SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar, Gujarat
(Reaccredited with 'A' Grade by NAAC (CGPA 3.25)
Syllabus with effect from the Academic Year 2022-2023

PROGRAMME STRUCTURE
Master of Science in Chemistry
M.Sc. (Analytical Chemistry) Semester - 3

Programme Outcome (PO) - For MSc Chemistry Programme	Master of Science program provides extended theoretical and practical knowledge of different science subjects. Master of Science programme at Sardar Patel University is designed keeping the overall back ground preparation in mind for the student to either seek a job or to become an entrepreneur. The students, after completion of Bachelor of Science can select the master's programme in the subject they have had at the final year or in a related discipline (depending upon eligibility criteria prescribed by university). **Programme outcomes: At the end of the program, the students will be able to** 1. Have a deep understanding of both the theoretical and practical concepts in the respective subject. 2. Understand laboratory processes and use scientific equipments and work independently. 3. Develop research temperament as a consequence of their theory and practical learning. 4. Communicate scientific information in oral and written form. 5. Understand the issues related to nature and environmental contexts and think rationally for sustainable development. 6. The students are able to handle unexpected situations by critically analyzing the problem.
Programme Specific Outcome (PSO) - For MSc Chemistry Semester - III	Students will have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Chemistry and Industrial polymer Chemistry. After completing M.Sc. chemistry program, students will be able to: ■ Demonstrate and apply the fundamental knowledge of the basic principles in various fields of Chemistry. ■ Apply knowledge to build up small scale industry for developing endogenous product. ■ Collaborate effectively on team-oriented projects in the field of chemistry or other related fields. ■ Communicate scientific information in a clear and concise manner both orally and in writing. ■ Inculcate logical thinking to address a problem and become result oriented with a positive attitude.

	■ Enhance the scientific temperament among the students so as to develop a research culture and implementation of the policies to tackle the burning issues at global and local level. ■ Apply the knowledge to develop the sustainable and eco-friendly technology. ■ Take up global level research opportunities to pursue Ph.D programme targeted approach and specific competitive exams conducted by service commission ■ Accept enormous job opportunities at all level of chemical industries, pharmaceutical industries and placements in R & D.

To Pass	At least 40% Marks in the University Examination in each paper and 40% Marks in the aggregate of University and Internal examination in each course of Theory, Practical & 40% Marks in Viva-voce.

Course Type	**Course Code**	**Name of Course**	**Type of Course**	**T /P**	**Credit**	Hours per Week	**Exam Duration in hrs**	**Component of Marks**		
								Internal Total	**External Total**	**Total Total**
Core Course	PS03CANC51	Spectroscopy-I	EM & EN	T	4	4	3	30/10	70/28	100/40
	PS03CANC52	Electroanalytical Methods	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03CANC53	Classical and Thermal Methods of Analysis	EM& EN	T	4	4	3	30/10	70/28	100/40
Core Course (Any One)	PS03CANC54	Practicals **OR**	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CANC55	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course (Any One)	PS03CANC56	Practicals **OR**	EM&SD	P	4	8	6	30/10	70/28	100/40
	PS03CANC57	Project Work	EM&SD	P	4	8		30/10	70/28	100/40
Core Course	PS03CANC58	Comprehensive Viva		-	1	1			50/20	50/20
Elective Course (Any one)	PS03ECHE51	Separation methods	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE52	Analytical techniques in Materials characterization	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE53	Applications of Inorganic Chemistry in Industry	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE54	Selected Topics in Advanced Inorganic Chemistry-I	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE55	Mechanical and Electrical Properties of Polymers	EM& EN	T	4	4	3	30/10	70/28	100/40

	PS03ECHE56	Selected Topics in Polymers-I	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE57	Advanced Characterization Techniques	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE58	Selected Topics in Physical Chemistry- II	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE59	Selected Topics in Organic Chemistry	EM& EN	T	4	4	3	30/10	70/28	100/40
	PS03ECHE60	Occupational Practices	EM& EN	T	4	4	3	30/10	70/28	100/40
					25					650
Add-on Course		MOOCs course from Swayam Portal								

EMPLOYABILITY = EM, ENTREPRENEURSHIP = EN and SKILL DEVELOPMENT = SD

* Project work **(as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.**

Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	PS03CANC51	Title of the Course	Spectroscopy-I
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. To understand and familiarize with the basic principles, theory and instrumentation of UV-Visible, IR, ^{1}H NMR, ^{13}C NMR, 2D-NMR and Mass spectrometry. 2. To impart knowledge in the theory and principles of above spectroscopic techniques for characterization and differentiation of various molecules. 3. To make enable to choose particular spectroscopic technique for specific analytical purpose.

Course Content		
Unit	Description	Weightage* (%)
1.	**UV-Visible Spectroscopy:** Theory and principles of electronic transition and UV-Visible absorption, chromophores and auxochromes, Woodward-Fieser rules for dienes and enones, characteristic absorptions in alkenes and alkynes, alcohols, ethers, amines, carbonyl compounds. Effects of conjugation. Characteristic absorptions in aromatic compounds. To **Infrared Spectroscopy:** Theory and principles, molecular vibrations and calculations of vibrational frequencies, characteristic group absorptions in hydrocarbons, aromatic compounds, alcohol and phenols, ethers, carbonyl compounds, amines, nitriles, nitro compounds, carboxylic acids and halide.	25
2.	**PMR Spectroscopy:** Proton resonance condition, aspects of PMR spectra – number of signals, chemical shifts, shielding and deshelling, diamagnetic anisotropy, factors affecting chemical shifts, peak area and integration, splitting of the signals – spin-spin coupling, coupling constants – vicinal, geminal, long range and virtual couplings, Pople notation and spin assignments, chemical shift equivalence and magnetic equivalence, first order and second order spectra, complex PMR spectra, simplification of the PMR spectra – high resolution spectra, use of shift reagents, spin-spin decoupling-double resonance, proton exchange, deuterium exchange, Nuclear Overhauser Effect (NOE). Use of PMR spectra in differentiation of compounds / stereoisomers.	25

3.	**^{13}C-NMR Spectroscopy:** Difficulties and solution for recording ^{13}C-NMR spectra, recording of ^{13}C-NMR spectra – scale, solvents, solvent signals and their positions, multiplicity, ^{13}C-^{1}H coupling constant – proton coupled and decoupled ^{13}C spectra, broad band decoupling, off resonance technique. Chemical shifts in ^{13}C spectra – chemical shift calculation for alkanes, alkenes and alkynes, chemical shift calculation in internal and terminal substituted compounds, aromatic compounds. Use of ^{13}C spectra in differentiating stereoisomers, Nuclear Overhauser Effect. ^{13}C – DEPT spectra–differentiation in primary, secondary and tertiary carbons by DEPT–45, DEPT–90, DEPT – 135 spectra. **2D-NMR Spectroscopy:** Theory and principles of 2D-NMR spectroscopy (COSY), Interpretation of ^{1}H-^{1}H COSY, ^{1}H-^{13}C HETCOR, HMQC, HMBC, INADEQUATE spectra.	25
4.	**Mass Spectroscopy:** Theory and principles of mass spectroscopy, Instrumentation, low- and high-resolution mass spectra, Ionization techniques–Electron Impact (EI) ionization, Chemical Ionization (CI), Field Desorption (FD), Fast Ion Bombardment (FAB), Electronspray Ionization (ESI) and Matrix Assisted Laser Desorption/Ionization (MALDI). Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak. Fragmentations – rules governing the fragmentations, McLafferty rearrangement. Interpretation of mass spectra of different class of compounds – saturated and unsaturated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, carboxylic acids, amines, amides, compounds containing halogens. To identify structure from mass spectral data.	25

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology will be blend of lectures / PPT presentation / seminar / tutorials / assignments etc.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand how light interacts with the organic molecules.
2.	Understand fundamental and basic terms involved in NMR (1D, 2D), IR, UV-Visible and MS.
3.	Choose particular technique for specific analytical purpose.
4.	Know effects of various factors on the spectra.
5.	Interpret spectral data.
6.	Identify structure of organic compounds by using combined spectral data.
7.	Distinguish isomers and other closely related compounds by using these spectral techniques.

Suggested References:	
Sr. No.	References
1.	Spectroscopic Identification of Organic Compounds, R. M. Silverstein and F.X. Webster, 6th edition (John Wiley & Sons).
2.	Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman and G. S. Kriz, 3rd edition (Thomson Brooks/Cole).
3.	Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, 4th edition (McGraw–Hill Book Company).
4.	Organic Spectroscopy, William Kemp, 3rd edition (Palgrave).
5.	Organic Spectroscopy – Principles and Applications, Jag Mohan, 2nd edition (Narosa Publishing House).
6.	Spectroscopy of Organic Compounds, P. S. Kalsi, 5th edition (New Age International Publishers).
7.	Principles of Instrumental Analysis, by Skoog, Holler and Neiman, Sunders

	College Publishers (USA).
8.	Instrumental Methods of Chemical Analysis, 24th Edition 2005, by B. K. Sarma, Goel Publishing House,Meerut.
9.	Elementary Organic Spectroscopy: Principles and Chemical applications (Revised Edition), by Y. R. Sharma (S.Chand Publishing).
10.	Instrumental methods of analysis by B. Sivasanker, Oxford University Press, 2012.

On-line resources to be used if available as reference material
On-line Resources: https://swayam.gov.in/

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	PS03CANC52	Title of the Course	Electroanalytical Methods
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	From this course students may get to know the following: 1. Knowledgeable of current electroanalytical techniques 2. Understand the factors that must be controlled to obtain reliable and reproducible data from electroanalytical experiments 3. Capable of identifying the most appropriate electroanalytical technique for a specific analysis 4. Experienced in the analysis of data using current theoretical models 5. Proficient at evaluating the electrode reaction mechanism from data obtained using several electroanalytical techniques

Course Content		
Unit	Description	Weightage* (%)
1.	**pH and Ion-Selective electrodes:** Introduction, Construction and working of electrodes, Ion selective electrodes- Glass-membrane electrodes, Solid-state sensors, Liquid-membrane electrodes, Gas-sensing and Enzyme electrodes Interferences, Application of pH measurements, Ion-activity Evaluation Methods, Electrometric Measurement of pH and pI.	25
2.	**Potentiometry:** Introduction, types of electrodes and its classification, Location of the Equivalence point, EMF and thermodynamic of the cell reactions, Determination of activity co-efficient from EMF measurements, Potentiometric titrations Methods and Its applications. **Coulometry & Electrogravimetry:** Introduction, Faradays laws of electrolysis, Methods of Coulometry, Instrumentations-Constant current and constant voltage instruments, Potentiostatic coulometry-Instrumentation and applications, Applications of Coulometry, Coulometric titrations, Advantages and limitations of Coulometric titrations, EG, applications, problems.	25
3.	**Conductometry:** Introduction, Principle, Basic terms and their inter relationships, Measurement of conductance, factors affecting conductance, type & cell, Conductometric titrations, Applications such as Determination of degree of dissociation & dissociation constant of acids-bases,	25

	Determination of ionic product of water, Determination of Basicity of Organic compounds, Determination of solubility and solubility product of sparingly soluble salts, Determination of degree of hydrolysis and hydrolysis constant, advantages. **High Frequency Conductance Measurements:** Introduction, Types of Cells used, Instrumentation, Applications	
4.	**Polarography & Voltametric Methods:** Introduction, Principle, Apparatus and electrode systems, Polarogram and Polarographic currents, Component of limiting current, Polarographic maxima, Half-wave potential, Derivation of a relation between half-wave potential & diffusion co-efficient, The ILKOVIC equation, Factors governing diffusion current, Evaluation Methods, Applications of polarography; Modified voltametric techniques such as A. C. Polarography, Rapid Scan Polarography, Pulse polarography, Cyclic Voltammetry, Hydrodynamic Voltammetry etc.… **Ampereometric titrations:** Principle, Apparatus, Amperometric titrations. Biampereometric titrations - Titration with the Rotating platinum microelectrode, advantages and disadvantages, applications.	25

Teaching-Learning Methodology	Lectures (3 hours per week), Seminar (1 hour per week), Tutorial, Continuous evaluation by quizzes, Discussions, Questioning, Problem Solving, Demonstrations (Such as models, laboratory work, and Industrial visits)

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: After completing M.Sc. chemistry program, students will be able to:	
1.	Understand the different types of electrodes like construction and working of electrodes, Ion selective electrodes- Glass-membrane electrodes, Solid-state sensors, Liquid-membrane electrodes, Gas-sensing and Enzyme electrodes.

2.	Understand the theory and applications of potentiometric titrations.
3.	Understand the theory and applications of coulometric titrations.
4.	Explain the advantages and limitations of coulometric titrations.
5.	Know the factors affecting conductance, type & cell..
6.	Explain the principle, basic terms and their inter relationships and measurement of conductometric titrations and high frequency conductometric titrations.
7.	Know the theory, instrumentation and applications of polarography and various voltametry.

Suggested References:	
Sr. No.	References
1.	Principles of Instrumental Analysis, 6th Edition 2006, by Douglas A. Skoog, F. James Holer, Timothy A. Nieman. Sunders College Publishers (USA).
2.	Undergraduate Instrumental Analysis, by James W. Robinson, Marcel Dekker, Inc. (Ny.)
3.	Introduction to Instrumental Analysis, by Robert D. Braun, Pharme Med Press Hyderabad- India.
4.	Instrumental Method of Analysis, Willard, Merritt, Jr., Dean and Settle Jr., CBS Publishers and distributors, New Delhi, India.
5.	Instrumental method of chemical analysis, B. K. Sharma. 28th edition, GOEL Publishing house Meerut. 2012.
6.	Analytical Chemistry, 6th Edition 2004, by Gary D. Christian, John Wiley & Sons Inc.
7.	Instrumental Methods of Analysis, B. Sivasankar, Oxford University Press, 2012.
8.	Contemporary Chemical Analysis, by J. F. Rubinson and K. A. Rubinson, Princtice-Hall International Inc. 1998.
9.	The Principles of Electrochemistry, by Duncan A. Maclnnes, Dover Publications Inc., N.Y.

On-line resources to be used if available as reference material
On-line Resources

RSC learning portal http://www.rsc.org/learn-chemistry
NPTEL: http://nptel.iitm.ac.in
Open access: https://electroanalytical.imedpub.com/
https://chemistry.tcd.ie/assets/pdf/js/CH3403/JS%20CH3403%20Electroanalytical%20Chemistry%20%202013-2014.pdf

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	PS03CANC53	Title of the Course	Classical and Thermal Methods of Analysis
Total Credits of the Course	4	Hours per Week	3 L + 1S = 4 h

Course Objectives:	1. To provide students with the knowledge of fundamental methods in chemical analysis 2. To increase knowledge of students in specialized subject 3. To make students ready for their professional life

Course Content		
Unit	Description	Weightage* (%)
1.	**Gravimetric and Thermal Methods of Analysis** **Gravimetry**: Introduction and gravimetric factors ● Factors governing size/types of gravimetry PPTs ● Properties of PPTs and precipitating agents ● Requirements of Gravimetry PPTs ● Peptization and co-precipitation processes. **Thermal Methods :** thermal events, and classification of thermal methods ●Factors affecting TA curves, and TA analysis results ● TGA, DTA, and DSC techniques and their applications	
2.	**Titrimetric methods of analysis:** Introduction, general principle and classification ● Requirements of titrimetry reaction and endpoint detection ●Acid-base/redox/ precipitation/complexation equilibrium reactions ● acid-base theories ● dissociation of acids/bases in aqueous and non-aqueous media	
3.	**Acid-Base and oxidation-reduction titrations:** Derivations of theoretical acid-base titration curves ●Feasibility of the titrations between mono/dibasic acid Vs base ● Applications of titrimetric methods. **Redox titrations:** Redox system and potentials, Formal potential, Nernst equation● Calculation of redox reaction equilibrium constant ● derivation of theoretical titration curves ● Feasibility and	

	redox indicators	
4.	**Precipitation and complexation titrations:** **Precipitation titrimetry**: Introduction ● Factors affecting precipitation titrimetry ●theoretical titration curves ● Volhard, Fajan and Mohr's methods. **Complexometric titrations:** Introduction ● detecting of endpoint ● stability constants ● EDTA titration curves ●Metallo chromic indicators ● titration error and feasibility ● titration of mixture containing metal ions, and masking and de-masking strategies ● auxiliary reagent ammonia	

Teaching-Learning Methodology	Class room teaching with board work and computer aids, Assignments of teaching contents to students, training for better communications of subject knowledge,

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Explore the knowledge of chemical analysis important in almost all fields of the science.
2.	Gain the expertise on how to deal with the chemical analysis in academic and applied fields.
3.	Know the working principle of any sophisticated instruments/methods of chemical analysis
…	

Suggested References:	
Sr. No.	References
1.	Principles of Instrumental analysis-by D.A. Skoog & F.J. Holler & T.A. NiemenbvSaunders College Publishers, 5th edition, 1998
2.	Analytical Chemistry: Principles-by J.H. Kennedy, Saunders College Publishers, 2nd edition, 1990
3	Introduction to Chemical Analysis-by R.D. Braun, Mc-Graw Hill Book Co.2nd edition 1995
4.	Vogel's Textbook of Quantitative Chemical Analysis-by G.H. Jeffory, J. Mendham, R.C. Denney, 5th edition, 1998
5.	Analytical Chemistry - by G.D. Christian, Jhon Willey & Sons, 3rd edition
6.	Quantitative Analysis-by R.A. Day, Prantice hall of India(P)Ltd., New Delhi, 6th edition,1993

On-line resources to be used if available as reference material
On-line Resources:
e-books,

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	PS03CANC54	Title of the Course	Practical
Total Credits of the Course	04	Hours per Week	8

Course Objectives:	1. These all experiment provides laboratory skill to the students and hands of training to analysis of various type of samples with variety of methods. 2. Beside this such laboratory work provide the handling of various samples and their safety measure.

Course Content		
Unit	Description	Weightage* 100 (%)
	Classical Methods of Analysis	
1.	Safety and laboratory rules	
2.	Determination of Copper in Brass Alloy.	
3.	To determine % of purity of ferric alum.	
4.	To determine % of protein in a given sample of milk.	
5	Determination of purity of phthalic anhydride.	
6	Determination of Total Hardness of water by complexometry using EDTA.	
	Analysis of Industrial Products	
1	Calibration of glass wares (Vol. flask, pipette, burette, etc.,).	
2	Determination of purity of maleic anhydride.	
3	To determine % of Vitamin C in a given Tablet.	
4	To determine % of Vitamin C (ascorbic acid) in lemon juice.	
5	To determine the % of sulfa drugs in the given sample.	
6	To determine oxidizing power of commercial hydrogen peroxide	
	Instrumental Methods of Analysis	
1	Calibration of Instruments (pH meter, spectrophotometer,	
2	conductometer etc.)	

3	Determination of milk adulteration by conductivity measurements	
4	Titrate Cu(II) with EDTA photometrically and Determine the amount of Cu(II) in a given solution	

Teaching-Learning Methodology	Hands of training and demonstration of experiments and instruments

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	The course comprises various types of practical such as identification, determination, quantification and purification of substances, separation of the components of a solution or mixture, and determination of components/elements in the various compounds such as natural and synthesized. Practicals are classified in three groups:
2.	Analysis based on Instruments Analysis of classical methods Industrial analysis. These experiments improve laboratory skill and fundaments of theoretical aspect of the students and hands of training to analysis of various types of samples with variety of methods.

Suggested References:	
Sr. No.	References
1.	J. G. Dick, Analytical Chemistry, p.640, International student Edn., Mc Grow Hill, Kogaksusha Ltd., 1973.
2.	Analytical chemistry by S. Shapiro Ya., Gurvich Eng. Transition, Mir Publisher,

	Moscow P. 279, 1975.
3	A Textbook on Experiments Calculation in Chemical Engineering By S. S. Dara, S. Chand & Company Ltd., New Delhi, 1997
4	Quantitative Analytical Chemistry, P. 596, 15 Edition by James S. Fritz, George II. Schenk.
5	Experimental Physical Chemistry by R. C. Das and B. Behera. P. 27.
6	Quantitative Organic Analysis, Part-3 First Edition By A. I . Vogel (1958) p. 724 , p. 797.
7	Encyclopedia of Industrial methods of analysis, Vol. 8, p. 166
8	Analytical Chemistry by G. D. Christian, 3rd Edition, p. 278, p. 411.

On-line resources to be used if available as reference material
On-line Resources

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	**PS03CANC55**	Title of the Course	**Project Work**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	To provide exposure to research problem and carry out research in the novel and fascinating topics of research in analytical chemistry.

Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.

Suggested References: Published research articles on given research topic.

On-line resources to be used if available as reference material
Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	PS03CANC56	Title of the Course	Practical
Total Credits of the Course	04	Hours per Week	8

Course Objectives:	1. These all experiment provides laboratory skill to the students and hands of training to analysis of various type of samples with variety of methods. 2. Beside this such laboratory work provide the handling of various samples and their safety measure.

Course Content		
Unit	Description	Weightage* 100 (%)
	Classical Methods of Analysis	
1.	To determine Cl^- ion concentration in a given sample of water.	
2.	To study the influence of ionic strength on solubility of $CaSO_4$ and determine its thermodynamic solubility product and mean ionic activity using Debye-Huckel equation.	
3.	Determination of crystallizing point of given naphthalene ball sample.	
4.	To determine total iodide content (in ppm) in a given iodized edible salt.	
	Analysis of Industrial Products	
1.	To determine the percentage purity of glucose by iodimetry.	
2.	Determination of acid value of polyester resin.	
3.	To determine the epoxy equivalent weight of given epoxy resin.	
4.	To determine chemical oxygen demand (COD) in a given water sample.	
5.	Extraction of caffeine from dry tea leaves and its quantitative determination.	
	Instrumental Methods of Analysis	
1.	To determine the pKa Value of an indicator by spectrophotometric method.	

2.	To determine nicotine in a given tobacco sample by potentiometric and tritrimetric method.	
3.	To determine Rf value and/or of amino acids in mixture by using Ascending and Circular paper chromatography	
4.	To determine Rf value of pigments of ink using paper/thin layer chromatography.	

Teaching-Learning Methodology	Hands of training and demonstration of experiments and instruments

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	This course includes variety of practicals which are classified in three groups A) Analysis based on Instruments B) Analysis of classical methods C) Industrial analysis.
2.	The course comprises all field of practical such as water analysis, food analysis, pharmaceutical analysis, organic, inorganic, polymers, metals etc.
3.	These experiments improve laboratory skill and fundaments of theoretical aspect.
4.	The students are also able to perform some experiments sophisticated instruments. Such types of training are helpful to get job in industry as well as in research laboratory.

Suggested References:	
Sr. No.	References

1.	Encyclopedia of Industrial methods of analysis, Vol. 19, p. 365.
2.	Text book of Quantitative Chemical Analysis by A. I . Vogel.
3	Chemical experiments for Instrumental methods by Sawyer, Heineman and Beebe Ed., 1984.
4	A Textbook on Experiments Calculation in Chemical Engineering by S. S. Dara, S. Chand & Company Ltd., New Delhi, 1997.
5	Introduction to the chemical analysis of plastics, by A. Krause & A. Lange (Modified) p. 121.
6	Advanced Practical Physical Chemistry by J. B. Yadav. P. 99.
7	Vogel's "Textbook of Quantitative chemical analysis" by G. H. Jeffery, J. Basserr Edition. 1989.
8	Analytical Chemistry by G. D. Christian , 2rd Edition.
9	Encyclopedia of Industrial chemcial analysis, Vol. 14, p. 601.
10	Analytical Chemistry by G. D. Christian, 3rd Edition, p. 506.

On-line resources to be used if available as reference material
On-line Resources

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	**PS03CANC57**	Title of the Course	**Project Work**
Total Credits of the Course	**04**	Hours per Week	**08**

Course Objectives:	To provide exposure to research problem and carry out research in the novel and fascinating topics of research in chemistry.

Course Content	
Description	Weightage* (%)
Research work in laboratory on a topic given by the supervisor	100%

Teaching-Learning Methodology	Laboratory exercise and thesis writing

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Presentation and Viva-voce Examination (As per CBCS R.6.8.3)	30%
2.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to proceed for literature survey, synthesis and characterization of compounds/ materials using modern analytical and spectroscopic techniques and their study for various applications. They will be trained in research for pursuing higher studies. They will get training for working in research in academic and industries.

Suggested References: Published research articles on given research topic.

On-line resources to be used if available as reference material
Published papers by reputed publishers like American Chemical Society, Royal Society of Chemistry, Wiley, Elsevier, etc.

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Master of Science, Analytical Chemistry
M. Sc. Analytical Chemistry, Semester – III

Course Code	**PS03CANC58**	Title of the Course	**Comprehensive Viva**
Total Credits of the Course	**01**	Hours per Week	**01**

Course Objectives:	To assess the overall knowledge of the student in the relevant subjects covered in core as well as elective courses.

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