Post Graduate Diploma in Chemical Lab Technician (PGDCLT)

SYLLABUS

Department of Chemistry
(DST-FIST Sponsored)
School of Basic and Applied Sciences
Central University of Tamil Nadu
Thiruvarur- 610 005
2023

CENTRAL UNIVERSITY OF TAMIL NADU

VISION

To develop enlightened citizenship of knowledge society for peace and prosperity of individuals, nation and the world, through promotion of innovation, creative endeavors, and scholarly inquiry and to be a global destination of higher education and research.

MISSION

- To serve a beacon of change, through multi-disciplinary learning, for creation of knowledge community, by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India.
- The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research and innovation in pure and applied areas of learning.

OBJECTIVES AND GOALS

- To disseminate and advance knowledge by providing instructional and research facilities in such branches of learning as it may deem fit
- To make special provisions for integrated courses in humanities, social sciences, science and technology in its educational programmes
- To take appropriate measures for promoting innovations in teaching-learning process and inter-disciplinary studies and research
- To educate and train manpower for the development of the country
- To establish linkages with industries for the promotion of science and technology
- To pay special attention to the improvement of the social and economic conditions and welfare of the people, their intellectual, academic and cultural development

DEPARTMENT OF CHEMISTRY

The Department of Chemistry started functioning from the year 2010 with five-year integrated M.Sc. Chemistry programme. The Department has the distinction of starting the first two-year PG programme in Science at CUTN. Besides the state-of-the-art PG and research laboratories, the Department is committed to excellence in Chemistry by establishing research programmes for meeting Scientific and Technological challenges faced by the ever changing, science centered world of the 21st century.

The department is presently offering M.Sc., Integrated M.Sc. Post Graduate Diploma in Chemical Lab Technician (PGDCLT) and Ph.D. programmes. The Department provides ample opportunity for the students to accumulate a thorough fundamental knowledge of all fields of Chemistry. Meticulous lecture courses in the general areas of inorganic, organic and physical chemistry are conducted regularly in addition to the state-of-the-art laboratory courses which provide hands-on experience to the students at all levels.

The focus of the department is to instill the necessary spark and provide the scientific impetus so that the students can virtually experience the jiggling and wiggling of atoms and molecules. To enable students to have a glimpse of contemporary research, both in terms of academia and industry, the final year students in Chemistry will be completely engaged in project works. As a part of the curriculum the students have to undergo Internships at industry, institutes, and Universities. The department aim is to produce highly sought after and knowledgeable graduates for pursuing careers with academia, industry and government.

VISION AND MISSION OF THE DEPARTMENT

VISION

The Department envisions establishing itself as a place of excellence for chemistry education and research programmes globally.

MISSION

- To bridge the gap between academia and industry by regularly updating the curriculum on par with recent developments in science and encourage doing in house projects
- To educate and invoke the students to deliver their maximum outputs in competitive examinations and meet industrial competences.
- To develop chemists with excellent analytical and synthetic skills through the curriculum with more laboratory components and industrial visits/internships.

1. THE PROGRAMME

The one year PGDCLT programme offered by the Department of Chemistry, CUTN has 2semesters, which include 12 courses in total with an overall credit of 46.

2. COURSE FEATURES

The 12 courses embrace core, department specific elective, skill enhancement, value added courses and also project on innovative lab practices & protocols are included in the curriculum.

3. ELIGIBILITY AND ADMISSION

Bachelor's degree in Chemistry(Main) or with Chemistry as one of the major subjects. Candidates should have secured a minimum of 60% marks or 6.5 CGPA (on a 10-point scale) in the qualifying degree examination for General category, 55% marks or 6.0CGPA (on a10 point scale) for OBC and 50% aggregate marks or 5.5CGPA (on a 10-point scale) for SC/ST/PWD candidates.

4. EXAMINATION

The assessment of a student pursuing PGDCLT programme shall be based on his/her performances in the Continuous Internal Assessment (CIA) and the End Semester Examinations (ESE). The distribution of marks for CIA and ESE are 40% and 60%, respectively. Irrespective of the score obtained by a student in the CIA, he/she must score a minimum of 50% in the ESE for passing a course.

4.1. CONTINUOUS INTERNAL ASSESSMENT (CIA)

The 40% marks for CIA shall be based on the students' performance in the following

(i) Periodical assessment tests (30 %)

(ii) Assignment and seminar presentations (10 %)

4.2. END SEMESTER EXAMINATION (ESE)

The ESE for theory courses (maximum marks 60 %) will be conducted by the University at the end of each semester (odd and even). The student must register for the semester examination in order to be eligible for registration in the following semester examinations. To attend the examination 75 % attendance is mandatory.

4.3. QUESTION PAPER PATTERN

The end semester examination question paper comprises three sections, with maximum marks of 60 and allowed time of 3 hours.

SECTION A (10 X 1 = 10) Answer ALL the questions

Ten Multiple Choice Questions, two questions from each unit. Four choices of answers in each question.

SECTION B (5 x 3 = 15) Answer ALL questions

Five questions to be answered from the given choice of seven questions.

SECTION C (5 x 7 = 35) Answer ALL the questions

Answer all questions choosing either (a) or (b) from each question. One question from each unit.

5. PRACTICAL COURSE ASSESSMENT

The assessment of practical courses will be done based on the students' performance in the laboratory, regular attendance, the number of experiments performed, on-time submission of observation and record notes, and written/viva-voce examinations.

6. ATTENDANCE

In each semester, the minimum attendance for a student to get eligible for appearing in the end semester examination is 75%. Upon failing the minimum requirement, the student shall abide by the University norms for eligibility.

7. RESEARCH PROJECT

Students shall undertake a project on innovative lab practices and protocols (8 credit) during the 2ndsemester. The students' research guide will be allotted based on research interest and academic ranking. The project report shall be submitted in the form of a dissertation at the end of the 2ndsemester on or before the date notified by the Department. The student shall present the research project work and shall be evaluated.

8. REVISION OF CURRICULUM

The Department of Chemistry shall revise and amend the regulations in the curriculum based on the feedback received from the stakeholders.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Post Graduate Diploma in Chemical and Lab Technician (PGDCLT) programme will enable the student to

PEO1: Apply knowledge of chemistry and scientific laboratory procedures and techniques to perform operations of chemistry in laboratories and industries.
PEO2: Acquire knowledge about preparation of samples, storage of chemicals, maintenance of equipments and facilities, safe use of equipments and chemicals and storekeeping functions
PEO3: Have societal, health, safety, and cultural issues relevant to the science practices and provide a strong foundation for acquiring chemical lab safety and management

PEO4: Perform clerical work related to laboratory activities such as word processing, record keeping, filing, maintaining material safety data sheets for all chemicals and products

PEO5: enhance skills for employability through activities such as hands-on-training on analytical instrument, workshop and submission of research project dissertation about innovative lab practices and protocols

GRADUATE ATTRIBUTES

- **Disciplinary Knowledge**: Content and pedagogical knowledge synchronised with the curriculum frameworks and policies
- **Communication Skills**: Possess clarity in conveying the ideas
- **Critical Thinking**: Capacity to apply analytical thought in the teaching and learning process
- **Problem Solving**: Participate in the educational problem solving and applying the knowledge in the day-to-day professional endeavours.
- **Cooperation**: Appreciate collaboration and cooperation among stakeholders of education.
- **ICT Skills**: Selecting and integrating appropriate ICT skills for professional development.
- **Ethics**: Doing what is right to society
- **Self-Directed Learning**: Developing autonomy and self-regulation in teaching learning and professional development.
- **Reasoning**: Ability to interpret and draw the conclusion from qualitative/quantitative data with open-mindedness
- **Creativity**: Ability to produce new ideas
- **Societal and Environmental Concern**: Performing an act or solving a problem with respect to societal and environmental concern
- **Lifelong Learning**: Understands the need for learning and practices it throughout life

PROGRAMME OUTCOMES (POs)

On successful completion of PGDCLT programme, the student will be able to

PO1: Assembles supplies, constructing apparatus, preparation of lab solutions related to experiment and demonstration

PO2: Operate, maintain and fix repairs on laboratory or analytical equipments such as electroanalytical instruments, analytical balance, spectrophotometers etc.

PO3: Design methodologies, analyze, and evaluate innovative ideas towards chemical and lab safety problems.

PO4: Become an lab technician/ employee / entrepreneur

PO5: Work independently as well as in a team.

POs	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	3	3
PO2	3	3	2	3	2
PO3	3	3	3	2	2
PO4	3	3	2	3	3
PO5	3	3	2	3	2

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On successful completion of PGDCLT programme, the student will be able to

PSO1: Acquire the knowledge of fundamental concepts of analytical chemistry and spectrophotometer instruments in scientific field

PSO2: Understand the importance of chemical lab safety and management

PSO3: Develop technical skill about maintenance of analytical instruments and laboratory equipments

PSO4: Apply technical skill in a sophisticated laboratory environment and secure challenging position in industry and academics.

PSO5: Enhance employability through chemical lab technician and lab clerical work activities.

COURSE STRUCTURE

CC: Core Course; CCP: Core Course Practical; DSE: Department Specific Elective; SEC: Skill Enhancement Course; VAC: Value Added Course; Research Project/Dissertation

FIRST YEAR

No	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
SEMESTER – I							
1	CHE5011	Analytical Chemistry	CC	4	4	40	60
2	CHE5012	Physical Methods in Chemistry	CC	4	4	40	60
3	CHE5013	Basic Laboratory Techniques - I	CCP	4	8	40	60
4	CHE5014	Basic Laboratory Techniques - II	CCP	2	4	40	60
5	CHEEXX	Elective	DSE	4	4	40	60
6	CHEVAXX	Value Added Course	VAC	2	-	40	60
			Total	**20**	**24**		

No	Course Code	Course Title	Type	Credit	Hours / Week	Marks	
						Int	Ext
SEMESTER – II							
1	CHE5021	Advanced Instrumental Methods	CCP	4	8	40	60
2	CHE5022	Project on Innovative Lab Practices and Protocols	CCP	8	16	40	60
3	CHEEXX	Self-Study/Elective/MOOC Course	DSE	4	4	40	60
4	CHESEXX	Skill Enhancement Course	SEC	2	2	40	60
5	CHEEXX	Elective	DSE	4	4	40	60
6	CHEEXX	Elective	DSE	4	4	40	60
			Total	**26**	**38**		
			Cumulative Total	**46**			

CREDIT FRAMEWORK

No.	Course Components / Name of the Course	Nos	Credits	Percentage
1	Core Courses (CC)	2	8	17
2	Core Courses Practical (CCP)	3	10	22
3	Department Specific Elective (DSE)	4	16	35
4	Skill Enhancement Course (SEC)	1	2	4
5	Value Added Course (VAC)	1	2	4
6	Research Project	1	8	17
	Total	**12**	**46**	**100**

Semester I **Course Type: Theory** **Course Code: CHE5011**
Credit: 4 **Course Title: Analytical Chemistry**

Course Outcomes		Level
CO-1	**Analyze the accuracy and precision of statistical data**	**Apply**
CO-2	**Understand the importance of gravimetric analysis**	**Understand**
CO-3	**Introduce various thermal and electroanalytical methods**	**Knowledge**
CO-4	**Understand the methodologies of analytical spectroscopy & separation techniques**	**Understand**
CO-5	**Elucidate the analytical applicability of chromatography & spectroscopy in real samples (water quality, waste water treatment, etc.)**	**Skill**

Unit-I Error Analysis

Errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals, Correlation & regression, correlation coefficient and linear regression.

Unit –II Gravimetric & Electroanalytical Methods

Gravimetric Analysis: Principles, methods, requirements. Precipitation and theories of precipitation. Types of precipitation – co precipitation, post precipitation and precipitation from homogeneous solution – digestion, filtration and washing, drying and ignition. Inorganic and organic precipitating agents.

Electroanalytical Methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit –III Spectrophotometry

Optical methods of analysis: Origin of EMR spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments. Applications: Estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Woodward–Fieser Rules (enones only), Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles & sampling techniques. Factors influencing vibrational frequencies. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Unit –IV Flame & Thermal Analysis

Flame Atomic Absorption and Emission Spectrometry: Basic principles, choice of flame and burner designs, techniques of atomization and sample introduction, method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Thermal methods of analysis: Theory of thermogravimetry (TG), Differential Thermal Analysis (DTA), Differential Scanning Calorimeter (DSC) – Basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Unit –V Separation Techniques

Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition &ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Reference Books

1. G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5thEd., John Wiley & Sons, **1989.**
2. H.H. Willard, L.L.Merritt, J.Dean, and F.A.Settoe, Instrumental Methods of Analysis, 7thEdn. Wadsworth Publishing Company Ltd., Belmont, California, USA, **1988.**
3. G. D.Christian, P. K. Dasgupta, K. A. Schug, Analytical Chemistry, 7th Ed., John Wiley& Sons, New York, **2004.**
4. D. C.Harris, Exploring Chemical Analysis, Ed. New York, W.H. Freeman, **2004.**
5. S.M.Khopkar, Basic Concepts of Analytical Chemistry,3rdEdn., New Age, International Publisher, **2017.**
6. D.A.Skoog, F.J.Holler and T.A. Nieman, Principles of Instrumental Analysis, 6thEdn, Cengage Learning India Ed.**1998**.
7. O.Mikes, Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, **1979.**
8. R.V. Ditts, Analytical Chemistry; Methods of Separation, New York van Nostrand, **1974.**

CO	**Program Outcomes**				
	1	**2**	**3**	**4**	**5**
1	2	3	1	2	1
2	1	3	2	2	2
3	2	3	1	2	1
4	1	3	2	2	2
5	2	3	2	2	2

Semester I Course Type: Theory Course Code: CHE5012
Credit: 4 Course Title: Physical Methods in Chemistry

Course Outcomes		Level
CO-1	**Demonstrate the utility of UV-visible and IR spectroscopy in structural characterization**	**Knowledge**
CO-2	**Provide basic knowledge about the use of NMR spectroscopy towards structure determination**	**Knowledge**
CO-3	**Elucidate the structure of organic compounds based on ^{1}H and ^{13}C NMR spectroscopy**	**Apply**
CO-4	**Identify the fragmentation patterns of compounds and solve the structure of compounds using mass spectrometry**	**Understand**
CO-5	**Characterize unknown compounds using Thermal and EPR techniques**	**Apply**

Unit I UV-Visible and Infra-Red Spectroscopy

Basics of UV Spectroscopy, factors governing absorption maximum and intensity. Woodward Fieser and Fieser-Kuhn's rules - calculation of λmax for simple organic molecules. Instrumentation of UV-Visible and applications of UV spectroscopy. Principle, instrumentation and sampling technique- Hook's law, vibrational frequency, modes of vibrations, and selection rules. Factors influencing vibrational frequency. Fingerprint and functional group region. Interpretation of the IR spectra of alkane, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenol, carbonyl compounds, amines and heterocyclics– related problems.

Unit-II NMR Spectroscopy

^{1}H NMR, Spectral parameters – intensity, chemical shift, multiplicity, coupling constant, factors affecting chemical shift. Analysis of first order and second – order spectra – shift reagents - structure determination of organic compounds by ^{1}H NMR spectra. Chemical shifts and coupling constants (spin-spin coupling) involving different nuclei (^{1}H, ^{13}C) interpretation and applications to inorganic compounds. Examples for different spin systems.^{13}C NMR: Proton coupled; off–resonance decoupled; proton noise decoupled ^{13}C NMR spectra. Assignment of chemical shifts, additively effect, characteristic chemical shifts of common organic compounds and functional groups.

Unit-III Mass spectrometry and Mossbauer spectroscopy

Instrumentation – methods of ionisation - EI, CI, APCI, ESI. Mass analyser – magnetic and electrostatic sector, Molecular ion, base peak, multicharged ion, metastable ions and isotope ratio. Fragmentation patterns of saturated, unsaturated and aromatic hydrocarbons, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, amines, nitro, nitrile and halides. McLafferty rearrangement. Mossbauer spectroscopy- basic principle-isomer shift, quadrupole splitting, magnetic field effect. Applications.

Unit-IV ESR spectroscopy and magnetic measurements

Its principle, hyperfine structure, ESR of simple radicals. Electron spin resonance spectroscopy-basic principles, hyperfine splitting, zero field splitting and Kramer's degeneracy, factors affecting 'g' value. Introduction, Experimental determination of magnetic measurements Gouy balance and NMR method, Curie and Curie-Weiss law, magnetic moment calculations, Neel and Curie temperature, Applications.

Unit V Thermal methods and Circular dichroism

Principle, instrumentation and applications of TG, TGA and DTA. Thermogram of calcium oxalate monohydrate, copper sulphate pentahydrate and polymer. Thermometric titrations, Principle and applications of DSC. Introduction, Cotton effect, ORD and CD, Axial halo ketone and Octant rule. Applications of ORD and CD in biomolecules (DNA and Protein only).

Reference Books

1. R. M. Silverstein and F. X. Webster, Spectrometric identification of organic compounds, John Wiley and Sons. Inc., 6th edition, 1997.
2. W. Kemp, Organic Spectroscopy, 3rd edition, MacMillan, 1994.
3. Jag Mohan, Organic Spectroscopy: Principles & Applications, Narosa Publishers, 2012.
4. R. S. Drago, Physical Methods for Chemistry, 2nd Edition, Saunders College Publishing, 1992.
5. Pavia, Lampman and Kriz, Introduction to Spectroscopy, Brooks/Cole Pubs Co, 5th edition, 2015.
6. D. H. Williams and Ian Fleming, Spectroscopic methods in organic chemistry, Tata McGraw Hill, 1998.
7. William Kemp, NMR in chemistry: A multinuclear introduction, MacMillan, 1988.

CO	Program Outcomes				
	1	**2**	**3**	**4**	**5**
1	2	1	3	3	1
2	2	1	3	3	2
3	2	1	3	3	1
4	2	1	3	3	1
5	2	1	3	3	1

Semester I **Course Type: Practical** **Course Code: CHE5013**
Credit: 4 **Course Title: Basic Laboratory Techniques – I**

Course Outcomes		Level
CO-1	Acquire the knowledge of multistep organic synthesis in microwave assisted synthesis and photochemical reactions	**Understand**
CO-2	Organize experiments based on the organic preparations and qualitative analysis	**Analyze**
CO-3	Use knowledge of the purification techniques	**Apply**
CO-4	Report separation of two mixture present in the organic compounds	**Understand**
CO-5	Support on estimation of organic compounds *viz* volumetric methods	**Evaluate**

Multistep organic synthesis (any four) - conventional synthesis - microwave assisted synthesis - photochemical reactions. Purification of the compounds using column chromatography and characterization of the compounds using spectroscopic techniques.
Qualitative Analysis: Separation and analysis of organic mixture containing two components.

Estimation of Organic Compounds

(a) Estimation of phenol and aniline - volumetric method.
(b) Estimation of glucose by Betrands method.
(c) Estimation of methyl ketone – iodimetric method
(d) Determination of iodine and saponification value of an oil sample.

Reference Books

1. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford, P. W. G. Smith, Textbook of Practical Organic Chemistry, Prentice-Hall, 5th Ed, 1996.
2. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Ed, Pearson Education India, 2009.
3. B. Haynes, Qualitative Organic Analysis, Pearson Education, 2011.
4. P. B. Cranwell, L. M. Harwood, C. J. Moody, Experimental Organic Chemistry, 3rd Ed, Wiley-Blackwell, 2017.
5. V. K. Ahluwalia, R. Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

CO	Program Outcomes				
	1	**2**	**3**	**4**	**5**
1	2	3	3	3	3
2	2	3	3	3	3
3	2	3	3	3	3
4	2	3	3	3	3
5	2	3	3	3	3

Semester I **Course Type: Practical** **Course Code: CHE5014**
Credit: 2 **Course Title: Basic Laboratory Techniques – II**

Course Outcomes		Level
CO-1	Estimate inorganic compounds from a mixture	**Apply**
CO-2	Value volumetric and gravimetric procedures	**Evaluate**
CO-3	Apply UV-Vis spectroscopy to estimate concentration of an ion in given solution	**Apply**
CO-4	Handle spectrophotometric tools and analytical materials of specific interest	**Skill**
CO-5	Application of Job's method to analyze the complexes	**Analyze**

1. Estimation of inorganic compounds in a mixture by Volumetric and Gravimetric analysis.
   A mixture of solutions should be given for estimation (Any three mixtures)
   (i) Cu (V) and Ni (G)
   (ii) Fe (V) and Zn (G)
   (iii) Fe (V) and Ni (G)
   (iv) Zn (V) and Cu (G)

2. Validation of Beer-Lambert's law by estimating unknown concentration of $KMnO_4$/$CuSO_4$ by spectrophotometry.

3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.

Reference Books

1. G. Svehla, Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. In-house manual prepared by Department of Chemistry, CUTN, Thiruvarur.
4. M. Ghoshal and Nad, An Advanced Course in Practical Chemistry, New Central Book Agency, 2011.
5. V. Venkateswaran, R. Veerasamy and A. R. Kulandaivelu, Basic principles of Practical Chemistry, 2nd edition, New Delhi, Sultan Chand & sons, 1997.
6. M. Hein, J. N. Peisen and R. L.Miner, Foundations of College Chemistry in the Laboratory, John Wiley and Sons, 2011.
7. Amita Dua, Navneet Manav, Practical Inorganic Chemistry, Manakin Press, New Delhi, 2017.

CO	Program Outcomes				
	1	**2**	**3**	**4**	**5**
1	2	2	2	1	3
2	1	2	1	1	3
3	2	3	3	1	3
4	2	3	2	1	3
5	2	2	3	3	2

Semester II **Course Type: Practical** **Course Code: CHE5021**
Credit: 4 **Course Title: Advanced Instrumental Methods**

Course Outcomes		Level
CO-1	Understand the instrumentation methods involved in the experiments	**Understand**
CO-2	Perform or develop working models	**Create**
CO-3	Gain the required experimental skills for career development	**Create**
CO-4	Apply QM methods for modeling simple organic/inorganic compounds for structural optimization and reaction modeling	**Apply**

Part A: List of Wet Lab Chemistry (Any 10-12 Experiments)

1. *Surface Chemistry*
   (a) Verification of adsorption isotherms (Freundlich and Langmuir): charcoal-acetic acid or charcoal-oxalic acid system.
   (b) Kinetics & Determination of surface area by adsorption of acetic acid on Charcoal.
2. *Phase Diagram*
   (a) Determination of the concentration of the electrolyte using CST of phenol-water system.
   (b) Three Component Liquid Systems: Acetic Acid – Chloroform – Water
3. *Partition Coefficient*
   (a) Partition coefficient of benzoic acid between benzene and water.
   (b) Molecular formula of copper-ammonia complex by the partition coefficient method.
4. *Spectroscopy*
   (a) Formation kinetics of Chromium-EDTA complex (Spectrometry).
   (b) Simultaneous Estimation of Manganese and Chromium in a Solution of Dichromate and Permanganate Mixture.
   (c) Photocalorimetric determination of Bimolecular rate constant.
5. *Surface Tension*
   (a) Determine the surface excess of amyl alcohol.
6. *Potentiometry*
   (a) Titration of a strong and weak Acid Mixture with a Strong Base-Potentiometry.
   (b) Determination of stability constant of silver diammine complex by potentiometric titrations.
   (c) Dissociation of a weak acid by potentiometric titration.
7. *Conductometry*
   (a) Verification of Ostwald's dilution law and determination of dissociation constant of weak acid.
   (b) Conductometric titrations of a mixture of acids Vs strong base.
   (c) Van't Hoff's factor of benzoic acid between benzene and water.
   (d) Critical Micelle concentration of surfactant by conductivity measurements.
   (e) Verification of Onsager's Equation and Determination of Equivalent Conductance at Infinite Dilution of Strong Electrolytes.
   (f) Conductometric determination of Nickel using DMG.

8. *Kinetics*
   (a) Second order rate constant for the alkaline hydrolysis of ethyl acetate by conductivity measurements.
   (b) Arrhenius parameters for the Acid–Catalysed Hydrolysis of Methyl acetate.

9. *Viscometry*

(a) Determination of molecular weight of a polymer by viscosity measurements.

10. *Additional*

(a) Specific and molar refraction of a liquid by Refractometry.

(b) Reversibility of a redox process and determination of concentration of a given solution by cyclic voltammetry.

(c) Inversion of Sucrose-Polarimeter.

Part B: List of Computational Chemistry Experiments (Any 3-4 Experiments)

1. Calculation of electrostatic charges of atoms in organic molecules using population analysis.
2. Calculation of Resonance energy of aromatic compounds.
3. Calculation of dimerization energy of carboxylic acids.
4. Perform the conformational analysis of butane using potential energy scan.
5. Find the transition state of simple organic reactions and plot the reaction profile.
6. Determination of heat of hydration of organic molecules.
7. Find the Gibbs free energy of simple gaseous phase reactions and calculate equilibrium constant.
8. Calculation of pKa of simple organic molecules and compare it with experimental values.
9. Docking studies involving protein ligand interactions.
10. Calculation of electrophilicity index in hard-soft acids and bases.

Reference Books:

1. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
2. G.W. Garland, J. W. Nibler, D.P. Shoemaker, Experiments in Physical Chemistry, 8thEdn. McGraw Hill, 2009.
3. B. Viswanathan, Practical Physical chemistry, Viva Pub., 2005.
4. S. Kumar and N. Kumar, Physical Chemistry Practical, New Central Book Agency,2012.
5. A.M. James, F.E. Prichard, Practical Physical Chemistry Paperback, 1974.
6. J. Foresman and A. Frisch, Exploring Chemistry with Electronic Structure Methods, Gaussian Inc., 2000.
7. D.C. Young, Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems, John Wiley & Sons, 2001.
8. D. Rogers Computational Chemistry Using the PC, 3rdEdn, John Wiley & Sons,2003.
9. A.R. Leach, Molecular Modelling: Principles and Applications, 2ndEdn, Longman, 2001.
10. J. M. Haile, Molecular Dynamics Simulation: Elementary Methods, 2001.

CO	**Program Outcomes**				
	1	**2**	**3**	**4**	**5**
1	2	2	2	3	3
2	3	3	3	3	3
3	3	3	3	3	3
4	3	3	3	3	3

Semester II **Course Type: Practical** **Course Code: CHE5022**
Credit: 4 **Course Title: Project on Innovative Lab Practices and Protocols**

Course Outcomes		Level
CO-1	**Develop a project based on lab practices and safety methods**	**Create**
CO-2	**Design a research-oriented project independently in a particular context.**	**Create**
CO-3	**Acquire the skill to write a dissertation, communication skills in a presentation**	**Evaluate**
CO-4	**Demonstrate the utility of various software such as ChemDraw, Origin, MS-Office etc.**	**Apply**
CO-5	**Prepare a dissertation report with complete follow up of research methodology and to develop the skill of communication in presentation**	**Create**

Individual project report for developing innovative lab practices and safety methods, critical studies based on environmental, governmental acts and regulations.

CO	Program Outcomes				
	1	**2**	**3**	**4**	**5**
1	2	2	2	3	3
2	2	3	2	3	3
3	1	3	3	3	3
4	2	2	1	3	3
5	1	2	1	3	2

List of Elective Courses

Course Code	Title of the Course	Credits
CHEE01	Principles of Polymer Science	4
CHEE02	Principles of Fluorescence Spectroscopy	4
CHEE03	Asymmetric Catalysis	4
CHEE04	Essentials of carbohydrate chemistry	4
CHEE05	Organic Electronics	4
CHEE06	Photochemistry in Molecules and Materials	4
CHEE07	Medicinal Inorganic Chemistry	4
CHEE08	Organic Semiconductors	4
CHEE09	Advances in Polymer Science	4
CHEE10	Advances in carbohydrate Research	4
CHEE11	Advanced Organic Materials & Catalysis	4
CHEE12	Chemistry of C-H Activation	4
CHEE13	Advanced Bioinorganic Chemistry	4
CHEE14	Principles of Biochemistry	4
CHEE15	Mathematics for Chemists and Biologists	4
CHEE16	Electrochemical Energy System	4
CHEE17	Fundamentals of Analytical Chemistry	4
CHEE18	Computational Chemistry	4
CHEE19	Supramolecular Chemistry	4
CHEE20	Computational Materials Modelling	4
CHEE21	Organometallics, Catalysis and Inorganic Spectroscopy	4
CHEE22	Physical Methods in Chemistry	4
CHEE23	Applications of Computational methods in Chemistry	4
CHEE24	Chemical Lab Safety and Management	4
CHEE25	Advances in Organic Chemistry	4
CHEE26	Green Chemistry	4
CHEE27	Selected Topics in Synthetic Organic Methods	4
CHEE28	Advanced Topics in Organometallic Chemistry	4
CHEE29	Industrial Chemistry	4
CHEE30	Advanced Organic Nanomaterials	4
CHEE31	Computer Software for Chemists	4
CHEE32	Selected Experiments in Applied Chemistry	4
CHEE33	Luminescence Spectroscopy for Advanced Research	4
CHEE34	Research Methodology	4
CHEE35	Chemistry in Nanoscience and Technology	4
CHEE36	Advanced NMR Techniques	4
CHEE37	Advanced Organic Synthesis	4
CHEE38	Nanoscience and Nanotechnology	4
CHEE39	Medicinal Chemistry	4
CHEE40	Introduction to Biochemistry	3
CHEE41	2D NMR Spectroscopy	2
CHEE42	Separation Techniques	2
CHEE43	Separation Techniques & 2D NMR Spectroscopy	4

*New electives will be appended based on the availability of course instructor.
Electives will be offered based on the individual faculty's availability

List of Skill Enhancement Courses

Course Code	Title of the Course	Credits
CHESE01	Computer software for Chemists	3
CHESE02	Selected Experiments in Applied Chemistry	3
CHESE03	Instrumentation Methods in Chemistry	3
CHESE04	Water & Waste Water Treatment	3
CHESE05	Pharmaceutical Chemistry	3

List of Value-Added Courses

Course Code	Title of the Course	Credits
CHEVA01	Instrumental Techniques for Chemical Analysis -01	2
CHEVA02	Instrumental Techniques for Chemical Analysis -02	2
CHEVA03	Basic Analytical Experiments	2
CHEVA04	Research Methodology and Publication Ethics	2
CHEVA05	Climate Change & Atmospheric Chemistry	2