K. C. E. Society's
Moolji Jaitha College
An 'Autonomous College' Affiliated to
K.B.C. North Maharashtra University, Jalgaon.
NAAC Reaccredited Grade - A (CGPA : 3.15 - 3rd Cycle)
UGC honoured "College of Excellence" (2014-2019)
DST(FIST) Assisted College

KNOWLEDGE IS POWER
ESTD. 1945

के. सी. ई. सोसायटीचे
मूळजी जेठा महाविद्यालय
क.ब.चौ. उत्तर महाराष्ट्र विद्यापीठ, जळगाव संलग्नित
'स्वायत्त महाविद्यालय'
नॅकद्वारा पुनर्मानांकित श्रेणी – 'ए' (सी.जी.पी.ए. : ३.१५ – तिसरी फेरी)
विद्यापीठ अनुदान आयोगाद्वारा घोषित 'कॉलेज ऑफ एक्सलन्स' (२०१४-२०१९)
डी.एस.टी. (फीस्ट) अंतर्गत अर्थसहाय्य प्राप्त

Date :- 01/08/2023

NOTIFICATION

Sub :- CBCS Syllabi of M. Sc. in Chemistry (Sem. I & II)

Ref. :- Decision of the Academic Council at its meeting held on 26/07/2023.

The Syllabi of M. Sc. in Chemistry (First and Second Semesters) as per **NATIONAL EDUCATION POLICY - 2020** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2023-24.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

Sd/-
Chairman,
Board of Studies

To :

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

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समर्थ कॉलनी जवळ, जळगांव – ४२५ ००२. (महाराष्ट्र, भारत) । दूरध्वनी क्र. : +९१ २५७–२२३७३६३, २२३४२८१ । ई–मेलः mjcollege@kces.in । वेबसाईटः mjcollege.kces.in

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Moolji Jaitha College, Jalgaon

An "Autonomous College"

Affiliated to

KavayitriBahinabai Chaudhari

NorthMaharashtraUniversity, Jalgaon-425001

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STRUCTURE AND SYLLABUS

F. Y. M.Sc. (Analytical Chemistry)

UnderChoiceBasedCreditSystem(CBCS)

and

as per NEP-2020 Guidelines

[w.e.f.AcademicYear:2023-24]

Preface

Chemistry, being central to all other sciences, its study provides a fundamental insight into the changes taking place in and around our fascinating nature. No one can understand the modern world without the basic knowledge of chemistry and its advanced study help us to have a thorough knowledge of the entire world.

The envisioned aim of the M. Sc. Part I syllabus is to provide a focused, outcome-based syllabus with in-depth knowledge of the various concepts and theoretical principles of chemistry with an agenda to structure the teaching-learning experiences in a more student-centric manner. The syllabus is intended to familiarize the students with the sound basic understaning of the subject as well as expose them to advanced learning which would link to research programmes. The students will gain knowledge about relevant working methods for research, industry, administration, and education through lectures, laboratory work, exercises and project work. The Master's degree program in chemistry lays the foundation for doctoral programs in chemistry.

Program Outcomes (PO) for M.Sc. Program:

Upon successful completion of the M.Sc. program, student will be able to:

PO No.	PO
1	Student possess an in-depth understanding of advanced theories, concepts, and methodologies in their specific field of study.
2	Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3	Student should be capable of critically analyzing complex problems and synthesizing information from various sources.
4	Student should be proficient in effectively communicating scientific information to both technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and the use of appropriate visual aids.
5	Student should demonstrate leadership qualities and the ability to work effectively as part of a team.
6	Student should have developed advanced research skills and the ability to independently design and conduct rigorous scientific investigations. They should be able to analyze scientific literature,formulate research questions, develop research plans, collect and analyze data, draw valid conclusions and know about IPR.
7	Student should understand and adhere to ethical principles and professional standards in their field
8	Student should recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

Program Specific Outcome PSO (M.Sc. Chemistry):

After completion of this course, students are expected to:

PSO No.	PSO
1	understand the principles of organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry etc.
2	learn the main synthetic routes and reactivity for variety of organic compounds such as intermediates, natural products, other bioactive molecules.
3	get knowledge about stereochemical nomenclature, asymmetric synthesis, and its applications in organic synthesis.
4	understand the theory and principles of NMR, FT-IR, and Mass etc. for identification of unknown structure.
5	understand the laboratory techniques such as instrumentation, mixture separation, reflux, distillation, recrystallization, vacuum filtration, thin-layer chromatography and good laboratory practices and safety.
6	equiped with the required knowledge and generic skills required for employment or further training in R and D, science based industry and establishments, education, and training at management levels in other professions.

Credit distribution structure for two years/one-year PG MSc programme

Level	Sem	Major (Core) Subjects		Minor Subjects	OJT/Int, RP	Cumulative Credits/Sem	Degree/ Cumulative Cr.
		Mandatory (DSC)	Elective (DSE)				
6.0	I	DSC-1 (4T) DSC-2 (4T) DSC-3 (4T) DSC-4 (2P)	DSE-1(2T) A/B DSE-2(2P) A/B	RM (4T)		22	First year PG OR One year PG diploma after 3year UG
	II	DSC-5 (4T) DSC-6 (4T) DSC-7 (4T) DSC-8 (2P)	DSE-3(2T) A/B DSE-4(2P) A/B		OJT/Int (4)	22	
	Cum. Cr.	28	8	4	4	44	
	Exit option: PG diploma (44 Credits) after three year UG degree						
6.5	III	DSC-9 (4T) DSC-10 (4T) DSC-11 (4T) DSC-12 (2P)	DSE-5(2T) A/B DSE-6(2P) A/B	--	RP (4)	22	Second year PG after 3 year UG OR PG degree after 4 year UG
	IV	DSC-13 (4T) DSC-14 (4T) DSC-15 (2P) DSC-16 (2P)	DSE-7(2T) A/B DSE-8 (2P) A/B	...	RP (6)	22	
	Cum. Cr.	54	16		4+10	88	
2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree							

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical, **RM**- Research Methodology, **OJT**- On Job Training, **Int**- Internship, **RP**- Research Project, **Cum. Cr.**:Cumulative Credits

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
6.0	One-year PG Diploma program after 3 Yr Degree	40	44	2	1
6.5	Two-year master's Degree program After 3-Yr UG OrPGDegreeafter 4-Yr UG	80	88	4	2

M.Sc. Chemistry Course Structure

Semester	Course Module	Credit	Hours/ week	TH/ PR	Code	Title
I	DSC	4	4	TH	CHA-DSC-511	Advanced Physical Chemistry
	DSC	4	4	TH	CHA-DSC-512	Modern Inorganic Chemistry
	DSC	4	4	TH	CHA-DSC-513	Principles of Organic Chemistry
	DSE	2	2	TH	CHA-DSE-514 (A)	Laboratory Planning and Safety
	DSE	2	2	TH	CHA-DSE-514 (B)	Thermal and Electro Analytical Methods
	DSC	2	4	PR	CHA-DSC-515	Systematic Experimental Physical Chemistry
	DSE	2	4	PR	CHA-DSE-516 (A)	Systematic Experimental Inorganic Chemistry
	DSE	2	4	PR	CHA-DSE-516 (B)	Organic Compound Preparations
	DSC	4	4	TH	CHA-RM-517	Research Methodology for Chemistry
II	DSC	4	4	TH	CHA-DSC-521	Quantum Chemistry and Molecular Spectroscopy
	DSC	4	4	TH	CHA-DSC-522	Applied Inorganic Chemistry
	DSC	4	4	TH	CHA-DSC-523	Organic Reactions and Spectroscopy
	DSE	2	2	TH	CHA-DSE-524 (A)	Symmetry and Group Theory
	DSE	2	2	TH	CHA-DSE-524 (B)	Applications of Nanotechnology
	DSC	2	4	PR	CHA-DSC-525	Advanced Analytical Chemistry Practicals
	DSE	2	4	PR	CHA-DSE-526 (A)	Applied Organic Chemistry Practicals
	DSE	2	4	PR	CHA-DSE-526 (B)	Practicals in Applied Inorganic Chemistry
	DSC	4	8	OJT	CHA-OJT-527	Intership/ On Job Trainning

DSC	**:**	Department-Specific Core course
DSE	**:**	Department-Specific elective
TH	**:**	Theory
PR	**:**	Practical

Examination Pattern for MSc

Theory Question Paper Pattern:

- 60 (External) +40 (Internal) for 4 credits
    - External examination will be of three hours duration
    - There shall be 5 questions each carrying equal marks (12 marks each) while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 3 out of 4 sub-questions; each 4marks
    - Q 2, Q3, Q4 and Q5Attempt any 2 out of 3 sub-question; each 6 marks.
- 30 (External) +20 (Internal) for 2 credits
    - External examination will be of 1½ hours duration
    - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
    - Q1 Attempt any 2 out of 3 sub-questions; each 3marks
    - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

1. Continuous & Comprehensive Evaluation (CCE):CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course.Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each method carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

2. Internal Assessment Tests (IAT):IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course.IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that was not covered by the CCEs.Thesubject teacher is at liberty to decide which units are to be assessed using CCEs and which unit is to be assessed on the basis of IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.

The subject teachers are required to communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

Practical Examination Credit 2: Pattern (30+20)

External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours duration and shall be conducted as per schedule.
- There shall be 05 marks for journal and viva-voce. Certified journal is compulsory to appear for practical examination.
- Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule for 2 consecutive days in case of practical where incubation condition, allied aspects are essential.

Internal Practical Examination (20 marks):

- Internal practical examination of 10 marks will be conducted by department as per schedule given.
- For internal practical examination student must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and the Head of the department.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities assigned by the faculty during regular practicals. For details refer internal theory examination guidelines.
- Finally 40 (10+30) marks performance of student will be converted into 20 marks.

Semester-I

F. Y. M. Sc.
Semester-I
CHA-DSC-511: Advanced Physical Chemistry

Total Hours: 60 **Credits: 4**

Course objectives	• To orient and acquaint the PG students towards the advanced concepts of physical chemistry • To acquire knowledge about thermodynamics and phase equilibria • To learn the concepts of nuclear chemistry • To study and understand the concepts of reaction kinetics	
Course outcomes	After successful completion of this course, students are expected to • the fundamental and advance concepts of thermodynamics • importance of phase rule • core study of nuclear chemistry • complex reactions and their kinetics	
Unit	**Contents**	**Hours**
Unit I	**Thermodynamics** State functions, exact and inexact differentials, test of exactness, enthalpy of a system, entropy of a system, standard entropy and residual entropy, molar heat capacities, relation between Cp and Cv, laws of thermodynamics, Maxwell relations, thermodynamic equation of state, partial molar quantity and its significance, partial molar volumes, chemical potential, Gibbs-Duhem equation, thermodynamics of mixing-Gibb's free energy of mixing, entropy of mixing, enthalpy of mixing, volume of mixing.	**15**
Unit II	**Phase equilibria** Phase, components, degree of freedom, the Gibb's phase rule, derivation of phase rule, phase equilibria of one component system (water system, carbon dioxide system and sulphur system) phase equilibrium of two component system (two component system solid-liquid equilibria and simple eutectic systems), phase equilibrium of three component system, Clapeyron equation, Clausius-Clapeyron equation, integrated form of Clausius-Clapeyron equation and related numerical.	**15**
Unit III	**Nuclear Chemistry** Parent-daughter decay-growth relationships: daughter nucleus is stable, parent shorter-lived than daughter, parent and daughter of nearly the same half-life, parent longer lived than daughter, secular and transient equilibrium. Applications of radioactivity: Typical reactions involved in the preparation of radio isotopes (Tritium, Carbon-14, Sodium-22, Phosphorous-32, Sulphur-35), Typical applications of radioisotopes as tracers: Analytical applications (isotope dilution analysis and neutron activation analysis) and related numerical	**15**

Unit IV	**Chemical Kinetics** Complex reactions, types of complex reactions and their kinetics (opposing reactions, parallel reactions, consecutive reactions, chain reactions), elucidation of mechanism of complex reactions: rate determining step of the reaction and steady state approximation, pre-equilibria, Michaelis-Menten mechanism of enzyme catalysis, Lindemann-Hinshelwood mechanism, and related numerical.	**15**
Study Resources	• Atkins, P. W. (1998). Physical Chemistry, ELBS. • Barrow, G. M. (2003). Physical Chemistry, International Student Edition. • Moore, W. J. (1998). Physical Chemistry, Orient Longman. • Glasstone, S. (1965). Thermodynamics for Chemist, Van Nostrand, East-West. • Arnikar, H. J. (1995). Essentials of Nuclear Chemistry, New Age Publication Ltd. • Friedlander, G., Kennedy, J. W., Macias, E. S., and Miller, J. M., (1981). Nuclear and Radiochemistry, John-Wiley. • Harwey, B. G. (1963). Introduction to Nuclear Physics and Chemistry, Prentice Hall. • Glasstone, S. (1967). Sourcebook of Atomic Energy, Van Nostrand, East-West. • Laidler, K. J. (1985). Chemical Kinetics, McGraw Hill. • Moore, J. W., Pearson, R. G. (1981). Kinetics and Mechanism, Wiley. • Agrawal, G. L. (1990). Basic Chemical Kinetics, Tata McGraw-Hill Publishing Company Lid., New Delhi. • Maron, S. H., and Prutton, C. F. (2012). Principles of Physical Chemistry (4th Edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. • McQuarrie, D. A., and Simon, J. D. (2006). Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi. • Bahl, B. S., Bahl, A., and Tuli, G. D. (2005). Essentials of Physical Chemistry, S. Chand and Co Ltd., New Delhi. • Puri, B. R., Sharma, L. R., and Pathania, M. S. (2007). Principles of Physical Chemistry (42nd Edition), Vishal Publishing Co., Jalandhar.	

F. Y. M. Sc.
Semester-I
CHA-DSC-512: Modern Inorganic Chemistry

Total Hours: 60 **Credits: 4**

Course objectives	• To familiar with Modern inorganic chemistry. • To understand the Reaction Mechanism of Coordination Compounds. • To get the knowledge of Metals and Metallurgy. • To know the Molecular symmetry.	
Course outcomes	After successful completion of this course, students are expected to • understand Reaction Mechanism involve in Coordination Compounds. • get the knowledge of Metallic Bond involvement in various chemical compounds. • be familiar with the metallurgical process. • get the knowledge of symmetry elements and operations in molecular symmetry.	
Unit	**Contents**	**Hours**
Unit I	**Reaction Mechanism of Coordination Compounds** Substitution reactions in octahedral complexes: Unimolecular Nucleophilic Substitution (SN_1) and Bimolecular Nucleophilic Substitution (SN_2) reactions, Types of intermediates formed during S_{N1} and S_{N2} reactions, lability and inertness of octahedral complexes. Acid and base hydrolysis of octahedral complexes, substitution reactions of square planar complexes. Oxidation Reduction reactions. Two electron transfer reactions.	**15**
Unit II	**The Metallic Bond** General properties of metals: Conductivity, Luster, malleability and cohesive force. Theories of Bonding in metals: Free electron theory, valence bond theory, molecular orbital or band theory. Conductors, Insulators and semiconductors. Alloys–interstitial alloys and related compounds, alloys, Cu/Ni (Phase diagram expected), and super conductivity.	**15**
Unit III	**Metals and Metallurgy** Occurrence of metals, various steps involved in metallurgical process, concentration ore, calcination, roasting, reduction to free metal, Electrometallurgy, hydrometallurgy, specialized technique for extraction of metals, refining and purification, and thermodynamics of the oxidation of metals to metal oxides.	**15**
Unit IV	**Molecular Symmetry** Symmetry elements and operations, symmetry planes, reflections, inversion centre, proper /improper axes of rotation, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, and Classification of point groups and procedure to determine the point group (with at least one example of each point group)**.**	**15**
Study Resources	• Huheey, J. E., Keiter, E. A., and Keiter, R. L. (1993), Inorganic chemistry: principles of structure and reactivity, 4th edn, New York, NY: Harper Collins College Publishers. • Lee, J. D. (2006). Concise Inorganic Chemistry, 5th edition, Blackwell Science, London. • Sharpe, A. G., (1981). Inorganic chemistry, 3rd edition, Pearson	

	Education. • Cotton, F. A. (1991). Chemical applications of group theory. John Wiley & Sons. • Shrivers, D. F., Atkins, P. W. and Langfor C. H., (1990), Inorganic Chemistry, CH Langford. • Puri, B. R., Sharma L. R., Kalia K. C., (2005). Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co. • Gray H. B., Electrons and Chemical Bonding. (1965). W. A. Benjamin, Inc., New York. • Emeleus H. J. and Sharpe A. G., Modern Aspects of Inorganic Chemistry, Universal Book Stall, New Delhi. • Bhattacharya P. K., Group Theory and its Chemical applications, Himalaya Publishing House. • Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). Advanced inorganic chemistry. John Wiley and Sons, Inc.	

F. Y. M. Sc.
Semester-I
CHA-DSC-513:Principles of Organic Chemistry

Total Hours: 60 **Credits: 4**

Course objectives	• To study basic principles of organic chemistry • To learn structure and bonding in organic molecules. • To learn stereochemistry and the concepts of reaction mechanism. • To study the role of common synthetic reagents.	
Course outcomes	After successful completion of this course, students are expected to • develop better understanding of structure and bonding in organic molecules. • learn the concepts of stereochemistry and apply them effectively. • help students to understand different concepts involved in reaction mechanism • learn applications of different synthetic reagents in organic synthesis.	
Unit	**Contents**	**Hours**
Unit I	**Structure and Bonding** Review of basic principles of structure and bonding, application of acid base concepts, HSAB theory, aromaticity and antiaromaticity, Hückel's rule, homo-aromaticity, n-annulenes, heteroannulene, fullerenes, C-60, cryptates, Bonds weaker than covalent: addition compounds, inclusion compounds, crown ethers, cyclodextrins, catenanes and rotaxanes.	**15**
Unit II	**Stereochemistry** Conformational analysis of cycloalkanes. Effect of conformation on reactivity. Elements of symmetry, chirality, molecules with more than one chiral center. Projection formulae (i) Fischer (ii) Sawhorse (iii) Newman (iv) Flying Wedge. Threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon.	**15**
Unit III	**Reaction Mechanism** Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Hammond postulate, Curtin-Hammett principle, transition states and intermediates, methods of determining mechanisms, isotopic effects. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Effect of structure on reactivity. The Hammett equation and linear free energy relationship (sigma-rho) relationship, and Taft equation.	**15**
Unit IV	**Synthetic Reagents** **Oxidation Reactions**: CrO_3, Pyridinium dichromate (PDC), Pyridinium chlorochromate (PCC, Corey's reagent), $KMnO_4$, MnO_2, Swern oxidation, SeO_2, $Pb(OAc)_4$, OSO_4, per-acid, HIO_4, DDQ, and Oppenauer oxidation.	**15**

	Reduction reactions: $LiAlH_4$, $NaBH_4$, $NaCNBH_3$, MPV reduction, Na/liq. NH_3, H_2/Pd-C, Willkinsons catalyst, DIBAL-H, Wolff Kishner reduction, Zn-Hg/H_2O/HCL, and Bu_3SnH.	
Study Resources	• Smith, M. B. (2020). March's advanced organic chemistry: reactions, mechanisms, and structure. John Wiley & Sons. • Carey, F. A., & Sundberg, R. J. (2007). Advanced organic chemistry: part A: structure and mechanisms. Springer Science & Business Media. • Clayden, J., Greeves, N., & Warren, S. (2012). Organic chemistry. Oxford University Press, USA. • Carruthers, W., & Coldham, I. (2004). Frontmatter. In Modern Methods of Organic Synthesis (pp. I-Iv). Cambridge: Cambridge University Press. • Vollhardt, K. P. C., & Schore, N. E. (2003). Organic chemistry: structure and function. Macmillan. • Nasipuri, D. (1994). Stereochemistry of organic compounds: principles and applications. New Age International. • Pine, S. H. (1987). Organic Chemistry McGraw-Hill. New York London. • Sanyal, S. N. (2019). Reactions, Rearrangements and Reagents. Bharati Bhawan. • Ahluwalia, V. K., & Parashar, R. K.; Organic Reaction Mechanism (2011). Penguin Books Ltd, 2011.	

F. Y. M. Sc.
Semester-I
CHA-DSE-514 (A) :Laboratory Planning and Safety

Total Hours: 30 **Credits: 2**

Course objectives	• Demonstrate safe laboratory skills for particular laboratory experiments. • Learn and observe the safety and laboratory rules. • To describe hazard information: material safety data sheets (MSDSS), understand. • To describe what is GLP and Principles of Good Laboratory Practice (GLP).	
Course outcomes	After successful completion of this course, students are expected to • apply laboratory skills such as proper handling of materials and chemical waste for particular laboratory experiments. • apply safety management guidelines, material safety data sheets (MSDS) about laboratory hazards. • apply Chemical Management, Storage, Waste and Security. • apply Personal Protections during laboratory experiments.	
Unit	**Contents**	**Hours**
Unit I	**Laboratory Planning** Introduction- definition of Laboratory, setting up a Laboratory. Process Planning -Standard operating procedure, special procedure, Ordering materials Emergency Planning-Posting and signs, Emergency action plan, Alarm system activation, Evacuation procedure, Fire emergencies, spill/release containment and 15 Cleanup method, Intruders, Vandalism or Theft, Medical emergencies, accident reporting, safety equipment and supplies, utility outages. • Equipment- Safety equipment, bio-safety cabinet, containment/safety shields, eyewash fountains, fire extinguishers, First aid kits, Flammable safety cans, laboratory fume hoods, Laboratory Refrigeration / Freezers, safety showers, spill kits. • Training- Laboratory specific training, refresher training, and documentation.	**8**
Unit II	**Safety Training** General lab Safety, Emergency Management, Waste Management, Chemical safety, Biosafety, Radiation safety, Laser safety, Compressed gas safety, Fume Hood safety, Personal protective equipment, Chem. watch, Electrical safety, Machine shop safety, Mechatronics lab safety, Clean room Safety and Laboratory Specific training	**7**
Unit III	**Chemical Safety, Waste and Recycling** Safety data sheet, General chemical procedure, Chemical Exposure monitoring, Chemical spills, Compressed gas safety, Carcinogenic, Reproductive and highly toxic chemicals, and Chemical storage guideline, Biohazardous waste materials, Chemical waste materials, Equipment Disposal, and Radiological waste materials.	**7**

Unit IV	**Personal Protective Equipment (PPE),Glassware Safety and OSHA laboratory**: Introduction, Hazard Assessment, Eye and face protection, Head protection, Hand protection, Protective clothing, Respiratory protection, Hearing protection, and Foot protection. Inspecting glassware before use, Safe handling and storage, Working with glass rods or tubing, Vacuum and pressure operations, Cleaning and drying glassware, Disposal and spill clean-up. OSHA Laboratory Practices.	**8**
Study Resources	• Laboratory Safety Manual, IOWA State University. http://publications.ehs.iastate.edu/labsm/files/assets/common/downloads/publication.pdf • FENS Laboratory, Laboratory safety handbook, 1stedition, Sabanci University ISBN9786059178594. • OSHA Laboratory Practices. Laboratory Safety Guidance. https://www.osha.gov/Publications/laboratory/OSHA3404laboratory-safety-guidance.pdf	

F. Y. M. Sc.
Semester-I
CHA-DSE-514 (B):Thermal and Electro Analytical Methods

Total Hours: 30 **Credits: 2**

Course objectives	• To learn the instrumental methods of analysis. • To understand the working principle of instrumental methods of analysis. • To comprehend the comparative study of various methods of thermal analysis. • To understand various electroanalytical method.	
Course outcomes	After successful completion of this course, students are expected to • understand the instrumental methods of analysis. • learn the working principle of various instrumental methods • learn about thermal as well as electroanalytical methods. • learn different quantitative analysisi methods.	
Unit	**Contents**	**Hours**
Unit I	**Thermoanalytical Methods** Introduction, Thermogravimetric analysis (TGA): types, principle and method, instrumentation, factors affecting, Differential Thermal Analysis (DTA): Principle, instrumentation, factors affecting, applications,	**8**
Unit II	**Differential Scanning Calorimetry** Differential scanning calorimetry (DSC): Principle, instrumentation, factors affecting and applications.	**7**
Unit III	**Electrogravimetric Analysis** Introduction, Polarisation, Causes of Polarisation, The EMF of polarisation, Measurement of Decomposition potential, Importance and significance of decomposition potential, Overvoltage, Electrochemical Overpotential, Importance of Overvoltage.	**8**
Unit IV	**Electroanalytical Methods** Electrochemical reduction and oxidation, Principles involved in Electrogravimetric analysis, Electrolysis at constant current- Principle, Apparatus. Electrolysis at controlled potential- Principle, Apparatus.	**7**
Study Resources	• Willard H. H., Merrit L. L., Dean J. D., Settle S. A., (1984). Instrumental Methods of Chemical Analysis. 6th Ed, CBS publishers. • BraunR. D.(2016). Introduction to Instrumental Analysis- Pharmamed press-2nd Edition. • SinghM., (1993). Analytical Chemistry Instrumental Techniques. Dominant publishers. • Chatwal G. and AnandS. (2019). Instrumental Methods of Chemical Analysis. Himalaya publications-5th edition. • Sharma B. K.(2007). Instrumental Methods of Chemical Analysis.Goel publishing house- 28th edition	

F. Y. M. Sc.
Semester-I

CHA-DSC-515: Systematic Experimental Physical Chemistry

Total Hours: 60 **Credits: 2**

Course objectives	• To orient and acquaint the PG students towards the physico-chemical experiments • To developed the experimental skills. • To learn the principle and concepts of microwave spectroscopy • To learn handling of conductometer, potentiometer, pH meter, spectrophotometer	
Course outcomes	After successful completion of this course, students are expected to • learn the preparation for each experiment by studying lab handouts and links therein • safety requirements and lab skills to perform physico-chemical experiments • how to keep records of instruments, parameters, and experimental observations reporting of experimental result	
	Contents	**Hours**
	Perform **any fifteen experiments** of the followings: 1. To determine the equivalent conductance of a strong electrolyte at various concentrations and hence verify the Onsager's equation. 2. To determine the hydrolysis constant of sodium acetate conductometrically. 3. To determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements. 4. To study the second order velocity constant of hydrolysis of ethyl acetate by sodium hydroxide using conductivity measurements. 5. To determine the critical micelle concentration (cmc) of sodium lauryl sulphate (SLS) conductometrically. 6. To determine the stability constant of the silver-ammonia complex by potentiometric method. 7. To determine the stability constant of the complex ion $Ag(S_2O_3)_2^{---}$ potentiometrically. 8. To determine the amount of chloride, bromide and iodide present in their mixture by potentiometric titration. 9. To determine the redox potential of Fe^{2+}/Fe^{3+} system by titrating it with standard $K_2Cr_2O_7$ solution potentiometrically. 10. To determine the solubility product of the given sparingly soluble salts by potentiometric method. 11. To determine the dissociation constants of the given dibasic acid pH–metrically. 12. To determine the dissociation constants of polybasic acid (H_3PO_4) pH–	**60**

	metrically. 13. To determine to Hammett constant of p-nitro benzoic acid pH – metrically. 14. To determine the acidic and basic dissociation constants of an amino acid (glycine) and hence the isoelectric point of the acid by pH–metric titration. 15. To determine the isosbestic point of given indicator (methyl red) spectrophotometrically. 16. Simultaneous determination of cations from their binary mixture spectrophotometrically. 17. To determine the order of reaction between potassium persulphate and potassium iodide by fractional change method. 18. To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir adsorption isotherms. 19. To construct the phase diagram of toluene, alcohol and water system. 20. To determine the molar volume of ethanol and its partial molar volume at room temperature in dilute aqueous solutions.	
Study Resources	• James, A. M., and P. E. Prichards (1974). Practical Physical Chemistry (Third Edition), Longman Group Ltd., New York. • Rose, J. (1964). Advanced Experiments in Physical Chemistry: A Textbook of Practical Physical Chemistry and Calculations, Publisher I, Pitman. • Garland, C. W., Nibler, J. W., and Shoemaker, D. P. (2009). Experiments in Physical Chemistry (Eighth Edition), McGraw-Hill, New York. • Das, R. C., and Behera, B. (1983). Experimental Physical Chemistry, Tata McGraw Hill. • Yadav, J. B. (2008). Advanced Practical Physical Chemistry (Tewnty Sixth Edition), Goel Publication House, Meerut.	

F. Y. M. Sc.
Semester-I
CHA-DSE-516 (A) : Systematic Experimental Inorganic chemistry

Total Hours: 60 **Credits: 2**

Course objectives	• To study analysis of ores. • To study inorganic Preparations and purity of complexes. • To study the determination of concentration of metal by flame photometer. • To acquire the skill of analysis of binary mixtures. • To study instrumental methods of quantitative analysis.	
Course outcomes	After successful completion of this course, students are expected to • understand the concept of ore analysis. • apply the concept of potentiometric titration. • understand the synthesis of inorganic complexes and determination of its purity. • be able to apply the concept to calculate concentration of metal by flame photometry.	
	Contents	**Hours**
	Analysis of ores:	
1	Pyrolusite ore-Estimation of silica gravimetrically and Manganese volumetrically.	**4**
2	Haematite-Estimation of copper volumetrically and Iron gravimetrically.	**4**
3	Chromite ore–Estimation of Iron gravimetrically and chromium volumetrically.	**4**
	Inorganic Preparations and purity determinations	
4	Copper(I)-tris(thiourea).	**4**
5	sodium trioxalatoferrate(III)	**4**
6	Nitropentammino cobalt (III) chloride.	**4**
7	8-hydroxy Quinoline Nickel(II).	**4**
8	Prussian Blue/ Iron(III) hexacyanidoferrate (II)	**4**
9	Hexaammine cobalt (III) chloride.	**4**
10	Chloropentaamminecobalt(III) Chloride.	**4**
	Determination of ions from given solution by flame photometer using calibration curve method	
11	To determine the Li from given solution.	**4**
12	To determine the Na from given solution.	**4**
13	To determine the K from given solution.	**4**
14	To determine the Ca from given solution.	**4**
	Analysis of binary mixtures by gravimetric and volumetric methods from the mixture solutions.	
15	Copper- Nickel	**4**
16	Copper-Magnesium	**4**
17	Copper-Zinc	**4**
18	Iron-Magnesium	**4**
19	Silver-Zinc	**4**
20	Lead-Tin	**4**
Study Resources	• Mendham, J., (2009). Vogel's Quantitative Chemical Analysis ,6th Edition, Pearson, Germany. • Svehla, G., Shivshankar B., (2012). Vogel's Qualitative Inorganic Analysis, Pearson Education India.	

	• Christian, G. D., (2006). Analytical chemistry, 6th Edition, Wiley-India. • Mendham, J., Denny R. C.,Barnes J. D., Thomas M.,Sivasankar B., (2009). Quantitative Chemical Analysis., 6th Edition, Pearson, Germany. • Jeffrey, H., Bassett J., Mendham, J., Denney R. C., (1989). Vogel's Textbook of Quantitative Inorganic Analysis, 5th Edition, Longman Scientific and Technical, England co published with John willey and Sons, New York. • Patel, H. N., Turakhia, S. P., Kelker, S. S., Puniyani, S.R., (2010). College Practical Chemistry, Himalaya Publishing House, Mumbai.	

F. Y. M. Sc.
Semester-I

CHA-DSE-516 (B): Organic Compound Preparations

Total Hours: 60 **Credits: 2**

Course objectives	• To promote safety awareness and encourage safe working practices in the laboratory. • Understanding the organic synthesis by single stage and double stage preparations derivatives of organic compounds. • Studying experimental techniques such as steam distillation and column chromatography for the purification and analysis of given organic compounds. • To draw a structure and reactions, elemental analysis, IUPAC name and predict the NMR Signals of organic compounds.	
Course outcomes	After successful completion of this course, students are expected to • understand the importance of laboratory safety. • trained to draw structures, reaction mechanism and predicted nmr spectra by using chemistry software's. • synthesize organic compounds by single and double stage preparation method. with purification and analysis. • apply the green Chemistry principals for preparations of organic compounds.	
	Contents	**Hours**
	Safety in chemical Laboratory, Laboratory Equipment &technique : **Laboratory safety**: Toxicity of Compounds used in Chemistry Laboratory, Safety Symbol, Material Safety Data Sheet (MSDS), Precautions in handling hazardous substances, Good Laboratory Practices (GLP), Information about laboratory glasswares, equipmentsetc: Multiple adapters, Condensers and Receiver Adapters Or connecters, Funnels, Hot water Funnels etc.	**60**
	Purification Techniques (Any Two) • Distillation, Recrystalization and Sublimation • Steam distillation. • Column Chromatography. • Solvent extraction using soxhlet extractor.	
	Use of Chemistry software's Introduction to ISI draw, Chem Draw, ChemSketch. Draw the structure of simple aliphatic and aromatic compounds, heterocyclic compounds with different substituent. IUPAC name and predict the NMR Signals. Sketch Design reaction mechanism scheme of any two addition and two substitution reactions.	
	Derivatives (Any Three) • Phenyl hydrazone derivative of Aldehyde/ketone. • Anilide derivative of carboxylic acid.	

	• Imine derivative of aldehyde or ketones. • Oxime derivative of aldehyde or ketones. • Aryloxy derivative of carboxylic acid.	
	Green Synthesis (Any Three) • Brominating of acetanilide using cerric ammonium nitrate. • Preparation of Benzilic Acid using NaOH /KOH under solvent-free conditions. • Synthesis of acetanilide from aniline by using ZnO/AcOH. • Synthesis of Dihydropyrimidinone from Ethyl acetoacatate, benzaldehyde and urea.	
	Use of Reagents (Any Three) • Resorcinol to 7-hydroxy, 4-methyl coumarin (H_2SO_4). • Camphor to Borneol ($NaBH_4$). • P- nitrotoluene to p- nitrobenzoic acid (Sodium Dichromate). • Cyclohexanone to adipic acid (HNO_3).	
	Organic Estimation (Any Two) **Estimation of:** • Phenol • Aniline • Glucose • Ethyl methyl ketone • Nitro compound • Methoxy groups • Unsaturation	
Study Resources	• Vogel, A. I. (1974). Practical Organic chemistry. Long Man Group Lted, London. • Furniss, B. S. (Ed.). (2011). Vogel's textbook of practical organic chemistry. Pearson Education India. • Sharma, R. K., Sidhwani, I. T., & Chaudhuri, M. K. (2012). Green Chemistry Experiments: A Monograph. IK International Pvt Ltd. • Ahluwalia, V. K., & Dhingra, S. (2004). Comprehensive Practical Organic Chemistry: Qualitative Analysis. Universities Press. • Agarwal, O. P. (2006). Advances Practical Oraganic Chemistry. Krishna Prakashan Media. • Singh, R. K. P., Singh, J., Yadav, L. D. S., Siddiqui, I. R., & Srivastava, J. (2010). Advanced Practical Chemistry. Pragati Prakashan.	

F. Y. M. Sc.
Semester-I
CHA-RM-517: Research Methodology for Chemistry- I

Total Hours: 60 **Credits:4**

Course objectives	• To study the role of research for societal betterment. • To learn to survey literature by various sources. • To cultivate analytical and reasoning thinking in research. • To learn the preparation of a research design.	
Course outcomes	After successful completion of this course, students are expected to: • learn to apply research in societal development. • collect data effectively through literature survey. • apply analytical and reasoning thinking skills to solve research problem. • prepare research design for successful completion of research.	
Unit	**Contents**	**Hours**
Unit I	**Research Fundamentals and Terminology** Research: Definition, Meaning, objectives, types and significance, qualities and criteria of good research, research methodology versus methodology, research and scientific method, research process, list of National Importance Institutes and CSIR laboratories.	**15**
Unit II	**Research Problem And Research Design** Research Problem: Meaning, necessity, components, criteria of selection and technique involved in defining a problem. Research Design: meaning, need, features; basic principles of experimental design and important concepts relating to research design.	**15**
Unit III	**Literature Survey By Print** Print:Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction: Chemical Abstracts Service, Beilstein database, Subject Index, Substance Index, Author Index, Formula Index with examples.	**15**
Unit IV	**Literature Survey By Digital Means** Digital Means: Internet , World Wide Web, internet resources for chemistry, finding and citing published information, web resources, e-journals, journal access, TOC alerts, hot articles, citation index, Impact factor, H-index, UGC infonet, e-books, internet discussion groups and communities, blogs, preprint servers, search engines, Scirus, google scholar, ChemIndustry, wiki- databases, ChemSpider, Science Direct, SciFinder, Scopus, C & EN News Reaxys.	**15**
Study Resources	• Kothari C. R., (2004). Research Methodology: Methods and techniques, 2nd Edition, New Age International (P) Ltd., New Delhi. • Kothari C. R., Garg G., (2019). Research Methodology: Methods and techniques, 4th Edition, New Age International (P) Ltd., New Delhi. • Dean J. R.(2002), Practical skills in chemistry, Pearson Education,Canada.	

	• De Levie R., (2001). How to Use Excelâ in Analytical Chemistry: And in General, Scientific Data Analysis, Cambridge University Press, United Kingdom. • Cooper C., Purchase R., (2017). Chemical Hazard Information for the Laboratory In Organic Chemist's Desk Reference (pp. 171-196), CRC Press, USA. • OSU Safety Manual 1.01 • http://www.cebm.net/wp-content/uploads/2014/06/CEBM-study-design-april2013.pdf • http://www.cebm.net/study-designs/	

Semester-II

F. Y. M. Sc.
Semester-II
CHA-DSC-521: Quantum Chemistry and Molecular Spectroscopy

Total Hours: 60 **Credits: 4**

Course objectives	• To orient and acquaint the PG students towards the advanced concepts of physical chemistry • To acquire knowledge about quantum mechanics • To learn the principle and concepts of microwave spectroscopy • To learn and understand the concepts of infra-red and Raman spectroscopy	
Course outcomes	After successful completion of this course, students are expected to • the fundamental and advance concepts of quantum chemistry • theoretical aspect of spectroscopy, which is helpful in development of theoretical research in physical chemistry	
Unit	**Contents**	**Hours**
Unit I	**Quantum Mechanics** Introduction to quantum mechanics, wave function and its physical meaning, conditions for acceptable wave function, condition of normalization of wave functions, condition of orthogonality, operators, algebra of operators (addition and subtraction, multiplication), commutative property, linear operator, commutator operator, the operator ∇ and ∇^2, eigen values and eigen functions, Hermitian property of operators, properties of a Hermitian operator, basic postulates of quantum mechanics and related numerical.	**15**
Unit II	**Microwave Spectroscopy** Introduction, the rotation of molecules, classification of molecules on the basis of the relative values of their three principal moments of inertia (linear, symmetric top, spherical top and asymmetric top molecules), rotational spectra: diatomic molecules - the rigid diatomic molecule, the intensities of spectral lines, effect of isotopic substitution, polyatomic molecules (linear, symmetric top and asymmetric top molecules, techniques and instrumentation and related numerical.	**15**
Unit III	**Infra-red Spectroscopy** Introduction, principle of infra-red spectroscopy, theory-molecular vibrations, vibrational frequency, force constant, the vibrating diatomic molecule: the energy of diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator, the vibrations of polyatomic molecules: fundamental vibrations and their symmetry, techniques and instrumentation and related numerical.	**15**
Unit IV	**Raman Spectroscopy** Introduction, quantum theory of Raman effect, classical theory of the Raman effect: Molecular polarizability, Pure rotational Raman spectra: linear and symmetric top molecules, vibrational Raman spectra: Raman activity of	**15**

	vibrations, rule of Mutual exclusion and related numerical.	
Study Resources	• Prasad, R. K. (1992). Quantum Chemistry, Wiley Eastern Ltd.. • Chandra, A. K. (1979). Introductory to Quantum Chemistry, Tata McGraw Hill. • Levine, I. N. (1983). Quantum Chemistry (Third Edition), Allyn and Bacon. • Hanna, M. (1970). Quantum Mechanics in Chemistry, John Wiley and Sons. • Atkins, P. W. (1998). Physical Chemistry, ELBS. • Barrow, G. M. (2003). Physical Chemistry, International Student Edition. • Moore, W. J. (1998). Physical Chemistry, Orient Longman. • Maron, S. H., and Prutton, C. F. (2012). Principles of Physical Chemistry (4th Edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. • McQuarrie, D. A., and Simon, J. D. (2006). Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd., New Delhi. • Bahl, B. S., Bahl, A., and Tuli, G. D. (2005). Essentials of Physical Chemistry, S. Chand and Co Ltd., New Delhi. • Puri, B. R., Sharma, L. R., and Pathania, M. S. (2007). Principles of Physical Chemistry (42nd Edition), Vishal Publishing Co., Jalandhar.	

F. Y. M. Sc.
Semester-II
CHA-DSC-522: Applied Inorganic Chemistry

Total Hours: 60 **Credits: 4**

Course objectives	• To recognize the inorganic chemical substances involvement in biological processes. • To get the knowledge of inorganic polymers. • To understand role of inorganic substances as catalyst. • To understand the role of elements in medicinal chemistry	
Course outcomes	After successful completion of this course, students are expected to • apply knowledge of inorganic substance to understand Bioinorganic Chemistry. • get the knowledge of Inorganic polymers. • be aware about the role of inorganic substances as catalyst. • understand the role of elements in medicinal chemistry.	
Unit	**Contents**	**Hours**
Unit I	**Bioinorganic Chemistry** Introduction, role of myoglobin and hemoglobin in biological systems. Metallo-enzymes: carbonic anhydrase, carboxypeptidase, peroxidases, catalases, cytochrome P-450. Inhibition and poisoning of enzymes, role of alkali and alkaline earth metal ions in biological system, biological activity and toxicity of some elements, and biological fixation of nitrogen.	**15**
Unit II	**Inorganic Polymers** Introduction, properties of inorganic chemistry, glass transition temperature. Types: 1) Phosphorus-based polymers: a) Phosphorus-based chain polymers: Polyphosphazenes, Polyposphonitrilic chlorides, Polyphosphoryl Chlorides. b) Phosphorus-based network polymers: Polymeric phosphorus Pentoxide, Polyorthophosphates of boron, Polymeric silver phosphate, borophosphate glasses. 2) Sulphur-based polymers: Polymeric sulphur, polymeric sulphur nitride, chalcogenideglasses. 3) Boron-based polymers: Polyboranes, polymeric boron nitride 4) Siliconbased Polymers: organosilicones, silicone rubber, silicon resins. 5) Coordination polymers: natural and synthetic coordination polymers.	**15**
Unit III	**Catalysis** Catalysis, Catalyst: Properties, types. Catalytic steps in organotransition metal catalyst, hydrogenation of alkenes, hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, alkene polymerization, heterogeneous catalysis, nature of heterogeneous catalyst, examples of heterogeneous catalysts (hydrogenation, oxidation).	**15**
Unit IV	**Chemistry of Elements in Medicine** Introduction, Chelation therapy, use of cis-$[PtCl_2(NH_3)_2]$ complex in cancer treatment, Complexes of Au against rheumatoid arthritis, Imaging agents, and contribution of individual elements(Na, K, Li, Mg, Ca, Mn, Fe, Co, Ni, Cu, Zn, Mo, W, Pt, Au, Bi, and Ru).	**15**

Study Resources	• Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). Inorganic chemistry: principles of structure and reactivity, 4th edn, New York, NY: Harper Collins College Publishers. • Lee, J. D. (2006). Concise Inorganic Chemistry, 5th edition, Blackwell Science, London. • Sharpe, A. G., (1981). Inorganic chemistry, 3rd edition, Pearson Education. • Cotton, F. A. (1991). Chemical applications of group theory. John Wiley & Sons. • Shrivers, D. F., Atkins, P. W. and Langfor C. H., (1990). Inorganic Chemistry, CH Langford. • Puri, B. R., Sharma L. R., Kalia K. C., (2005). Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co. • Gray H. B., Electrons and Chemical Bonding. (1965). W. A. Benjamin, Inc., New York. • Emeleus H. J. and Sharpe A. G., Modern Aspects of Inorganic Chemistry, Universal Book Stall, New Delhi. • Bhattacharya P. K., Group Theory and its Chemical applications, Himalaya Publishing House. • Cotton, F. A., Wilkinson, G., Murillo, C. A., & Bochmann, M. (1999). Advanced inorganic chemistry. John Wiley and Sons, Inc.	

F. Y. M. Sc.
Semester-II
CHA-DSC-523:Organic Reactions and Spectroscopy

Total Hours:60 **Credits: 04**

Course objectives	• To make a systematic study of aliphatic and aromatic nucleophile substitution reactions • To make a systematic study of aromatic electrophilic substitutions reactions • To learn important name reactions involved in organic synthesis. • To learn fundamental of PMR technique.	
Course outcomes	After successful completion of this course, students are expected to • understand systematic details of aliphatic and aromatic nucleophile substitution. • understand systematic details of electrophilic substitutions reactions. • learn various name reactions involved in organic synthesis. • learn and apply applications of spectroscopy.	
Unit	**Contents**	**Hours**
Unit I	**Nucleophilic Substitution** a) Aliphatic Nucleophilic Substitution: S_N1, S_N2, mixed S_N1 and S_N2, S_Ni mechanism, neighbouring group participation by π bonds andanchimeric assistance. Nucleophilic substitutions at an allylic, aliphatic and vinylic carbon. Effects of substrate structure, attacking nucleophile, leaving group and reaction medium on reactivity of SN reactions. b) Aromatic Nucleophilic Substitution : S_NAr, Benzyne mechanism. Reactivity: Effect of substrate, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser and Smiles rearrangements.	**15**
Unit II	**Aromatic Electrophilic Substitution** Arenium ion mechanism, orientation and reactivity, energy profile diagram, calculation of partial rate factor, the ortho/ para ratio, Ipso substitution, Orientation in other ring systems such as Naphthalene, Anthracene, six and five membered heterocycles, Diazonium coupling, Vilsmeier reaction, and Gattermann–Koch reaction.	**15**
Unit III	**Name Reactions** Bayer-Villiger Oxidation, Reformatsky, Robinson annulation, Stork enamine, Sharpless asymmetric epoxidation, ENE reaction, Hell-Volhard-Zelinsky reaction, Chichibabin reaction, Ulman reaction, Rosenmund reaction, Darzen reaction, Knovenagel reaction, and Biginelli reaction.	**15**
Unit IV	**Spectroscopy** PMR: Fundamentals of PMR, chemical shift, factors affecting chemical shift,	**15**

	anisotropic effect, spin-spin coupling, coupling constant, applications to simple structural problems integration coupling (1st order analysis). Problems on UV, IR and PMR.	
Study Resources	• Smith, M. B. (2020). March's advanced organic chemistry: reactions, mechanisms, and structure. John Wiley & Sons. • Carey, F. A., & Sundberg, R. J. (2007). Advanced organic chemistry: part A: structure and mechanisms. Springer Science & Business Media. • Clayden, J., Greeves, N., & Warren, S. (2012). Organic chemistry. Oxford University Press, USA. • Carruthers, W., & Coldham, I. (2004). Frontmatter. In Modern Methods of Organic Synthesis (pp. I-Iv). Cambridge: Cambridge University Press. • Ahluwalia, V. K., & Parashar, R. K.; Organic Reaction Mechanism (2011), Penguin Books Ltd, 2011. • Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. A. (2014). Introduction to spectroscopy. Cengage learning. • Silverstein, R. M., & Bassler, G. C. (1962). Spectrometric identification of organic compounds. Journal of Chemical Education, 39(11), 546. • Kalsi, P. S. (2007). Spectroscopy of organic compounds. New age international.	

F. Y. M. Sc.
Semester-II
CHA-DSE-524 (A): Symmetry and Group Theory

Total Hours: 30 **Credits: 2**

Course objectives	• To understand the important role of symmetry elements and operations in point groups and their applications in the prediction of various molecular properties. • To understand the representation of groups. • To understand the molecular Orbital Theory aspects to group theory. • To learn L-S coupling for dn states.	
Course outcomes	After successful completion of this course, students are expected to • understand the important role of symmetry elements and operations in point groups and their applications in the prediction of various molecular properties.. • understand the representation of groups. • understand the molecular Orbital Theory aspects to group theory. • learn L-S coupling for dn states.	
Unit	**Contents**	**Hours**
Unit I	**Group Theory and Point Groups** Symmetry elements and symmetry operations, definition of group and its characteristics, subgroups, classes, similarity transformation. Products of symmetry operations, relations between symmetry elements and operations	**7**
Unit II	**Representation of Groups** representation of groups, reducible and irreducible representations, Great orthogonality theorem, direct product, character tables, Wave functions as basis for irreducible representations (p- and d-orbitals), vanishing integral and chirality .	**7**
Unit III	**Symmetry Aspects of Molecular Orbital Theory:** General Principles (SALC and indirect projection operator), MO study of cyclopropylium cation, butadiene, cyclobutadiene, benzene), Secular equations, (resonance energies and aromaticity), MO of C2v, C3v, Td and Oh molecules including hybridized orbitals as LCAO.	**8**
Unit IV	**Molecular Vibrations and Electronic Transitions** Normal Mode analyses. Selection rules, spectral transition probability, Electronic configurations and states, free-ion term, L-S coupling for dn states, splitting of one electron levels in an octahedral and tetrahedral environment, vibronic coupling, Correlation Diagrams, Orgel and Tanabe-Sugano diagrams.	**8**
Study Resources	• Cotton, F. A., (1990). Chemical Applications of Group Theory, 3rd Ed., Wiley InterScience,. • Carter, R. L., (2005) Molecular Symmetry and Group Theory, John Wiley and Sons. • Vincent, A. (2001). Molecular Symmetry and Group Theory, 2nd Ed., John Wiley and Sons Ltd. • Veera Reddy, K., (2010). Symmetry and Spectroscopy of Molecules, New Age International (P) Ltd, India. • Bishop, D. M., (1993).Group Theory and Chemistry, Dover Publications, New York,.	

F. Y. M. Sc.
Semester-II
CHA-DSE-524 (B): Applications of Nanotechnology

Total Hours: 30 **Credits: 2**

Course objectives	• To aware the concept of nano. • To learn the techniques used in fabrication of nanomaterial. • To learn the methods of synthesis and applications of nanomaterials. • To learn the concept of Nanomaterials for Environmental Remediation.	
Course outcomes	After successful completion of the course the students: • student will understand future perspective of nanotechnology. • student will aware of the techniques to study nanomaterials. • new window for research work will open for the students.	
Unit	**Contents**	**Hours**
Unit I	**Nano-The expanding Horizon** Introduction, Fundamentals of nano, Nanoscale phenomena, Sigificance of nanomaterials and its impact, Classification of nonmaterial's, need for it, issues and other perspectives, Prospective applications.	**8**
Unit II	**Fabrication of Nanomaterials** Top-down and Bottom-up approaches, Gas phase synthesis, Liquid phase synthesis, Solid phase synthesis, Lithography.	**7**
Unit III	**Nanomaterial Evaluation:** Need for material studies, Structural property studies, Morphological analysis, Optical property studies, Electrical property studies, Magnetic property studies, Mechanical property studies.	**8**
Unit IV	**Nanomaterials for Environmental Remediation** Environmental remediation by chemical degradation/ Removal of contaminants, Nanomaterials as sorbents, Nanofiltration- for clean water, Dendrimers- the nanoreactors for remediation, carbon nanomaterials- Versatile new Adsorbents, Nanoscale biopolymers, Future prospects.	**7**
Study Resources	• Pradeep T. (2003). A Textbook of Nanoscioence and Nanotechnology. Tata McGrawHill Education pvt ltd. • Mohan Kumar G. (2016). Nanotechnology. Nanomaterials and nanodevices.Narosapublishing House. • Heller, Mehmud, Tumbull.(2014). The University Textbook of Nanotechnology. • Dominant publishers. • Sharma P. K. (2008). Prospects of Nanotechnology. Vista International • Er Rathi Rakesh.(2009). Nanotechnology. S. Chand	

	• Das A., Das M. An Introduction to Nanomaterials and Nanoscience (1905) CBS Publishers and Distributors Pvt Ltd.	

F. Y. M. Sc.
Semester-II
CHA-DSC-525: Advanced Analytical chemistry Practicals

Total Hours: 60 **Credits: 2**

Course objectives	• To know various instrumental analysis techniques. • To learn to operate various instruments. • To learn solutions, preparations. • To learn principle and working of analysis and instrumentation.	
Course outcomes	After successful completion of this course, students are expected to • do qualitative and quantitative analysis using instruments. • handle instruments like conductometer, potentiometer, flame photometer, spectrophotometer, etc. • understand determination of strength of acids. • estimate halide ion in given sample.	
Unit	**Contents**	**Hours**
	Perform **any fifteen experiments** of the followings: **Instrumental techniques: Electroanalytical techniques** 1. Analysis of commercial vinegar by conductometric titration. 2. Estimation of phenol by conductometric titration with NaOH. 3. Determination of strength of HCl and CH_3COOH in a mixture conductometrically. 4. Determination of strength of HCl and oxalic acid in a mixture conductometrically. 5. Determination of strength of oxalic acid and CH_3COOH in a mixture conductometrically. 6. Determination of degree of dissociation and dissociation constant of acetic acid conductometrically. **Potentiometry** 1. Determination of strength of HCl and CH_3COOH individually and in a mixture potentiometrically. 2. Determination of Fe(II) by potentiometric titration with $K_2Cr_2O_7$. 3. Estimation of halide in a mixture by potentiometry. 4. Determination of stepwise stability constant of silver thiosulphate complex by potentiometrically. **Optical methods** 1. Determination of pK of indicator by colorimetry. 2. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent. 3. To study the complex formation between Fe(III) and salicylic acid and find the formula and stability constant of the complex colorimetrically (Job's method). 4. To determine the dissociation constant of phenolphthalein colorimetrically. 5. Estimation of iron in wastewater sample using 1,10-phenanthroline.	**60**

	6. Estimation of Na+ / K+ / Ca2+ by Flame photometry. **Non-instrumental** 1. To determine the Hardness of a given water sample. 2. To determine the acidity of a given water sample. 3. To determine the alkalinity of a given water sample. 4. To determine the acid value of a given oil sample. 5. Extraction and separation of curcumine/beetroot/ginger by soxhlet apparatus.	
Study Resources	• Vogel A. I. (2012). A Text Book of Qualitative Inorganic Analysis (3rd Edition). Pearson education India. • Welcher F. J. (2006). Standard Methods of Chemical Analysis (A Series of Volumes).Krieger publishing company. • KolthoffI. M. & EwingP. J. (1963). Treatise on Analytical Chemistry (A Series ofVolumes). Wiley Blackwell. • Association of Official Analytical Chemistry (AOAC).13th Edition 1980. • Willard H. H, & Merritt L. L. (1984). Instrumental Methods of Analysis (6th Edition).CBS publisher.	

F. Y. M. Sc.
Semester-II
CHA-DSE-526 (A): Applied Organic Chemistry Practicals

Total Hours: 60 **Credits: 2**

Course objectives	• To study systematic qualitative analysis of organic binary mixture. • To learn single stage organic synthesis. • To learn binary stage organic synthesis. • To learn an estimation of different organic compounds.	
Course outcomes	After successful completion of this course, students are expected to • identify types, presence of elements/functional groups and various other qualitative properties of organic compounds. • perform, explain and calculate theoretical and practical yield of the product. • learn to perform single stage and two stage organic synthesis.	
	Contents	**Hours**
	Organic Qualitative Analysis (Eight Binary Mixtures) **Systematic Analysis of Binary Mixture (**Solid-solid, solid-liquid, liquid-liquid mixtures) will include determination of: • Nature • Type • Separation and Purification • Individual Analysis of each Compound (i)Preliminary Tests (ii) Physical constant (iii) Detection of elements (iv) Detection of functional group tests (v) Characteristic / Confirmatory tests of functional group (s)	**60**
	Single Stage Preparation Monitored by TLC (Any Five) • Acetophenone to benzalacetophenone • Resorcinol to 7-hydroxy,4-methyl coumarin • Camphor to Borneol • Benzophenone to benzhydrol • Acetoacetic ester to pyrazolone • p-Amino benzoic acid to p-chloro benzoic acid • 2-Methoxy naphthalene to 1-formyl-2-methoxy naphthalene • Glycine to benzoyl glycine • Cyclohexanol to adipic acid • Cyclohexanone to oxime • p-Nitro toluene to p-nitro benzoic acid	

	Two stage Preparations: (Any Two) • Phthalic acid - phthalic anhydride - phthalimide. • Chlorobenzene- 2,4- dinitrochloro benzene - 2,4-dinitrophenol. • Acetophenone-Oxime-Acetanilide. • Nitrobenzene - m- Dinitrobenzene - m-Niroaniline.	
Study Resources	• Vogel, A. I. (1974). Practical organic chemistry. Long Man Group Lted, London. • Furniss, B. S. (Ed.). (2011). Vogel's textbook of practical organic chemistry. Pearson Education India. • Sharma, R. K., Sidhwani, I. T., and Chaudhuri, M. K. (2012). Green Chemistry Experiments: A Monograph. IK International Pvt Ltd. • Ahluwalia, V. K., and Dhingra, S. (2004). Comprehensive Practical Organic Chemistry: Qualitative Analysis. Universities Press. • Agarwal, O. P. (2006). Advances Practical Oraganic Chemistry. Krishna Prakashan Media. • Singh, R. K. P., Singh, J., Yadav, L. D. S., Siddiqui, I. R., and Srivastava, J. (2010). Advanced Practical Chemistry. Pragati Prakashan.	

F. Y. M. Sc.
Semester-II
CHA-DSE-526 (B): Practicals in Applied Inorganic Chemistry

Total Hours: 60 **Credits: 2**

Course objectives	• To study analysis of Drug samples. • To determine the lattice energy of binary salts. • To determine the ions by chromatography. • To determine the elements by using different instruments. • To study various estimation methods.	
Course outcomes	After successful completion of this course, students are expected to • understand the experimental techniques for Drug analysis. • determine lattice energy of binary salts. • learn separation and identification using paper chromatographic technique. • apply the knowledge of instrumentation for the inorganic qualitative analysis. • the knowledge of difference type of inorganic estimations.	
	Contents (any 15)	**Hours**
	Drug Analysis.	
1	Determination of iron from given drug sample.	**4**
2	Determination of calcium from given drug sample.	**4**
3	Estimation of ascorbic acid in Vitamin-C tablets	**4**
	To determine the lattice energy of binary salts	
4	Sodium Chloride (NaCl)	**4**
5	Potassium Chloride KCl	**4**
6	Calcium Chloride CaCl	**4**
7	Manganese dichloride ($MnCl_2$)	**4**
8	Copper dichloride ($CuCl_2$)	**4**
	Chromatography	
9	Determination of the Rf value of Pb, Cu, Cd ions by using paper chromatographic technique.	**4**
10	Determination of the Rf value of Fe, Al, and Cr ions by using paper chromatographic technique.	**4**
11	Determination of the Rf value of Ba, Sr, and Ca ions by using paper chromatographic technique.	**4**

	Instrumentation:	
12	Estimation of phosphate from wastewater by calibration curve method using spectrophotometrically.	**4**
13	Spectrophotometric determination of phosphate: estimation of phosphate in cola drinks.	**4**
14	Estimation of Manganese from steel by spectrophotometrically.	**4**
15	To determine the amount of copper present by iodometric method (potentiometrically).	**4**
16	To determine the number of chloride ions in the $[Co(NH_3)_5]Cl_3$ and $[Co(NH_3)_5Cl]Cl_2$ (potentiometrically)	**4**
17	Estimation of Boric acid using NH_4OH by conductometric method.	**4**
18	To determine the strength of given mixture of carbonate and bicarbonate in the given mixture by pH metric method	**4**
	Estimations:	
19	Estimation of Sodium bicarbonate content from soda water.	**4**
20	Estimation of total hardness of water sample.	**4**
21	Estimation of Zn-Mg in the given mixture solutionby titration with EDTA.	**4**
Study Resources	• Mendham, J., (2009). Vogel's Quantitative Chemical Analysis ,6th Edition, Pearson, Germany. • Svehla, G., Shivshankar B., (2012). Vogel's Qualitative Inorganic Analysis, Pearson Education India. • Christian, G. D., (2006). Analytical chemistry, 6th Edition, Wiley-India. • Mendham, J., Denny R. C.,Barnes J. D., Thomas M.,Sivasankar B., (2009),Quantitative Chemical Analysis., 6th Edition, Pearson, Germany. • Jeffrey, H., Bassett J., Mendham, J., Denney R. C., (1989). Vogel's Textbook of Quantitative Inorganic Analysis, 5th Edition, Longman Scientific and Technical, England co published with John willey and Sons, New York. • Patel, H. N., Turakhia, S. P., Kelker, S. S., Puniyani, S.R., (2010). College Practical Chemistry, Himalaya Publishing House, Mumbai.	

F. Y. M. Sc.
Semester II
CHA-OJT-527: Internship/ On Job Training

Hours: 120 **Credits: 4**

Course objectives	• To provide the students with actual work experience • To make aware prescribe standards and guidelines at work • To develop the employability of participating student • To avail an opportunities to eventually acquire job experiences	
Course outcomes	After successful completion of this course, students are expected to: • get actual work experience with office and virtual exposure to various management styles, technical, industrial, and proceduralsystems • acquaintheknowledge related to working hours, work protocols and guidelines • understand the roles and responsibilities of employee as well as team work • justify job experiences that match theirpotentials, skills, and competencies	
	Internship An internship is a professional learning experience that offers meaningful, practical work related to a student's field of study or career interest. An internship gives a student the opportunity for career exploration and development, and to learn new skills. **On the job training** On the job training is a form of training provided at the workplace. During the training, employees are familiarized with the working environment they will become part of. Employees also get a hands-on experience using machinery, equipment, tools, materials, etc.	