John Wilson Education Society's
Wilson College (Autonomous)

Chowpatty, Mumbai
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for PG Second Year (S.Y.) under
New Education Policy (NEP 2020)

Program: M.Sc. (Analytical Chemistry)

Program Code: WSCHA (Analytical Chemistry)

Choice Based Credit System (CBCS) with effect from

Academic year 2024–2025

PROGRAM OUTLINE 2024-2025

YEAR	COURSE	COURSE CODE	COURSE TITLE	REDITS
MSc-Sem 3	Mandatory Course-I	WSCHAMT631	Advance Instrumental Techniques-I	04
	Mandatory Course-II	WSCHAMT632	Bio analytical Chemistry and Food Analysis	04
	Mandatory Course-III Practical	WSCHAMP631	Analytical Chemistry Practical-I	04
	Mandatory Course-IV	WSCHAMT633	Chromatographic Techniques	02
	Elective- I	WSCHAET631	Pharmaceutical and Organic Analysis	02
	OR			
	Elective- II	WSCHAET632	Forensic and Cosmetic Analysis	02
	Elective Practical	WSCHAEP631	Advanced Chemical Analysis- I	02
	Project	WSCHARP631	Research Project	04
MSc-Sem 4	Mandatory Course-I	WSCHAMT641	Advanced Instrumental Techniques-II	04
	Mandatory Course-II	WSCHAMT642	Material Science and Integrated Environmental Chemistry	04
	Mandatory Course-III Practical	WSCHAMP641	Analytical Chemistry Practical-II	04
	Elective I	WSCHAET641	Intellectual Property Rights-I	02
	OR			
	Elective- II	WSCHAET642	Quality In Analytical Chemistry	02
	Elective Practical	WSCHAEP641	Advanced Chemical Analysis- II	02
	Project	WSCHARP641	Dissertation	06

PROGRAMME SPECIFIC OUTCOME (PSOs)

1. Gain knowledge of the advanced concepts in the branch of chemistry, scrutinize and accomplish a solution to problems encountered in the field of research and analysis.

2. Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards.

3. Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analysed using practical skills inculcated in them during the course.

4. Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques actually implemented in the industry.

5. Use the subject knowledge, communication and ICT skills to become an effective team leader/team member in the interdisciplinary fields.

6. Understand, Manage and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained.

7. Exhibit professional work ethics and norms of scientific development.

PREAMBLE:

Master of Science (M.Sc.) in Chemistry is a postgraduate course of Department of Chemistry, Wilson College, Chowpatty, Mumbai (Autonomous). The Choice Based Credit System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students in the second year of the M.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also, to expose the students and to develop interest in them in various fields of Chemistry.

The new and updated syllabus is based on a interdisciplinary approach with vigour and depth taking care that the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop an understanding of various aspects of chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledge are among such important aspects.

PROGRAM(s): M.Sc.-II		**SEMESTER: III**			
Course: Mandatory Course-1		**Course Code: WSCHAMT631**			
Teaching Scheme					**Evaluation Scheme**
Lectures (hours per week)	**Practical (hours per week)**	**Tutorial (hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks40)**	**Semester End Examination (Marks- 60)**
04	**NA**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To understand the steps involved in surface preparation for analysis and the challenges associated with surface analysis.
2. To describe ESR principles, instrumentation, and its applications in research.
3. To Explain atomic emission spectroscopy principles, instrumentation, and its applications based on plasma and electrical discharge sources.
4. To Evaluate principles, instrumentation, and applications of advanced electroanalytical techniques.
5. To Describe optical rotatory dispersion (ORD) and circular dichroism (CD) principles, instrumentation, and applications in stereochemistry and structural analysis

Course Outcomes:

At the end of the Course student will be able to-

CO1: Analyze surface analytical techniques including secondary ion mass spectroscopy, particle induced X-ray emission, low energy ion scattering, and Rutherford Backscattering to assess their principles, instrumentation, and applications.

CO2: Evaluate Electron spin resonance spectroscopy, Mossbauer's spectroscopy, and atomic emission spectroscopy to appraise their principles, instrumentation, and applications.

CO3: Demonstrate understanding of Advanced Electroanalytical techniques such as current sampled polarography, potential sweep methods, potential step method, controlled potential technique, and stripping voltammetry by comparing and contrasting their methodologies and applications.

CO4: Examine the principles, instrumentation, and application of Chemiluminescence techniques, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD), Photoacoustic spectroscopy, and Spectro electrochemistry to evaluate their effectiveness in various analytical scenarios.

Detailed Syllabus- Mandatory Course-I Advance Instrumental Techniques-I

Course Code: WSCHAMT631	**Course/Unit Title**	04 Credits/ 60 Lectures
UNIT I	Spectral Methods I	15L
	1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L) 1.2 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy. (4L) b. Particle-Induced X-Ray Emission (5L) c. Low-Energy Ion Scattering and Rutherford Backscattering (5L)	
UNIT II	Spectral Methods – II	15L
	Principle, Instrumentation, and Applications of 2.1 Electron Spin Resonance Spectroscopy (ESR) (5L) 2.2 Mossbauer's Spectroscopy (5L) 2.3 Atomic Emission Spectroscopy- based on plasma and electrical discharge sources (5L)	
UNIT III	Electroanalytical Methods	15L
	Advanced Electroanalytical Techniques: - 3.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L) 3.2 Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry. (3L) 3.3 Potential Step method- Chronoamperomertry (2L) 3.4 Controlled potential technique- Chronopotentiometry (2L) 3.5 Stripping Voltammetry- anodic, cathodic, and adsorption (2L) 3. 6 Chemically and electrolytically modified electrodes and ultra microelectrodes in voltammetry (3L)	
UNIT IV	Miscellaneous Techniques	15L

	Principle, Instrumentation, and Applications of: 4.1 Chemiluminescence: principle and techniques with application of phenomenon in fireflies(3L) (3L) 4.2 Chirooptical Methods: ORD, CD (5L) 4.3 Photoacoustic spectroscopy (3L) 4.4 Spectro electrochemistry (4L)	

List of books and references:

1. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986)
2. Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt- Saunders 6th Edition (1992)
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann, 5th Edition (1998)
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6th Ed CBS (1986)
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr 7th Ed CBS (1986)
6. Introduction to Instrumental Analysis, R. D. Braun, Mc Graw Hill (1987) 7. Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
8. Electroanalytical Chemistry, J.J . Lingane, 2nd Ed Interscience, New York (1958)
9. Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980.
10. Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
11. Techniques and mechanism of electrochemistry, P. A. Christian and A. Hamnett, Blachie Academic and Professional (1994)
12. Wilson and Wilson's Comprehensive Analytical Chemistry, Ed. G. Svehla. (A series of Volumes)
13. Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience Pub. (A series of volumes).
14. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, (A series of volumes)
15. Polarographic Methods in Analytical Chemistry, M. G. Arora, Anmol Publications Pvt Ltd

16 Surface Analysis –The Principal Techniques, 2nd Edition Edited by John C. Vickerman and Ian S. Gilmore 2009 John Wiley & Sons, Ltd. ISBN: 978-0-47001763-0 17. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester

PROGRAM(s): M.Sc.-II		**SEMESTER: III**			
Course: Mandatory Course-II		**Course Code: WSCHAMT632**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial l (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
04	**NA**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Analyze the bioanalytical chemistry of various body fluids, evaluating their physiological and nutritional significance with reference to vitamins, employing analytical techniques to assess vitamin content.

CO2: Evaluate immunological methods employed in assessing human nutrition, integrating principles to understand their significance in maintaining health.

CO3: Assess the fuel value of different foods, scrutinize the role of food additives, and analyze the impact of food contaminants on human health, applying critical thinking to develop strategies for mitigation.

CO4: Synthesize knowledge of food packaging techniques, employing analytical methods to investigate the composition and quality of milk, oils, fats, and spices, and evaluating their suitability for consumption.

Detailed Syllabus- Mandatory Course-II Bio analytical Chemistry and Food Analysis

Course Code: WSCHAMT632	**Course/course Title**	04 Credits/ 60 Lectures
UNIT I	Bio analytical chemistry	15L
	1.1 Body Fluids 1.1.1 Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases. (5L) 1.1.2 Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals. (5L) 1.1.3 Analytical techniques (including microbiological techniques) for vitamins. (5L)	
UNIT II	Immunological Methods	15L
	2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays, HA HI test (8L) 2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.(7L)	
UNIT III	Food Analysis - I	15L
	3.1 Fuel value of food and importance of food nutrients, Glycemic index (2L) 3.2 Food Additives – General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour. (5L) 3.3 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. (8L)	
UNIT IV	Food Analysis - II	15L
	4.1 Food packaging 4.1.1 Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L) 4.1. 2 Processing and Quality requirements of Milk and milk products (cheese, butter and ice cream), vegetables and fruits, meat and meat products. (6L)	

	4.2 Analysis of Milk – Fat content, proteins, acidity, bacteriological quality and milk adulterants. (2L) 4.3 Analysis of Oils and Fats – acid value, sap value, iodine value. Determination of rancidity and antioxidants. (2L) 4.4 Analysis of spices (cloves, cinnamon, pepper, mustard) Determination of volatile oils and fixed oils.(3L) 4.5 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. (8L)	

List of books and references:

1. General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.
2. Advance dairy chemistry, vol 3, P. F. Fox, P. L. H. McSweeney Springer.
3. Physiological fluid dynamics vol 3, Nanjanagud Venkatanarayanasastry Chandrasekhara Swamy Narosa Pub. House, 1992
4. Molecular Biological and Immunological Techniques and Applications for food, edited by Bert Popping, Carmen Diaz-Amigo, Katrin Hoenicke, John Wiley & sons.
5. Food Analysis: Theory and practice, Yeshajahu Pomeranz, Clifton E. Meloan, Springer.
6. Principles of package development, Gribbin et al
7. Modern packaging Encyclopedia and planning guide, Macgra Wreyco.
8. Food Analysis, Edited by S. Suzanne Nielsen, Springer
9. Analytical Biochemistry, D, J. Homes and H. Peck, Longman (1983)
10. Bioanalytical Chemistry, S. R. Mikkelesen and E. Corton, John Wiley and sons 2004
11. Analysis of food and beverages, George Charalanbous, Accademic press 1978

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: Mandatory Course-III (Practical)		**Course Code: WSCHAMP631**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks-60)**
NA	**08**	**NA**	**04**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Generate conceptual and empirical knowledge in the field of Analytical chemistry through activities such as analyzing, synthesizing, and evaluating chemical data and phenomena.

CO2: Disseminate knowledge regarding rigorous interdisciplinary research practices by communicating, collaborating, and integrating findings from diverse fields.

CO3: Promote ethical research practices by demonstrating, adhering to, and evaluating ethical principles and guidelines in experimental design and data interpretation.

CO4: Extend the horizon of knowledge in various domains of Analytical chemistry by researching, proposing, and validating innovative methodologies and technologies.

CO5: Promote research that leads to actionable decisions by the industry by applying, predicting, and justifying analytical findings to solve real-world problems and inform decision-making processes.

Detailed Syllabus- Mandatory Course-III Practical Analytical Chemistry Practical-I

Course code: WSCHEMP631	**Course Title:** Analytical Chemistry Practical-I	**04 Credits**
	PAPER 1	02 Credits
	1. Estimation of fluoride in a toothpaste. 2. Determination of silica by molybdenum blue method. 3. Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method. 4. Analysis of lactose in milk 5. Estimation of Caffeine in tea 6. Estimation of Vitamin C in lemon Juice/squash by BB Dichlorophenol-indophenol method 7. Iodine value of oil/fat 8. Assay of Riboflavin in tablets by UV-Visible Spectrophotometry 9. Simultaneous Determination of Cr (VI) and Mn(VII) in a mixture without separation	
	PAPER 2	02 Credits
	1. Estimation of cholesterol and Uric acid in the given sample of blood serum 2. Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, and total residue by evaporation. 3. Estimation of Glucose by Folin-Wu method 4. Determination of copper and bismuth in mixture by photometric titration. 5. Estimation of RNA using spectrophotometer 6. Determination of the purity of crystal violet 7. To determine the nicotine content in the given tobacco sample by potentiometric method 8. Determination of Phosphorous in human serum using spectrophotometer 9. Estimation of Ni in tea powder	

PROGRAM(s): M.Sc-II		**SEMESTER: IV**			
Course: Mandatory Course IV		**Course Code: WSCHAMT633**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks- 30)**
02	**NA**	**–**	**02**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1- Disseminate knowledge regarding ion exchange chromatography, ion chromatography and exclusion chromatography

CO2-Evaluate chromatographic techniques like Supercritical fluid chromatography, Affinity chromatography and Optimum pressure liquid chromatography

Detailed Syllabus- Mandatory Course-IV Chromatographic Techniques

Course Code: WSCHAMT633	**Course/Course Title**	02 Credits/ 30 Lectures
UNIT I	Chromatographic Techniques -I	15L
	1.1 Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins, and their applications for separation of inorganic and organic compounds. (8L) 1.2 Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L) 1.3 Exclusion chromatography: Theory, instrumentation, and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers, (5L	
UNIT II	Chromatographic Techniques -II	15L
	2.1 Supercritical fluid Chromatography: Theory, the concept of the critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals, and polymeric analysis. (8L) 2.2 Affinity Chromatography: principle, instrumentation and applications (4l) 2.3 Optimum pressure liquid chromatography (OPLC) (3L)	

List of books and References:

1. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969 7. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969. 8. Analytical Chemistry, G. D. Christain, Wiley
2. Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978.
3. Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996
4. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2nded 1963
5. Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976
6. Chromatographic and electrophoresis techniques I Smith Menemann Interscience 1960

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: Elective-I		**Course Code: WSCHAET631**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks-30)**
02	**NA**	**–**	**02**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Investigate air pollution sources, sampling methods, analysis techniques, carbon credit mechanisms, greenhouse gas effects, and environmental legislation comprehensively.

CO2: Evaluate water quality standards, bore well water quality, purification processes, and regulatory requirements systematically.

CO3: Differentiate soil, noise, thermal, and radioactive pollution types, alongside conducting thorough environmental audits.

CO4: Analyze insecticides, pesticides, soaps, detergents, and petrochemical products deeply to understand their industrial significance.

Detailed Syllabus- Elective Course-I Pharmaceutical and Organic Analysis

Course Code: WSCHAET631	**Course/Course Title**	02 Credits/ 30 Lectures
UNIT I	Pharmaceutical Analysis	15L
	1.1 General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations, classification of dosage forms. Role of FDA in pharmaceutical industries. (7L) 1.2 Sources of impurities in pharmaceutical products and raw materials. (4L) 1.3 Standardization of finished products and their characteristics, official methods of quality control. (4L)	
UNIT II	Drugs	15L
	2.1 Analysis of compounds based on functional groups, instrumental methods for analysis of drugs, assays involving chromatographic separations, proximate assays, assays of enzyme containing substances, biological and microbiological assays and tests. (8L) 2.2 Limit tests, solubility tests, disintegration tests, stability studies, impurity profile of drugs, bioequivalence, and bioavailability studies. Polymers in pharmaceuticals and novel drug delivery systems. (7L)	

List of Books and References:

1. Drug Laws, M L Mehra, University Book Agency, Ahmedabad, 1997. 2.
2. Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
3. Textbook of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
4. Food Processing and Preservation, B Sivasankar, Prentice - Hall of India Private Limited, 2007.
5. Food Additives, R M Pandey and S K Upadhyay, INTECH, Open Science/Open Minds.
6. Food Science, B Srilakshmi, New Age International (P) Ltd. Publishers, 2003.
7. Food Contaminants: Sources and Surveillance, Edited by C Creaser, R Purchase, Elsevier, 1991.
8. The Chemical Analysis of Food and Food Products, Morris B Jacobs.
9. FSSAI (Food Safety and Standards Authority of India) Manuals of Methods of Analysis of Foods (Oils and Fats, Milk and Milk Products, Food Additives), Ministry of Health and Family Welfare, Government of India.

PROGRAM(s): M.Sc. II		**SEMESTER: III**			
Course: **Elective II**		**Course Code: WSCHAET632**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks- 30)**
02	**NA**	**–**	**02**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Comprehend the pharmaceutical industry's intricacies, including formulations, dosage standards, FDA regulations, impurity sources, finished product standardization, and quality control methods.

CO2: Investigate drug concepts encompassing analytical methodologies, limit tests, bioavailability assessments, and the utilization of polymers in drug delivery systems.

CO3: Acquire foundational knowledge about forensic science, forensic analysis techniques, and analytical toxicology principles.

CO4: Understand the analysis of cosmetics like deodorants, face powder, hair tonics, creams, lotions, and lipsticks through chemical examination and safety evaluation.

Detailed Syllabus- Elective Course-II Forensic and Cosmetic Analysis

Course Code: WSCHAET632	**Course/Course Title**	02 Credits/ 30 Lectures
UNIT I	Forensic Science	15L
	1.1 Analytical Chemistry in Forensic Science: General idea.(2L) 1.2 Forensic Analysis: Blood, DNA profiling, Hair analysis, Alcohol in body fluids, systematic drug identification.(5L) 1.2. Analytical Toxicology: Isolation, identification and determination of: 1.3.1 Narcotics: Heroin, morphine and cocaine. 1.3.2 Stimulants: Amphetamines and caffeine. 1.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax. 1.3.4 Hallucinogens: LSD and Cannabis. 1.3.5 Metabolites of drugs in blood and urine of addicts. 1.3.6 Viscera, stomach wash, vomit and postmortem blood for poisons like – cyanide, arsenic, mercury, insecticides and pesticides. (8L)	
UNIT II	Cosmetic Analysis	15L
	2.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis.(2L) 2.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.(3L) 2.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L) 2.4 Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers)(3L) 2.5 Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (2L) 2.6 Lipsticks: General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents.(2L)	

List of Books and References:

1. Analytical Biochemistry, David J Holmes and Hazel Peck, Longman, 1983.
2. Bioanalytical Chemistry, Susan R Mikkelesen and Eduardo Cotton, John Wiley and Sons, 2004.
3. Analysis of food and beverages, George Charalanbous, Academic press, 1978.
4. Harry's Cosmetology, 7^{th} Ed, Longman Scientific Co.
5. Formulation and Function of Cosmetics, Joseph Stefan Jellinek, Wiley Interscience, 1971.
6. Cosmetic Technology, Edward Sagarin, Interscience Publishers, 1957.
7. Modern Cosmetics, Edgar George Thommsen, Francis Chilson, Drug and Cosmetic Industry, 1947.
8. Encyclopedia of Industrial Chemical Analysis, Foster Dee Snell et al, Interscience Publishers, 1967.
9. Government of India Publications of Food, Drug and Cosmetic Act and Rules.
10. The Handbook of Drug Laws, M L Mehra, University Book Agency, Ahmedabad, 1997.
11. Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
12. Text book of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
13. Fundamentals of Urine and Body Fluid Analysis, Nancy A Brunzel, Elsevier health Sciences, 2013.
14. Lab Manual on Blood analysis and Medical Diagnostics, Dr Gayatri Prakash, S Chand and Company Ltd, New Delhi.
15. Manual of Medical Laboratory Techniques, S Ramakrishnan and K N Sulochana, Jaypee BrothersMedical Publishers (P) Ltd, 2012.
16. Indian Pharmacopeia, Volume I and II.
17. Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
18. Forensic Chemistry, David E Newton, Infobase Publishing, 2007.

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: Elective Practical		**Course Code: WSCHAEP631**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks- 30)**
NA	**04**	**NA**	**02**	**40**	**60**

Learning Objectives:

1. To Gain knowledge of the Fundamental concepts in the branch of Analytical chemistry and to develop a research aptitude.
2. To apply the basic knowledge of Analytical chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the job requirements as per global standards.
3. To deduce qualitative and quantitative information of analyte using prescribed Analytical technique and to develop practical skills in them during the course.
4. To develop skills in solving calculations in analytical chemistry.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Apply analytical techniques to generate conceptual and empirical knowledge in Analytical Chemistry, synthesizing theories and experimental data.

CO2: Exemplify ethical research practices in Analytical Chemistry, demonstrating integrity, honesty, and respect for intellectual property.

CO3: Investigate emerging trends and advancements in various domains of Analytical Chemistry, integrating knowledge from diverse sources and disciplines.

CO4: Translate research findings into actionable recommendations for industry stakeholders, demonstrating the practical relevance and impact of Analytical Chemistry research.

CO5: Disseminate research findings through rigorous interdisciplinary research practices, engaging with diverse audiences and stakeholders.

Detailed Syllabus- Elective Practical Advanced Chemical Analysis- I

Course code: **WSCHAEP631**	Course Title: Advanced Chemical Analysis- I	02 Credits
	1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry. 2. To analyze Magnalium for Mg by complexometry. 3. Determination of Paracetamol using colorimetry 4. Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry) 5. Analysis of water sample: Total hardness and salinity. 6. Analysis of water sample: Acidity and suphate (Benzidine method). 7. To determine the percentage of sulfa drug in the given sample 8. Determination of iron in iron wire using KMnO4 9. Analysis of dissolved oxygen (DO) in drinking water and sewage water.	

PROGRAM(s): M.Sc.-II		**SEMESTER: III**				
Course: Training/ Field Project		**Course Code: WSCHARP631**				
Teaching Scheme				**Evaluation Scheme**		
Lectures (hours per week)	**Practical (hours per week)**	**Tutorial (hours per week)**	**Credit**	**Log book (Marks-20%)**	**Report (Marks-50%)**	**Viva-Voce (Marks-30%)**
NA	**08**	**NA**	**04**	**20**	**50**	**30**

Learning Objectives:

1. To provide students the opportunity to test their interest in a particular career before permanent commitments are made.
2. To develop skills in the application of theory to practical work situations. To develop skills and techniques directly applicable to their careers.

Course Outcomes:

At the end of the Course, learners able to

1. Understand the importance of a research project.
2. Carry out a substantial research-based project.
3. Differentiate a purpose statement, a research question or hypothesis, and a research objective.
4. Analyze data critically and validate its applications.
5. Report research findings in written and verbal forms.

Course Code: WSCHARP631	**Research Project**	**04 Credits**
	1. Students should carry out a detailed research project. 2. This should make them familiar with i. Literature survey, research methodologies ii. Data Analysis iii. characterization techniques 3. Project report must be written and submitted in a proper format as follows; i)Certificate (Signed by Project guide and Head of the Department) ii) Certificates for Poster/Paper presented in conferences (if any) iii) Self declaration certificate for plagiarism iv) Introduction (not more than 6 pages) v) Experimental Section vi) Results and Discussions vii) Conclusion viii) References (Use ACS format) ix) Spectroscopic or other relevant supporting data x) Acknowledgement 4. Interdisciplinary projects shall be encouraged 5. Students should spend enough time for the project works (at least 8 hours per week) 6. If a student is performing a project in another institute, for such a student, an internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case a student has to obtain a certificate from both external and internal mentors. 7. Systematic record of attendance of project students must be maintained by a mentor. 8.Project will be evaluated jointly by three examiners. 9. Astudent has to present his practical work, discuss results and conclusions in detail which will be followed by a question-answer session 10. It is an open type of examination.	

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: Mandatory Course-1		**Course Code: WSCHAMT641**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-40)**	**Semester End Examination (Marks- 60)**
04	**NA**	**–**	**04**	**40**	**60**

Learning Objectives:

1: The learner will able to develop knowledge and skills in different areas of Analytical and Materials Chemistry.
2: The learner will learn the various instrumental principles and working of different types of instruments used for analysis.
3: Programme will help to develop eco-friendly protocols/procedures for chemical processes in the industry.
4: To understand basic concept of chromatographic and spectroscopic methods.
5: To apply the concepts of green chemistry to analytical chemistry for better environment.

Course Outcomes:

At the end of the Course student will be able to-

CO1: Analyze the principles of FTNMR and 2D NMR, including FID signal generation, and apply techniques such as homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), and heteronuclear correlation (HETCOR) to interpret complex NMR spectra effectively.

CO2: Evaluate mass spectra, extracting analytical insights such as molecular identification, metastable peaks, and Fragmentation Reactions to derive meaningful information.

CO3: Demonstrate proficiency in practical applications of GC-MS, ICP-MS, and GC-IR, utilizing these techniques for analytical purposes with precision.

CO4: Employ tandem mass spectrometry techniques, specifically LC-MS (including HPLC-MS and CE-MS), to identify and quantify various metabolites, showcasing competence in advanced analytical methodologies.

CO5: Investigate Neutron activation analysis (NAA) and Thermal analysis methods to determine element concentrations in diverse materials, demonstrating understanding and application of specialized analytical techniques for quantitative analysis.

Detailed Syllabus- Mandatory Course-I Advanced Instrumental Techniques-II

Course Code: WSCHAMT641	**Course/Course Title**	04 Credits/ 60 Lectures
UNIT I	Spectral Methods III	15L
	NMR Spectroscopy 1.1 Theory and Instrumentation- recapitulation, FTNMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR) (9L) 1.2 Radio waves in imaging- principle instrumentation and applications of MRI (3L) 1.3 Application of NMR to other nuclei C^{13}, $P^{31}$and F^{19}spectroscopy (3L)	
UNIT-II	Spectral Methods IV	15L
	2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from mass spectra- molecular identification, metastable peaks, Fragmentation Reactions (9L) 2.2 Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)	
UNIT III	Radiochemical And Thermal Methods	15L
	3.1 Activation analysis- NAA, radiometric titrations and radiorelease methods (7L) 3.2 Thermal analysis- Principle, Interfacing, instrumentation and Applications of (a) Simultaneous Thermal Analysis- TGDTA and TG-DSC (b) Evolved gas analysis- TG-MS and TG-FTIR (8L)	
UNIT IV	Hyphenated Techniques	15L
	4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2 L) 4.2 Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CEMS. (13L)	

List of Books and references:

1. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986)
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J Holler Holt- Saunders 6thEdition (1998)
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann 5thEd.
4. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A.
5. Thermal methods of Analysis, P. J. Haines, Blackie Academic & Professional, London (1995)
6. Thermal Analysis, 3rdEdition W. W. Wendlandt, John Wiley, N.Y. (1986)
7. Principles and Practices of X-ray spectrometric Analysis, 2ndEd E. P. Bertain,
8. Plenum Press, NY, (1975)
9. Nuclear Analytical Chemistry, D. Bane, B. Forkman, B. Persson, Chartwell - Bratt Ltd (1984)
10. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, A series of volumes
11. A Complete Introduction to Modern NMR Spectroscopy 1st Edition by Roger S. Macomber
12. Spectrometric Identification of Organic Compounds Hardcover – by Robert M.Silverstein Wiley
13. Tandem Techniques (Separation Science Series) 1st Edition by Raymond P. W. Scott John Wiley & Sons Ltd, 1997
14. Encyclopedia of Analytical Science, Editors-in-Chief: Paul Worsfold, Alan Townshend, and Colin Poole ISBN: 978-0-12-369397-6
15. Encyclopedia of Analytical Chemistry: Applications, Theory, and Instrumentation. Meyers Robert A Meyers
16. Introduction to Thermal Analysis Techniques and Applications Edited by Michael E. Brown
17. Principles and Applications of Thermal Analysis Edited by Paul Gabbott

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: Mandatory Course-II		**Course Code: WSCHAMT642**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-40)**	**Semester End Examination (Marks- 60)**
04	**NA**	**–**	**04**	**40**	**60**

Learning Objectives:

1: The learner will able to develop knowledge and skills in different areas of Analytical and Materials Chemistry.
2: The learner will learn the various instrumental principles and working of different types of instruments used for analysis.
3: To understand basic concept of chromatographic and spectroscopic methods.
4: To apply the concepts of green chemistry to analytical chemistry for better environment.

Course Outcomes:

At the end of the Course student will be able-

CO1: Analyze the processes involved in sewage treatment, distinguishing between various methods and their effectiveness in removing contaminants.
CO2: Apply electro dialysis, electrodeposition, and Ion Exchange techniques to extract metals from effluent, demonstrating proficiency in their application through experimentation.
CO3: Evaluate strategies for managing Non-Biodegradable Wastes, including alternative biomedical waste disposal methods, by assessing their environmental impact and efficacy.
CO4: Investigate metallic impurities in plastic through chemical analysis, and assess the environmental implications of plastic pollution, employing critical thinking and scientific inquiry.
CO5: Perform chemical analysis of ores to identify principal constituents, and demonstrate mastery of purification techniques through hands-on laboratory experiments and theoretical understanding.

Detailed Syllabus- Mandatory Course-II Advanced Material Science and Integrated Environmental Chemistry

Course Code: WSCHAMT642	**Course/Course Title**	04 Credits/ 60 Lectures
UNIT 1	Effluent Treatment & Solid Waste Management	15L
	1.1 Effluent treatment plant general construction and process flow charts(3L) 1.2 Treatment, disposal of Sewage and Recycle and reuse of process and treated (effluent) water 1.3. Effluent parameters for metallurgical industry 1.3.1 Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent. (2L) 1.3.2 Recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange etc.(3L) 1.4 Solid waste management: 1.4.1 objectives, concept of recycle, reuse and recovery (3L) 1.4.2 Methods of solid waste disposal and Treatment and disposal of sludge / dry cake (3L) 1.4.3 Managing non-decomposable solid wastes(2L) 1.5 Bio- medical waste: Introduction, Classification and methods of disposal (5L)	
UNIT-II	Green Chemistry	15L
	2.1 Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity (4L) 2.2 Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents (4L) 2.3 Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. (4L) 2.4 Designing Greener Processes: Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring. (3L)	
UNIT – III	Plastics and Polymers	15L

	3.1 Classification of plastic, determination of additives, molecular weight distribution, analysis of plastic and polymers based on styrene, vinyl chloride, ethylene, acrylic and cellulosic plastics. (5L) 3.2 Metallic impurities in plastic and their determination, (2L) 3.3 Impact of plastic on environment as pollutant. (2L) 3.4 Paints and pigments: Types of paints pigments, determination of volatile and non - volatile components, Flash point (significance and method of determination), separation and analysis of pigments, binders and thinners. (3L) 3.5 Role of Organo silicones in paints and their impact on environment. (3L)	
UNIT – IV:	Metallurgy	15L
	4.1 Ores and minerals: Dressing of ores, pollution due to metallurgical processes (ore dressing, calcination, smelting) (3L) 4.2 Chemical analysis of ores for principal constituents: Galena, Pyrolusite, Bauxite, Hematite, Monazite (4L) 4.3 Alloys: definition, analysis of Cupronickel, Magnalium, Steel and Stainless Steel, Bronze, Gun metal. (4L) 4.4 Techniques of purification: Zone refining, analysis of high purity materials like silicon, vacuum fusion and extraction techniques. (4L)	

List of books and references

1. Handbook of chemical technology and pollution control 3rdEdn Martin Hocking AP Publication (2005).
2. Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005
3. Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
4. Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines, 1979.
5. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
6. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology & Engineering (1960).

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: Mandatory Course-III (Practical)		**Course Code: WSCHAMP641**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-40)**	**Semester End Examination (Marks- 60)**
NA	**08**	**NA**	**04**	**40**	**60**

Learning Objectives:

1: The learner will able to develop knowledge and skills in different areas of Analytical and Materials Chemistry.
2: The learner will learn the various instrumental principles and working of different types of instruments used for analysis.
3: Programme will help to develop eco-friendly protocols/procedures for chemical processes in the industry.
4: To understand basic concept of chromatographic and spectroscopic methods.
5: To apply the concepts of green chemistry to analytical chemistry for better environment.

Course Outcomes:

At the end of the Course student will be able-

CO1: Analyze the working principles of various analytical techniques used in chemical analysis, employing experimentation and critical evaluation.
CO2: Create and evaluate methodologies for separating and analyzing chemicals using different chromatographic techniques, demonstrating proficiency in experimental design and problem-solving.

Detailed Syllabus- Mandatory Course-III Analytical Chemistry Practical-III

Course Code: WSCHAMP641	**Course/Course Title**	04 Credits
	PAPER 1	02 Credits
	1. Determination of pK value of H_3PO_4 potentiometrically 2. Spectrophotometric determination of pH of buffer solution. 3. Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method 4. To analyze Bronze for Zn by complexometric method 5. Analysis of drugs by non-aqueous titration: Glycine, Sodium Benzoate 6. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity 7. Colorimetric determination of iron by thiocyanate and Copper by aqueous ammonia 8. Estimation of aspirin in the given tablet using uv-visible spectrophotometer. 9. Determination of phosphate in cola drinks by Molybdenum blue method	
	PAPER 2	02 Credits
	1. Estimation of Ca in Ca-pentathonate/calcium lactate tablets 2. Immobilisation to enzyme invertase or amylase on sodium alginate 3. Analysis of Calcium, Iron and phosphorous in milk. 4. Determination of SAP value of oil. 5. Estimation of Aldehyde in lemon grass oil / Cinnamon oil 6. Analysis of water sample: $Mn^{2+}$by colorimetric method 7. Estimation of Na+ in dairy whitener by flame photometry 8. Estimation of sulphides in water sample by potentiometer 9. Determination of phosphate from fertilizer	

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: Elective I		**Course Code: WSCHAET641**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks- 30)**
02	**NA**	**–**	**02**	**40**	**60**

Learning Objectives:

1. To create awareness and understanding of terms like intellectual property, patents, copyright, industrial designs,
trademarks, geographical indications etc.
2. To know trade secrets, IP infringement issues, economic value of intellectual property and study of various related
international agreements.

Course Outcomes:

At the end of the Course student will be able-

CO1- To describe the terms with their meaning such as intellectual property, patents, copyright, industrial designs,trademarks, geographical indications etc.

CO2- To interpret various trades and their trade secrets.

CO3- To summarize the different IP infringement issues, economic value of intellectual property.

Detailed Syllabus- Elective Course I- Intellectual Property Rights-I

Course Code: WSCHAET641	**Course/Course Title**	02 Credits/ 30 Lectures
UNIT I	Intellectual Property Rights-I	15L
	1.1 Introduction to Intellectual Property: [2L] Historical Perspective, Different types of IP, Importance of protecting IP. 1.2 Patents: [5L] Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India. 1.3 Industrial Designs: [2L] Definition, How to obtain, features, International design registration. 1.4 Copyrights: [2L] Introduction, How to obtain, Differences from Patents. 1.5 Trade Marks: [2L] Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. 1.6 Geographical Indications: [2L] Definition, rules for registration, prevention of illegal exploitation, importance to India.	
UNIT-II	Intellectual Property Rights-II	15L
	2.1Trade Secrets: [2L] Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. 2.2 IP Infringement issue and enforcement: [2L] Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. 2.3 Economic Value of Intellectual Property: [5L] Intangible assets and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. 2.4 Different International Agreements: [6L] (a) World Trade Organization (WTO): [5L] ● General Agreement on Tariffs and Trade (GATT), ● Trade Related Intellectual Property Rights (TRIPS) agreement ● General Agreement on Trade-Related Services (GATS) ● Madrid Protocol. ● Berne Convention ● Budapest Treaty (b) Paris Convention [6L] WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity	

List of books and references

1. Andrew R. Leach & Valerie J. Gillet (2007) *An Introduction to Cheminformatics.* Springer: The Netherlands.
2. Gasteiger, J. & Engel, T. (2003) *Cheminformatics: A textbook.* Wiley–VCH 3. Gupta, S. P. *QSAR and Molecular Modeling.* Springer-Anamaya Pub.: New Delhi.

PROGRAM(s): M.Sc. II		**SEMESTER: IV**			
Course: **Elective II**		**Course Code: WSCHAET642**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks-20)**	**Semester End Examination (Marks- 30)**
02	**NA**	**–**	**02**	**40**	**60**

Learning Objectives:

1: The learner will able to develop knowledge and skills in different areas of Analytical and Materials Chemistry.

2: The learner will learn the various instrumental principles and working of different types of instruments used for analysis.

Course Outcomes:

At the end of the Course student will be able to-

CO1- Evaluate various sampling techniques and subsampling methods to ensure the quality of samples in analytical chemistry applications.

CO2- Analyze the role of sampling in forensic science investigations and evidence analysis to understand its significance in criminal justice applications.

CO3- Calculate signal-to-noise ratios and identify sources of noise in instrumental analysis to optimize signal quality.

CO4- Apply statistical methods to evaluate uncertainty in measurements, and utilize uncertainty analysis techniques to interpret analytical results effectively.

Detailed Syllabus- Elective Course-II Quality In Analytical Chemistry

Course Code: WSCHAET642	**Course/Course Title**	02 Credits/ 30 Lectures
UNIT I	Quality In Analytical Chemistry - I	15L
	1.1 Sampling: Definition, types of sample, sampling plan, quality of sample, subsampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of samples. Pre-treatment of samples: soil, food and cosmetics. (7L) 1.2 Selection of the Method: sources of methods, factors to consider when selecting a method, performance criteria for methods used, reasons for incorrect analytical results, method validation, and quality by design (PAT). (7L) 1.3 Importance of sampling in forensic science (1L)	
UNIT-II	Quality In Analytical Chemistry - II	15L
	2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L) 2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction. (6L) 2.3 Pharmaceutical Legislation: introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration.	

List of books and references:

1. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and Sons N.Y 1997.
2. Quality assurance in analytical Chemistry, W Funk, V Dammann, G. Donnevert VCH Weinheim1995.
3. Amit S. Patil et. al., Quality by Design (QbD): A new concept for development of Quality pharmaceuticals, International Journal of Pharmaceutical Quality Assurance; 4(2); 13-19.
4. Lalit Singh and Vijay Sharma, Quality by Design (QbD) Approach in Pharmaceuticals: Status, Challenges and Next Steps, Drug Delivery Letters, 2015, 5, 2-8. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y 1997
5. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication

PROGRAM(s): M.Sc.-II		**SEMESTER: IV**			
Course: Elective Practical		**Course Code: WSCHAEP641**			
Teaching Scheme					**Evaluation Scheme**
Lectures (hours per week)	**Practical (hours per week)**	**Tutorial (hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks 20)**	**Semester End Examination (Marks- 30)**
NA	**04**	**NA**	**02**	**40**	**60**

Learning Objectives:

1. Learn to interpret emission spectra and quantify analyte concentrations using flame photometry techniques.
2. Understand the principles of non-aqueous titrations and their advantages over traditional aqueous titrations
3. To apply practical experience in flame photometric analysis, including sample preparation and instrument operation.
4. Apply potentiometric techniques to determine the liquid junction potential in concentration cells.

Course Outcomes:

At the end of the Course student will be able-

CO1- Apply conductometric techniques to accurately determine the concentration of ions in solution and interpret experimental data for complex mixture analysis.

CO2- Utilize pHmetric titration methods to precisely determine the acidity or alkalinity of solutions and analyze titration curves for endpoint determination.

CO3- Apply non-aqueous titration techniques to accurately determine the concentration of analytes in solution and select appropriate indicators for endpoint detection.

CO4- Employ flame photometry techniques to quantitatively analyze elements in solution and interpret emission spectra for elemental identification and quantification

Detailed Syllabus- Elective Practical - Advanced Chemical Analysis- II

Course code: WSCHPEP641	Advanced Chemical Analysis- II	**02 Credits**
	1. Estimation of strong acid, weak acid, and salt in the given mixture conductometrically. 2. Analysis of a mixture of carbonate and bicarbonate (present in ppm range) using pHmetry. 3. Determination of copper by extractive photometry using diethyldithiocarbamate. 4. Estimation of drugs by non-aqueous titration: Pyridoxine hydrochloride, Sulphamethoxazole. 5. Determination of percentage purity of methylene blue indicator. 6. To determine the oxidizing power of commercial hydrogen peroxide 7. Determination of pKa of an organic Indicator (Methyl Orange) 8. Determination of moisture content and total alkali of soaps 9. Determination of calcium from milk samples using flame photometry	

PROGRAM(s): M.Sc. II		**SEMESTER: IV**					
Course: Project		**Course Code: WSCHARP641** **Course Title: Research Project**					
Teaching Scheme				**Evaluation Scheme**			
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Log book (Marks-20%)**	**Report (Marks-50%)**	**Viva-Voce (Marks-30%)**	
-	**12**	**–**	**06**	**30**	**75**	**45**	

Learning Objectives:

1. To understand and discuss the new research topics in the field of chemistry.
2. To display, organize and represent correlation between different types of data.
3. To summarize and provide a concise summary of research projects carried out.
4. Demonstrate a capacity to communicate research results clearly and comprehensively.
5. Ability to demonstrate oral/poster presentation.

Course Outcomes:

At the end of the Course student will be able to-

CO1- work and explain key research concepts and issues.

CO2- develop different experimental skills required for research.

CO3- read, comprehend and anticipate the solution of research problems in their project work.

CO4- analyze data critically and validate its applications.

CO5- Equip themselves with ethical issues related to Research and Publication.

CO6- communicate research findings in written and verbal forms.

CO7- develop a strong foundation for future research work in a systematic manner by applying notions of Research Methodology.

Detailed Syllabus: Project, Research Project

Course Code- WSCHARP641	**Research Project**	**06 Credits**
	1. Students should carry out a detailed research project. 2. This should make them familiar with i. Literature survey, research methodologies ii. Data Analysis iii. characterization techniques 3. Project report must be written and submitted in a proper format as follows; i)Certificate (Signed by Project guide and Head of the Department) ii) Certificates for Poster/Paper presented in conferences (if any) iii) Self declaration certificate for plagiarism iv) Introduction (not more than 6 pages) v) Experimental Section vi) Results and Discussions vii) Conclusion viii) References (Use ACS format) ix) Spectroscopic or other relevant supporting data x) Acknowledgement 4. Interdisciplinary projects shall be encouraged 5. Students should spend enough time for the project works (at least 12 hours per week) 6. If a student is performing a project in another institute, for such a student, an internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case a student has to obtain a certificate from both external and internal mentors. 7. Systematic record of attendance of project students must be maintained by a mentor. 8.Project will be evaluated jointly by three examiners. 9. Astudent has to present his practical work, discuss results and conclusions in detail which will be followed by a question-answer session . 10. It is an open type of examination.	

Modality of Assessment (4 credit)

Theory Examination Pattern:

A. Internal Assessment- 40%- 40 Marks per paper

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**20**
	Total	**40**

B. External Examination- 60%- 60 Marks pepaper Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
    a. There shall be 05 questions each of 15 marks on each unit.
    b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I
Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	Sub Questions: 3A. 2 out of 4 3B. 1 out of 2	12	Unit III

Q.4	Sub Questions: 4A. 2 out of 4 4B. 1 out of 2	12	Unit IV
Q.5	4 out of 8	12	Units (I+II+III+IV)
	TOTAL	**60**	

Modality of Assessment (2 credit)

Theory Examination Pattern:

C. Internal Assessment- 40%- 20 Marks per paper

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**10**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**10**
	Total	**20**

D. External Examination- 60%- 30 marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **One hour** duration.
2. Theory question paper pattern:
   a. There shall be 03 questions each of 15 marks on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I

Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	2 out of 4	06	Units (I+II)
	TOTAL	**30**	

Practical Examination Pattern:

A. Internal Examination: 40%

Particulars	**Mandatory Practical (4 credit)**	**Elective Practical (2 credit)**
Journal	10	05
Experimental tasks	20	10
Participation	10	05
Total	**40**	**20**

B. External Examination: 60%
Semester End Practical Examination:

Particulars	**Mandatory Practical (4 credit)**	**Elective Practical (2 credit)**
Laboratory work	50	25
Viva	10	05
Total	**60**	**30**

Research Project Evaluation

Semester III (4 Credit)			**Semester IV (6 Credit)**		
Log book (Marks-30%)	**Report (Marks-30%)**	**Viva-Voce (Marks-40%)**	**Log book (Marks-30%)**	**Report (Marks-30%)**	**Via-Voce (Marks-40%)**
30 Marks	30 Marks	40 Marks	45 Marks	45 Marks	60 Marks

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.