chemistry	**Course Code:** MCH43MEL637
Course category: ME	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding of Organic Chemistry	
Course Objectives: To understand basic concepts of industrial products and high energy materials. To learn manufacturing of dyes, cosmetics, cosmetics perfumery and fermentation technology	
Course Outcome: At the end of the course, the students will be able to-	
Describe: Principles of fermentation technology and synthesis of cosmetic products	
Apply : Principles of oil processing industry for preparation of cosmetic products	
Express: The content and techniques of processing perfumery and cosmetic product.	
Describe: Synthesis and applications of dyes	
Describe : Chemical & physical properties and applications of high energy material	

Course Contents

Unit	Content	Teaching hours
I	**Fermentation and biofuels (15 Hrs)** **Fermentation Industry**: Introduction, Outline of Fermentation, Basic requirement of Fermentation,Manufacture of chloramphenicol, acetic acid, butanol, ethyl acetate, oxalic acid,and citric acid.**Biofuels:**Introduction, Types of biofuels (bioethanol, biodiesel), Raw materials forsynthesis of biofuels, Properties of biofuels, biofuels and environment, biofuelsand economic, standard specification of biofuels uses of biofuels, Modification ofvegetables of oils as biodiesel.	**09**
II	**Oils and Oleo Chemicals Industries (15 Hrs))** Introduction, Properties and classification of oils, extraction, and purification of oils; Fatty acids Introduction, nomenclature and applications of fatty acids; Soap-Introduction, classification, uses and manufacturing process of soaps and detergents.	**09**
III	**Cosmetics and Dyes Industry (15 Hrs)** Introduction, manufacturing process of powder, cream and lotion, lipstick and nailpolish, shampoo and hair dyes, tooth paste. **Perfumery Industries:** Compounds used for different perfumes, Essential oils, Preparation of phenylethanol, Yara-Yara, β-ionone, musk ketone, musk ambrette, musk xylene, phenylacetic acid and its' esters, benzyl acetate, synthetic musk, jasmine.	**09**
IV	**Dyes:** Introduction, Classification of Dyes, Colour and Contribution Synthesis of Fast Red A, Naphthol BlueBlack 6B, Naphthol Green B, Rosaniline, Alizarin pyronene- G.	**09**
V	**High Energy Materials (HEMs) (15 Hrs)**	09

	Introduction, definitions of explosives, propellants and energetic polymers,Classification of Explosives – high explosive, low explosive, melt cast explosive,thermally stable explosive, energetic binder, energetic plasticizer, energeticoxidizer, thermochemistry of explosives.	

Text Books:
Title, Author, Edition, year of publication, Publisher
6. Fundamental of Ceramics by Michel W. Barsoum, McGraw Hill International edition,(1997) 7. Introduction to Materials Chemistry, 2nd Edition, Harry R. Allcock, ISBN:978-1-119- 34725-5, October 2019, Wiley Publishers. 8. Industrial Inorganic Chemistry, by Mark Anthony Benvenuto (Author) 1st edition, 2015, De Gruyter. 9. Inorganic Chemistry, Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong , 4th edition, W H Freeman & Co. 2006. 10. Industrial Inorganic Chemistry, H.C. mult. Karl Heinz Büchel, Hans-Heinrich Moretto, Peter Woditsch, Ist edition 2000, Print ISBN:9783527298495 WILEY-VCH Verlag GmbH
Reference Books:
Title, Author, Edition, year of publication, Publisher
5. D. W. Richerson& W. E. Lee. Modern Ceramic Engineering: Properties, Processing andUse in design. CRC Press, (2018). 6. J. S. Reed. Principles of Ceramic Processing. Wiley-Interscience, (2008). 7. M. H. Lewis. Glasses and Glass Ceramics. Springer, (2011). 8. M. Cable and J. M. Parker. High Performance Glasses. Chapman and Hall, London, (1992).
E - resources:
Industrial Inorganic Chemistry, Prof. Debashis Ray , IIT Kharagpur NPTEL Course https://onlinecourses.nptel.ac.in/noc23_cy27/preview

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Industrial Chemistry Lab-I	**Course code:** MCH43MEP612
Course category: ME	**Credits:** 01
Teaching scheme: P-2	**Evaluation scheme:** CA-30, ESE-20
Pre-requisites: Skills of handling of laboratory chemicals and glassware stoichiometric chemical calculations and should be performed experiments of various lab courses of M.Sc. Part-first.	
Course Objectives: To provide skills of handling instruments for chemical analysis and physical properties.	
Course Outcomes: At the end of the course, the students will be able to -	
LO1 **Demonstrate:** Analysis of chemicals by conductometry, potentiometry and pH metric techniques	
LO2 **Interpret:** UV-Visible spectra of metal complexes	

List of Experiments

Section-C: Instrumental Chemical analysis	
	Spectrophotometer:
1	Determine the stability constant, empirical formula, λmax. by job's method, mole ratio and slope ratio method
	pH-metry
2	Determine the Pk value of benzoic acid by using Irrivaing Rossotgi method by P^Hmetric method and metal ligand stability constant of its complex.
3	Determinethemetalligandstabilityconstantofcopperbenzoatecomplexbypmetricmethod
	Conductometry
4	Analyze the mixture of copper sulphate, hydrochloric acid and acetic acid by conductometric method.
5	Determine the stability constant and composition/formula of lead oxalate by conductometric method.
	Potentionmetry
6	Determine the redox potential of Fe(II)/Fe(III) system and hence determine the number of electron involved in the system using $K_2Cr_2O_7$ by potentiometric method.
7	Determine the amount of chloride, bromide and iodide in the given sample by potentiometric method.

Reference Book / Hand Books/ Lab Manual
5. Systematic Experimental Physical Chemistry, S. W. Rajbhoj, T. K. Chondekar, 3rd edition, 2013, Anjali Publication.
6. Advanced Practical Inorganic Chemistry, Gurudeep Raj, 20th edition, 2008 Goel Publishing House
7. Vogel's Qualitative Inorganic Anlysis, 7th edition, 2009, Person Education.
8. Inorganic Chemistry Lab Manual, G. T. Pawar, 2021.

Semester-III (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name:Research project	**Course code: MCH43RPJ611**
Course category: RP	**Credits: 4**
Teaching scheme: P-8	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: **Course Objectives:** To provide hands on training to understand research problem to design synthesis of target molecule.	
Course Outcomes: At the end of the course, the students will be able to -Skill to search literature on selected research oriented project work.	
LO1 Identify the advances in current research.	
LO2 Conduct experiments scientifically with safety.	
LO3 Interpret FT-IR, 1HNMR, 13C NMR and Mass spectrometry data of the prepared molecules by physical and spectral analysis.	

Content

Sr.No.	Title of the Experiment
1.	Student can choose project work topic as per expertise and research thrust area of department faculty members and undertake experimental work on chosen topic and present work in Viva-Voce examination and should submit project report which should contain. • Introduction: Literature review and to Limitation of existing work ,Aims and objectives of research topic, Scope of topic • Experimental section and Research methods/ Techniques • outcome of project work • References

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Unit Processes in Chemical Industries	**Course Code:** MCH43MEL643
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding organic reaction mechanism and organic synthesis. **Course Objectives:** To become a professional with understanding of basics of unit processes in chemical industries	
Course Outcome: At the end of the course, the students will be able to-	
CO1 Describe: industrial chemical process such as amination, alkylation, hydrolysis, eterification and sulphonation	
CO2 Describe: factors affecting on the rate of industrial chemical process.	
CO3 Distinguish: between unit processes and unit operations of chemical industries.	
CO4 Apply: the knowledge on newer techniques in industrially important products with the help of various unit processes.	
CO5 Expertise: Industrial unit process	

Unit	Content	Teaching hours
I	**Amination by Reduction** Introduction and definition, Methods of reduction, Metal and acid Reductions,Metal and alkali reductions, Amination by aminolysis, aminating agents, physical and chemical factors affecting aminolysis, manufacture of aniline byreduction of nitrobenzene, p-phenylenediamine, aniline by continuous ammonolysis.	09
II	**Alkylation:** Introduction and types of Alkylation, alkylating agents, factors controlling alkylation, equipment for alkylation, alkylation methods for i) Alkyl-aryl sulphonates, ii) Ethylbenzene, iii) Dimethylaniline.	09
III	**(a) Hydrolysis and (b) Esterification** (a) **Hydrolysis**: Definition and scope, hydrolyzing agents, materials susceptible to hydrolysis, kinetics, thermodynamics and mechanisms of hydrolysis, Equipment for hydrolysis, Technical operations involving hydrolysis. **(b) Esterification:** Esterification of organic acids and derivatives, esters by addition, to unsaturated systems, interesterification of lard, technical preparation of ethyl acetate, cellulose acetate, nitroglycerol, polyethyl ether.	09
IV	**Unit IV (a) Hydrogenation, (b) Nitration**	09

	(a) Hydrogenation Catalytic hydrogenation, Apparatus, Industrial processes, Hydrogenation of fatty oils, Synthesis of methanol. **(b) Nitration:**Introduction, Nitrating reagents, Aromatic nitration, Nitration of paraffinichydrocarbons, nitrate esters, N-nitro-compounds, process equipment for technical nitration, Mixed acid nitration, Typical Industrial nitration processes.	
V	**Sulfonation:** **(c) Sulfonation and Sulfation:** Introduction, sulfonating and sulfating reagents and their principle applications.Chemical and physical features in sulfonation and sulfation, mechanisms, thedesulfonation reaction, working up procedures, Industrial equipment andtechniques, Transition from batch to continuous processing.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Unit Processes in Organic Synthesis- P. H. Groggins, Tata McGraw-Hill, 5th Edition, New Delhi, 2010. 2. Dryden's Outline of Chemical Technology, M. GopalRao, Marshall Sittig East- West Press Pvt. Ltd., 3rd Edition, 2014. 3. Chemical Process Industries- B. Shreve., Tata McGraw Hill, New Delhi, 2012. 4. Comprehensive Industrial Chemistry, P. G. More, Pragati Edition, 2010
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. Industrial Organic Chemistry, Klaus Weissermel, Hans-Jürgen Arpe, First published:27 May 2003, Print ISBN:9783527305780 | WILEY-VCH Verlag GmbH & Co. KGaA
E - resources:
NPTEL Course Chemical Technology, Dr. I. D. Mali https://nptel.ac.in/courses/103107082

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name Agro Biomass Technology	**Course Code:** MCH43MML644
Course category: MM	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Basic understanding Fundamental Chemistry.	
Course Objectives: To learn principles of agro biomass transformation	
Course Outcome: At the end of the course, the students will be able to-	
Demonstrate: Methods to convert agriculture waste into useful materials	
CO1 Describe: The fundamentals of biomass, types, sources and their value added products.	
CO2 Explain: The process of conversion of agriculture waste biomass into biochar, fuels and other valuable materials	
CO3 Duscribe: Application biomass derived products for designing suitable chemical process	

Unit	Content	Teaching hours
I	**Sources of Biomass** Biomass, classification of biomass, characteristics of biomass, composition of biomass, Properties of Biomass, Classification of Conversion Technologies. Waste agricultural biomass, Types and composition, moisture content, energy content.	**09**
II	**Physical conversion of biomass** Sizing , separation, drying, dewatering, densification, factors affecting the densification, densification technologies, torrefaction,. thermochemical conversion of biomass, combustion, stages of combustion, Industrial combustion modes,	**09**
III	**Activated carbon from agriculture waste(11 Hrs)** Sources of agriculture waste, Preparation of activated carbon, process, types of charcoal Kiln, factors influencing charcoal yield, surface area, BET Analysis, pore size, characterization and application of activated carbons,Gas-Phase applications, liquid-Phase applications, Treatment of textile effluents, textile dyes, classification of textile colorants.	**09**
IV	**Production of chemicals(12 Hrs)** Ethanol production by fermentation, sugar fermentation, starch fermentation, enzymatic hydrolysis, acid hydrolysis, factors that influence the ethanol fermentation. Biodiesel from agriculture waste Production process, transesterification reaction, types of esterification, catalysts for biodiesel Production, catalytic transesterification, acid	**09**

	catalyzed transesterification.	
V	**Application of biomass derived product** Application of biochar, activated charcoal, ash, for development of sustainable process.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
5. Unit Processes in Organic Synthesis- P. H. Groggins, Tata McGraw-Hill, 5th Edition, New Delhi, 2010. 6. Dryden's Outline of Chemical Technology, M. GopalRao, Marshall Sittig East- West Press Pvt. Ltd., 3rd Edition, 2014. 7. Chemical Process Industries- B. Shreve., Tata McGraw Hill, New Delhi, 2012. 8. Comprehensive Industrial Chemistry, P. G. More, Pragati Edition, 2010
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. Technologies for converting waste agricultural biomass to energy- UNEP, Division of Technology, Industry and Economics International Environmental Technology Centre, Osaka 2. Biodiesel Production Technology – J. Van Gerpen, B.Shanks, and R. Pruszko,D. Clement ,G. Knothe, K. Shaine Tyson 3. Industrial Organic Chemistry, Klaus Weissermel, Hans-Jürgen Arpe, First published:27 May 2003, Print ISBN:9783527305780 | WILEY-VCH Verlag GmbH & Co. KGaA 4. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006. 5. 2. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013. 6. 3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa (Eds.), Biomass to Biofuels : Strategies for Global Industries, Wiley, 2010. 7. 4. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013. 8. 5. Shang-Tian Yang (Ed.), Bioprocessing for Value Added Products from Renewable Resources, Elsevier, 2007.
E - resources:
NPTEL Course Biomass Conversion and Biorefinery, By Prof. Kaustubha Mohanty | IIT Guwahati https://onlinecourses.nptel.ac.in/noc22_ch28/preview

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science
Course name: Transition Metal and Bioinorganic Chemistry **Course Code:** MCH43MML645
Course category: MM **Credits: 03**
Teaching scheme: L-3 **Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Fundamentals and Principles of Inorganic Chemistry
Course Objectives: The learners should be able to apply theories of chemical bonding, reaction mechanism, electronic structure and magnetic properties of coordination complexes to identify the occurrence, active site structure and functions of some transition metal ion containing metalloproteins or enzymes.
Learning Outcomes: At the end of the course, the learners should be able to:
CO1 Identify the principles, structure and reactivity of selected coordination complexes.
CO2 Describe: structure and bonding in transition metal complexes
CO3 Interpret their electronic spectra and magnetic properties
CO4 Describe: function of metal ions and metalloproteins in biological system.
CO5 Describe: applications of metal ions in medicine and toxicity.

Unit	Content	Teaching hours
I	**Transition Metal Chemistry:** Structure, bonding and properties of transition metal ligand complexes ligand, coordination, geometry, coordination number, isomerism (recapitulation) and optical isomerism, HSAB concept, thermodynamic stability, successive and overall stability constants, Irving-William series, chelate and macrocyclic effect.	**09**
II	**Theories of bonding** : VBT, CFT and their limitations; d-orbital splitting in octahedral, JT-distorted octahedral, square planar, square pyramidal, trigonalbipyramidal, and tetrahedral complexes; CFSE for d1 to d10 systems, pairing energy, low-spin and high-spin complexes and magnetic properties; LFT, and molecular orbital (MO) theory of selected octahedral and tetrahedral complexes.	**09**
III	**(a)Electronic Spectra** and **(b) Reaction mechanisms** **(a)Electronic Spectra**- UV-Vis, charge transfer, colors, intensities and origin of transitions, interpretation, term symbols and splitting of terms in free atoms, selection rules for electronic transitions, Orgel and Tanabe-Sugano diagram, calculation of Dq, B, C, Nephelauxetic ratio.	**09**

	(b) Reaction mechanisms - substitution reactions in octahedral and square planar complexes, trans effect and its influence, water exchange, anation and base hydrolysis, stereochemistry, inner and outer sphere electron transfer mechanism.	
IV	**Bioinorganic Chemistry (11 Hrs)** Transition metals in biology - their occurrence and function, active-site structure and function of metalloproteinsand metalloenzymes with various transition metal ions and ligand systems; O2 binding properties of heme(haemoglobin and myoglobin) and non-heme proteinshemocynin&hemerythrin), their coordination geometry and electronic structure, co-operativity effect, Hill coefficient and Bohr Effect; characterization of O2 bound species by Raman and infrared spectroscopic methods; representative synthetic models of heme and non- heme systems.	**09**
V	**Electron transfer proteins** Active site structure and functions of ferredoxin, rubridoxin and cytochromes, and their comparisons.Vitamin B12 and cytochrome P450 and their mechanisms of action. Metals in medicine - therapeutic applications of cis-platin, transition metal radio-isotopes (example: Tc, Co and Cu etc.) and MRI (Mn and Fe) agents. Toxicity of metals - Cd, Hg and Cr toxic effects with specific examples.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. M. Weller, T. Overton, J. Rourke and F. Armstrong, Inorganic Chemistry,6th Edition, Oxford University Press, 2014. (South Asia Edition 2015) **2.** J. E. Huheey, E. A. Keiter, R.L. Keiter and O. K. Mehdi, Inorganic Chemistry, Principles of Structure and Reactivity, 4th Edition, Pearson, 2006. **3.** C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, 4th Edition, Pearson, 2012. **4.** W. Kaim and B. Schwederski and Axel Klein, Bioinorganic Chemistry: **5.** S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books, 1994.
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6th Edition, Wiley, 2007
E - resources:
NPTEL Course Co-ordination chemistry (chemistry of transition elements), IIT Kharagpur Prof. D. Ray https://nptel.ac.in/courses/104105033

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science
Course name: Industrial Catalysis and Process Chemistry **Course Code:** MCH43MML646
Course category: MM **Credits: 03**
Teaching scheme: L-3 **Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Fundamental principles of catalysis and organic reaction mechanism
Course Objective: To learn principles of industrial catalytic process, green technology, fine chemical production and scale up of chemical process.
Learning Outcomes: At the end of the course, the learners should be able to:
CO1 Describe: Industrial catalytic process, organometallic, supra molecular and metal free or organo catalysis, types of chemical reactors and principles of process intensification
CO2 Develop: Alternative green chemical process for industrial productionof value added product
CO3 Apply: Principles of process development and engineering to improve existing chemical processes.
CO4 Assess: Alternative chemical processes and provide recommendations for the best choice.
CO5 Use: knowledge of catalysis for designing green protocol in organic synthesis

Unit	Content	Teaching hours
I	**Organometallic catalysis and supramolecular catalysis** Terminology in catalysis: Turnover, turnovernumber (TON), turnover frequency (TOF). Hydrogenation, Hydroformylation,Monsanto process, Wacker process, Ziegler-Natta polymerization, C-C coupling reactions, Olefin metathesis and metathesis polymerization	**09**
II	**Supramolecular and organo Catalysis** Relevance of supramolecular chemistry to mimic biological systems: cyclodextrins asenzyme mimics, ion channel mimics, supramolecular catalysis. (i) Homogeneous, (ii) Heterogeneous, (iii) bio (enzyme) catalysis, (iv) catalysis with non-toxic metals (Ca, Fe, Co, etc.), (v) solid supported catalysis (vi) metal free/organo catalysis(vii) Visible light catalysis(viii) phase transfer catalysis. Alternative/Green Solvents for Organic Synthesis (i) Water, ii) Ionic liquids, iii) Supercritical liquids (SCL), iv) Poly(ethylene glycol) (PEG)	**09**
III	**Production of Fine Chemicals** Introduction to the chemical reactors, continuous, batch and fixed bed reactor for Production Plants, Dedicated Continuous Plants, Batch ReactorSelection, Reactors for Liquid and Gas-Liquid Systems, Reactors	**09**

	for Gas-Liquid-Solid Systems, Batch Reactor Scale-up Effects, Temperature Control, Safety Aspects of Fine Chemicals, Thermal Risks, Safety and Process development.	
IV	**Selected Fine Chemical Technologies** Alkylation, Halogenation, Oxidation, Reduction, Esterification, Nitration, and Hydrogenation	**09**
V	**Process Intensification and Process Development** Introduction to intensification of chemical processes; Guiding principles and elements of process intensification, equipment and methods for process intensification, Separation process intensification, Examples and case studies**.** Scale-up of chemical processes; Objectives, steps and procedures; Pilot plants; Commercial scale-upof new chemical. Steps to transform a batch process reaction to a continuous process.	09

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Organometallic Compounds, Indrajeet Kumar 3rd edition, 2011, PragatiPrakashan. 2. Green Chemistry: An introductory text by Mike Lancaster, RSC publishing, 2nd Edition, 2010. 3. Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner,Oxford University Press, Oxford, 1998. 4. Industrial Chemical Process Design – D. L. Erwine, McGraw-Hill 5. Unit Processes in Organic Synthesis – P. H. Groggins, McGraw-Hill 6. Industrial Catalysis – A Practical Approach – Jens Hagen, Wiley-VCH 7. Chemistry, Principles of Structure and Reactivity, 4th Edition, Pearson, 2006.
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6th Edition, Wiley, 2007 2. Kamelia Boodhoo and Adam Harvey. Process Intensification for Green Chemistry Engineering Solutions for Sustainable Chemical Processing, Edited by Kamelia Boodhoo and Adam Harvey , School of Chemical Engineering & Advanced Materials Newcastle University, UK. Willey, 2013. 3. Juan¬Gabriel¬Segovia-Hernández¬ Adrián¬Bonilla-Petriciolet Editors, Process Intensi cation in Chemical Engineering Design Optimization and Control, Springer, 2016. 4. David Reay, Colin Ramshaw, and Adam Harvey, Process Intensification: Engineering for efficiency, sustainability and flexibility, IchemE, 2nd edition, 2013, Elsevier.
E - resources:
NPTEL Course Chemical Process Intensification, By Prof. Subrata K. Majumder | IIT Guwahati, https://onlinecourses.nptel.ac.in/noc19_ch18/preview

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science
Course name: Chemical Processes at Surfaces and Interfaces **Code:** MCH43MEL638
Course category: ME **Credits: 03**
Teaching scheme: L-3 **Evaluation scheme:** CA-60, ESE-40
Pre-requisites: Fundamental principles of catalysis and surface chemistry.
Course objectives: To introduce the basic concepts of surface and interfacial chemistry. The subject is very diverse and interdisciplinary in nature. The topics cover the chemical processes that occur at solid-liquid, solid-gas and liquid-gas interfaces. The spectroscopy and microscopy methods to study the interfacialphenomena
Learning Outcomes: At the end of the course, the learners should be able to
CO1 Understand: concepts of solid-liquid, solid-gas, liquid-gas interfaces
CO2 Apply : fundamental principles of chemistry to chemical processes occurring at interface
CO3 Describe: Various Surface phenonmenon
CO4 Describe: energetic and kinetics of surface phenomenon
CO5 Apply: spectroscopic methods to study interfaces and interfacial phenomena

Unit	Content	Teaching hours
I	**Solids and solid surfaces** Crystalline surfaces, single crystal surface structures,surface relaxation, clean and adsorbate induced surface reconstructions, bimetallicand semiconductor surfaces, adsorbateoverlayer structures and notations,thermodynamics of solid surfaces, surface energy and defects, surface diffusion,band structure of solids, Fermi energy and work function, density of states, quantumwires, nanostructures, and semiconductor quantum dots.	**09**
II	**Liquids and liquid surfaces**: microscopic picture of liquid surface, surface andinterfacial tension, Young-Laplace equation and its application, measurement ofsurface tension, Kelvin equation and capillary forces, nucleation and growth ofaggregates, Ostwald ripening, surface excess and Gibbs adsorption isotherm.	**09**
III	**Organized molecular assemblies** surfactants and detergency, films of insolublesurfactants, Langmuir films and LB films, Langmuir trough, surface pressure-arearelationships, self-assembling structures, soluble and insoluble monolayers, contactangle and wetting, capillary rise, dispersion, colloids, micelles (CMC), oil-water-surfactant phase diagram, vesicles, microemulsions, aerosols, surfactant and lipidmembranes, liquid crystals, ionic liquids	**09**
IV	**Energetics and kinetics** chemisorption, adsorption isotherms, measurement of heats of adsorption	**09**

	and isosteres, adsorption on porous materials, capillarycondensation phenomenon and hysteresis. Kinetics of catalytic reactions onsurfaces, structure sensitivity, chemisorbed molecular species on surfaces andBlyholder model of chemisorption bond, surface reaction mechanisms, oscillatoryreactions. Friction and lubrication forces, polymer coated surfaces.	
V	**Spectroscopy methods to study solid surfaces** x-ray and UV photo emission spectroscopies, Inverse photoemission, Auger spectroscopy, LEED structure determination and RHEED, scanning probe microscopies (STM & AFM), Thermal methods, vibrational spectroscopy (RAIRS & HREELS, SERS).	**09**

Text Books:
Title, Author, Edition, year of publication, Publisher
8. Organometallic Compounds, Indrajeet Kumar 3rd edition, 2011, Pragati Prakashan. 9. Green Chemistry: An introductory text by Mike Lancaster, RSC publishing, 2ndEdition, 2010. 10. Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner,Oxford University Press, Oxford, 1998. 11. Industrial Chemical Process Design – D. L. Erwine, McGraw-Hill 12. Unit Processes in Organic Synthesis – P. H. Groggins, McGraw-Hill 13. Industrial Catalysis – A Practical Approach – Jens Hagen, Wiley-VCH 14. Chemistry, Principles of Structure and Reactivity, 4th Edition, Pearson, 2006.
Reference Books:
Title, Author, Edition, year of publication, Publisher
5. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Advanced Inorganic Chemistry, 6th Edition, Wiley, 2007 6. Kamelia Boodhoo and Adam Harvey. Process Intensification for Green Chemistry Engineering Solutions for Sustainable Chemical Processing, Edited by Kamelia Boodhoo and Adam Harvey , School of Chemical Engineering & Advanced Materials Newcastle University, UK. Willey, 2013. 7. Juan¬Gabriel¬Segovia-Hernández¬ Adrián¬Bonilla-Petriciolet Editors, Process Intensi cation in Chemical Engineering Design Optimization and Control, Springer, 2016. 8. David Reay, Colin Ramshaw, and Adam Harvey, Process Intensification: Engineering for efficiency, sustainability and flexibility, IchemE, 2nd edition, 2013, Elsevier.
E - resources:
https://www.youtube.com/watch?v=zdhDei1JolI

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Fertilizer, pesticide and Agrochemicals	**Code: MCH43MEL639**
Course category: ME	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: General Organic, Inorganic and Physical Chemistry	
Course objectives: To provide knowledge about chemistry and importance of agrochemicals and the manufacturing processes of different agrochemicals	
Course Outcomes: At the end of the course, the learners should be able to:	
CO1 Describe the properties and applications of agrochemicals.	
CO2 Describe: composition, sturcute, properties and applications of various agrochemicals	
CO3 Explain : chemistry of pesticide	
CO4 Explain in detail about different formulations an application of pesticide	
CO5 Generalize with commercial manufacturing fertilizers	

Unit	Content	Teaching hours
I	**Unit I Introduction to Agrochemicals:(15 Hrs)** Introduction, Classification, Role of agrochemicals in agriculture. Pesticides-Classification, Nomenclature, formulation, toxicity, Principles of pest control.	09
II	**Chemistry of Agrochemicals** a) Insecticides: Cypermethrin, Phorate, Propoxur.b) Acaricides: Dichlorvos, Phosphamidon,c) Fungicides: Captan, Copper oxy chloride,d) Rodenticides: Warfarin, Zinc Phosphide.e) Nematicides: Aldicarb, Terbifos.f) Fumigants: Ethylene dibromide, Methyl bromide.g) Repellants (DEET) and attractants.h) Molluscicides: Metaldehydei) Herbicides (2, 4-D, Dicamba, Propanil, Maleic hydrazide) and Plant growthregulators, (Chloramequat chloride, Daminozide, Ethephone, IAA).Manufacturing processes of some pesticides:Lindane (BHC), Dimethyl phthalate, Parathion, Phorate, Ethylene oxide, 2, 4-D,Copper sulphate.	09
III	**Chemistry of Pesticides:** Introduction to biological classes of pesticides, Structure, Chemical name,Physical properties, Chemical properties, Synthesis, Degradation and metabolism,Formulations, Mode of action, Uses, Toxicity	09
IV	**Pesticide formulations(15 Hrs)** Introduction, Inert ingredients, Necessity of formulations,a) Dry formulations: Diluents, Carriers, Important properties/factors affectingquality and stability of pesticides formulations- particle size, bulk density,flowability, sorptivity, compatibility, Synergists, adjuvants; Stability and shelf lifeof formulations. Dusts (D/DP), Granules (G), Wettable powders (WP/WDP),Manufacturing processes.b) Liquid formulations: Solution/ oil Concentrates, Emulsifiable Concentrates	09

	(EC), Solvents, Adjuants, factors affecting quality and stability and shelf life offormulations.c) Other formulations: Fumigants, Smoke generators, Liquidators, Oils, creamsand gels, Bait, Seed dressings, Aerosols, ULV.	
V	**Unit V Fertilizers** Introduction, Classification, Principles, and methods of fertilizers applications.Synthetic fertilizers:Introduction, Manufacture and uses of nitrogenous fertilizers- Urea, Phosphaticfertilizers- triple super phosphate, Potassic fertilizers- potassium chloride,Complex/compound fertilizers- nitro phosphate, Mixed fertilizers – method ofpreparation and formulation. Fluid fertilizers- Introduction, Manufacturing ofnitrogenous and mixed fluids.	**09**

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Chemistry of Insecticides and Fungicides – U. S. SreeRamulu, Oxford and IBM Pub., 1979 2. Pesticides Formulations – Van Wade. Velkenburg, 1973. 3. Agro based Industries and Pesticides formulations – S. B. Shrivastava and V. 4. K. Agrawal, Small Industry Research Institute 5. Analytical Methods of Pesticides and Plant Growth Regulators and Food 6. Pesticides Synthesis – Mavy, Kohn, Menn, 1979. 1. 7. Chemical Technology – Dryden by M. Rao and M. Marshall, East west press, 1997
Reference Books:
Title, Author, Edition, year of publication, Publisher
Chemical Technology – Dryden by M. Rao and M. Marshall, East west press, 1997
E - resources:
NPTEL Course Chemical Technology, Dr. I. D. Mali https://nptel.ac.in/courses/103107082

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Industrial Inorganic Chemistry	**Code: MCH43MEL640**
Course category: ME	**Credits: 03**
Teaching scheme: L-3	**Evaluation scheme:** CA-60, ESE-40
Pre-requisites: General Inorganic and Physical Chemistry.	
Course objectives: To learn principles of inorganic chemical industry and its utility	
Course Outcomes: At the end of the course, the learners should be able to:	
CO1 Describe: various steps in isolation, extraction and purification of metals from its ore	
CO2 Apply: process in metal finish technology	
CO3 Explain : manufacturing process of various inorganic chemicals and material	
CO4 Deduce : structure and properties of inorganic polymers and its application	
CO5 Describe : synthesis, and applications of inorganic polymers	

Course content

Unit	Content	Teaching hours
I	**Metallurgy Industry** Introduction to metallurgy, types of metallurgy, ores and minerals, mineral in India, metallurgical process, concentration of ore, calcinations, rosting, smelting. Thermodynamics of metallurgy and Ellingham diagram, extraction of Zn, Fe, Cu, Al from there ores.Refining and purification techniques zone refining. Alloys: prepartion and applications and phase diagram study of alloys of Fe, Cu, Ni, Al, Zn, Sn.	09
II	**Metal finish technology(15 Hrs)** Electro refining of metals, electroplating of nickel, chromium,copper, cadmium, silver and Gold, surface treatment technology, surface coats. Introduction, Electrodeposition, electroplating (Factors affecting, requirements and applications), hotdipping, metal cladding, immersion plating, metal spraying, vapour deposition and chemicaland organic coating	09
III	**Inorganic Chemicals and material Industry(15 Hrs)** **Chloralkali Industries:** Soda Ash, Caustic Soda, Chlorine and flurochemicals. **Industrial Gases:** Manufacture and industrial uses of H2, O2, N2, CO2 & acetylene. Liquefaction of gases, production of low temperatures, **Chemicals of**	09
IV	**Utility Inorganic Chemicals** Inorganic fine chemicals, magnesia, alumina, $AlCl_3$, calciumcarbonate, sodium silicate, MnO_2, $FeSO_4$,PbO_2,Na_2HPO_4, NaOH and alum. **Glass and Refractory materials:** Raw materials, Soda glass, borosilicate glass, Lead Glass,Colored Glass, Refractory: Raw materials, clay pots, Zeolites.	
V	**Inorganic Polymers** Inorganic polymers: Introduction, general properties, glass transition	09

	temperature, synthesis properties and structure of Phosphorous, sulphur, boron, silicon based polymers, coordination polymers. Synthesis, structure, and applications of Metal Organic Framework (MOF), isopoly and heteroploly acids and anions.	

Text Books:
Title, Author, Edition, year of publication, Publisher
1. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, 33rd edition 2021 ISBN:978-93-82956-96-9 2. Lowenheim F A (1974) Modern Electroplating III Ed Chapman & Hall, Landon. 3. Gable, D: Principal of metal Treatment and protection. Pergamon, Press Oxford (1978) 4. G.A. Keneth: Electroplating for Engineering's A Hand Book IIIrdEdn VanNastradReinbold Co London
Reference Books:
Title, Author, Edition, year of publication, Publisher
1. F A Lowinbein: Modern Electroplating, Electroplating Publication New Jersey 2. Burke Progess in ceramic science Vol. IV 3. R.R.Iash: afromulary of paints and other coating Vol. I 4. J.D. Gilchrist: Extraction Metallurgy (Pergamon) 5. W.H. Dennis: Foundation of steel and iron Metallurgy (Elsevier) 6. S.D. Shukla& G N Pandey: A text book of chemical technology Vol. 1 7. Chemical Technology – Dryden by M. Rao and M. Marshall, East west press, 1997
E - resources:
NPTEL Course Chemical Technology, Dr. I. D. Mali https://nptel.ac.in/courses/103107082

Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Industrial Chemistry Lab-II	**Course code:** MCH43MEP613
Course category: ME	**Credits: 1**
Teaching scheme: P-2	**Evaluation scheme:** CA-30, ESE-20
Pre-requisites: skills in handling laboratory chemicals and glassware	
Course Objectives: To study the various methods and techniques of polymerization reactions, their chemistry, mechanism, structures, properties and applications.	
Course Outcomes: At the end of the course, the students will be able to –	
LO1 Prepare the various types of polymers and study their physical / chemical properties	
LO2 Apply the methods of polymerization reaction for the synthesis of polymers	
LO3 Describe awareness of the stereo chemistry and physical status of polymer molecules, molecular weight, stereo specificity and stability of polymer compounds	

List of Practical: (Any ten experiments)

Sr. No.	Title of the Experiment
1.	**Polymer Preparation:** Preparation of polyaniline. Preparation of poly (ethylene terephthalate). Preparation of polystyrene by redox method. Preparation of poly(acryl amide) and poly (acrylic acid) copolymers. Preparation of nylon 66/6
2.	**Methods of Polymerization:** Redox polymerization synthesis: preparation of poly (acrylamide) by free Radical polymerization Precipitation polymerization of acrylonitrile Suspension polymerization of methyl methacrylate. Emulsion polymerization of methylmethacrylate, polyacrylonitrile
3.	**Polymer characterization** 5. Determination of molecular weight by viscometry (PS-toluene/benzene, Polyacrylamide-aq.NaNO2 solution, Poly (methyl acrylate) - toluene/benzene.) 6. Determination of molecular weight by end group analysis PEG. (OH group). 7. Testing of mechanical properties of polymers. 8. Determination of hydroxyl No. of polymer using colorimetric method.

Reference Book / Hand Books/ Lab Manual
Experimental in polymer science -D.G. Hundiwale, V.D. Athawale, U. R. Kapadi, V.V.Gite., New age International (P) Limited, Pubilishers 2009.
Preparative method in polymer science, Wayne R. Sorenson, Tod W. Campbell
Material Science of Polymers for Engineers, Tim A. Oswald Georg Menges, Hanser Publications, 2012.
Preparative Methods of Polymer Chemistry, Wayne R. Sorenson and T. W. Campbell, 3rd edition, Wiley – Interscience, New York, 2001.

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Semester-IV (Industrial Chemistry)

Name of Faculty: Basic and Applied Science	
Course name: Research Project	**Course code: MCH43RPJ612**
Course category: MM	**Credits: 6**
Pre-requisites: skills in handling laboratory chemicals and glassware, Research methodology, Lab safety practices.	
Teaching scheme: P-12	**Evaluation scheme:** CA-60, ESE-40
Course Objective: To provide hands on training to understand research problem to design synthesis of target molecule, characterization and application study	
Course Outcome At the end of the course, the students will be able to –	
LO1 Demonstrate skill of designing multistep synthesis of target molecules in laboratory using simple starting molecules	
LO2 Optimize reaction condition and study of role of catalyst, solvent, catalyst loading, atom economy, monitoring of reaction by TLC, isolation of product by work up procedure, column chromatography.	
LO3 Interpret FT-IR, 1H-NMR, ^{13}C-NMR and Mass spectrometry data of the prepared molecules by physical and spectral analysis	
LO4 Research paper publication	
LO5 Demonstrate skill of presentation resecah paper writing	

Course Content

Student can continue minor research project topic at advanced level as chosen in IIIrd semester or can choose project work topic as per expertise and research thrust area of department faculty members and undertake experimental work on chosen topic.

The Major Research Project work should be submitted as Post Graduate Thesis in three (3) copies and should present project work in Viva-Voce examination conducted at the end of semester.

Post Graduate Thesis should contain.

- Introduction: Rationale of research work title along with appropriate literature review which define problem statement.
- Aims and objectives of research topic, Scope of topic
- Experimental section and Research methods/ Techniques
- outcome of project work
- References
- Post Graduate Thesis is to prepare as per template provided by Department of chemistry, School of Basic and Applied Sciences, MGM University.

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