SOPHIA COLLEGE FOR WOMEN, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: CHEMISTRY

Programme Code: SMSCHE

M.Sc. Part II

(Choice Based Credit System with effect from the year 2020-21)

Programme Outline: MSc (SEMESTER III)

Course Code	Unit No	Name of the Unit	Credits
SMSCHE301		QUALITY IN ANALYTICAL CHEMISTRY	4
	1	Quality in Analytical Chemistry – I	
	2	Quality in Analytical Chemistry – II	
	3	Chromatographic Techniques - I	
	4	Chromatographic Techniques - II	
SMSCHE302		ADVANCED INSTRUMENTAL TECHNIQUES	4
	1	Spectral Methods – I	
	2	Spectral Methods - II	
	3	Electroanalytical Techniques	
	4	Miscellaneous Techniques	
SMSCHE303		BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS	4
	1	Bioanalytical Chemistry	
	2	Immunological methods	
	3	Food Analysis – I	
	4	Food Analysis – II	
SMSCHE304		ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS	4
	1	Air Pollution	
	2	Water Quality Standards	
	3	Other types of Pollution	
	4	Industrial Methods	
SMSCHEP301		QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP A)	2
SMSCHEP302		ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL (GROUP B)	2
SMSCHEP303		BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS PRACTICAL (GROUP C)	2
SMSCHEP304		ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS PRACTICAL (GROUP D)	2

Programme Outline: MSc (SEMESTER IV)

Course Code	Unit No	Name of the Unit	Credits
SMSCHE401		QUALITY IN ANALYTICAL CHEMISTRY	4
	1	Separation Science	
	2	Separation, Analysis and Standardization of Herbal Products	
	3	Green Chemistry	
	4	Chromatographic Techniques – III	
SMSCHE402		ADVANCED INSTRUMENTAL TECHNIQUES	4
	1	Spectral Methods – III	
	2	Spectral Methods – IV	
	3	Radiochemical and Thermal methods	
	4	Hyphenated Techniques	
SMSCHE403		SELECTED TOPICS IN ANALYTICAL CHEMISTRY	4
	1	Effluent treatment	
	2	Solid Waste Management	
	3	Plastics and Polymers	
	4	Metallurgy	
SMSCHE404		INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS	4
	1	Introduction to Intellectual Property	
	2	Trade Agreements	
	3	Introduction to Cheminformatics	
	4	Applications of Cheminformatics	
SMSCHEP401		QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP A)	2
SMSCHEP402		ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL (GROUP B)	2
SMSCHEP403		SELECTED TOPICS IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP C)	2
SMSCHEP404		PROJECT WORK (GROUP D)	2

Preamble:

Programme: MSc-Analytical Chemistry

The M.Sc. Programme in Analytical chemistry was started under the affiliation of Mumbai University and is now brought under Autonomy. Although the same syllabus has been retained with minor modifications structural changes are incorporated to suit the credit system under autonomy.

The objective of the M.Sc. Analytical Chemistry programme is to provide a comprehensive and in-depth understanding of the fascinating world of Analytical Chemistry. The M.Sc. Programme in Analytical

Chemistry combines core and elective theory courses as well as practical courses and independent research guided by an experienced researcher from the department/industry or a national institute. Through a rigorous academic curriculum, industry training and hands-on research experience, we aim to nurture the intellectual curiosity and scientific acumen of our students, preparing them for successful careers in various sectors of the chemical sciences. On completing the programme, the students will be able to analyze and provide practical solutions to the problems within the broad/specialized field of analytical chemistry.

Our esteemed faculty members with expertise in their respective fields and with a passion for both teaching and research are committed to providing a learning environment, encouraging open discussions, and fostering collaborative research endeavors. Through their mentorship, students will have the opportunity to engage in cutting-edge research projects, pushing the boundaries of scientific knowledge and contributing to the advancement of the chemical sciences. We envision our M.Sc. (Analytical Chemistry) postgraduates act as catalysts for positive change, equipped to drive innovation, shape industries, and address societal challenges through their expertise in chemistry.

PROGRAMME OBJECTIVES

PO 1	To provide students with theoretical and applied knowledge in the interdisciplinary branches of chemistry with emphasis on qualitative and quantitative analysis.
PO 2	To expose the students to the advanced instrumental analysis through hands-on training, internships and research to make them job ready.
PO 3	To train students to address the environmental and societal issues and face the real life challenges more effectively.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	**Critical thinking:** A student with a Master's degree in Analytical chemistry will have an in- depth theoretical and practical knowledge of the subject which will foster their critical thinking.
PSO 2	**Skills in research and industrial field:** Students will build a scientific temper through research, develop entrepreneurial skill and will get an exposure to work in an industrial set up.
PSO 3	**Personality Development:** The students will be able to handle personal, social, environmental issues and will be responsible citizens.

SEMESTER 3

NAME OF THE COURSE	QUALITY IN ANALYTICAL CHEMISTRY	
CLASS	MSC	
COURSE CODE	SMSCHE301	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand various methods of sampling and criteria for method validation.
CO 2.	To understand the principle, instrumentation and applications of different chromatographic techniques.
CO 3.	To understand the different methods used to reduce signal to noise ratio
CO 4	To introduce the concept of regulatory affairs in drug pharmaceuticals and laboratory maintenance.

COURSE LEARNING OUTCOMES:

CLO 1.	Explain dissolution technology and methods of sampling and storage.
CLO 2.	Interpret the results and improve the quality of results
CLO 3	Describe methods used to reduce signal to noise ratio.
CLO 4	Explain supercritical fluid chromatography, affinity chromatography and ion-exchange in detail with applications.

UNIT 1	**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.	8L
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
UNIT 2	**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.	5L
UNIT 3	**CHROMATOGRAPHIC TECHNIQUES –I**	**15L**
3.1	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
3.2	Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications.	2L
3.3	Exclusion chromatography : Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers	5L
UNIT 4	**CHROMATOGRAPHIC TECHNIQUES –II**	**15L**
4.1	Supercritical fluid Chromatography: Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis.	8L
4.2	Affinity Chromatography: principle, instrumentation and applications	4L
4.3	Optimum pressure liquid chromatography (OPLC)	3L

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

6. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication.
7. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
8. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
9. Analytical Chemistry, G. D. Christian, Wiley
10. Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978.
11. Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996
12. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2nd edition 1963
13. Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976
14. Chromatographic and electrophoretic techniques I Smith Menemann Interscience 1960

NAME OF THE COURSE	QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To acquaint learners with spectroscopic techniques
CO 2.	To be acquainted with separation techniques
CO 3.	To familiarize students with the SOPs and train them in handling

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the knowledge to decide the most appropriate method of analysis based on requirements.
CLO 2.	Use technical skills to work with various instruments

	QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP A)	
	1.Determination of the pK value of an indicator. 2. Determination of copper and bismuth in mixture by photometric titration. 3. Estimation of strong acid, weak acid and salt in the given mixture conductometrically.	

	4. Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pHmetry. 5. Determination of copper by extractive photometry using diethyldithiocarbamate.	

REFERENCES:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES	
CLASS	MSC	
COURSE CODE	SMSCHE302	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the principles and instrumentation of the spectral methods
CO 2.	To understand the applications of the techniques discussed
CO 3.	To understand the concepts of the different techniques i.e. spectroscopic/electro-analytical.

COURSE LEARNING OUTCOMES:

CLO 1.	Differentiate and identify the appropriate technique of analysis for a sample.
CLO 2.	Interpret the esr/ mossbauer spectrum.
CLO 3.	Solve numericals based on the topics covered

UNIT 1	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. B) Particle-Induced X-Ray Emission C) Low-Energy Ion Scattering and Rutherford Backscattering	 4L 5L 5L
UNIT 2	**SPECTRAL METHODS- II**	**15L**
	Principle, Instrumentation, and Applications of: A) Electron Spin Resonance Spectroscopy (ESR) B) Mossbauer's Spectroscopy C) Atomic Emission Spectroscopy- based on plasma and electrical discharge sources.	 5L 5L 5L
UNIT 3	**ELECTROANALYTICAL TECHNIQUES**	**15L**
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- Chronoamperometry	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-micro electrodes in voltammetry	3L
UNIT 4	**MISCELLANEOUS TECHNIQUES**	**15L**
 4.1 4.2 4.3 4.4	Principle, Instrumentation and Applications: Chemiluminescence techniques Chiroptical Methods: ORD, CD Photoacoustic spectroscopy Spectroelectrochemistry	3L 5L 3L 4L

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: 978-0-470-01763-0
17. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP302	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To acquaint learners with spectroscopic techniques
CO 2.	To be acquainted with separation techniques

CO 3.	To learn how to analyse drug and cosmetic samples
CO 4.	To familiarize students with the SOPs and train them in handling

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the knowledge to decide the most appropriate method of analysis based on requirements.
CLO 2.	Use technical skills to work with various instruments

	ADVANCED ANALYTICAL PRACTICAL	
	1. Estimation of drugs by non aqueous titration: Pyridoxine hydrochloride, Mebendazole. 2. Determination of percentage purity of methylene blue indicator. 3. Estimation of cholesterol and Uric acid in the given sample of blood serum 4. Estimation of fluoride in a tooth paste. 5. Determination of silica by molybdenum blue method.	

REFERENCES:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.

NAME OF THE COURSE	BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS	
CLASS	MSC	
COURSE CODE	SMSCHE303	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the application of analytical chemistry in the chemical and biological fields
CO 2.	To understand immunological methods and food analysis using a variety of experimental techniques
CO 3.	To introduce quality assessment of dairy products and species

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the knowledge for estimating dairy products
CLO 2.	Differentiate and identify the techniques of analysis
CLO 3.	Explain the principle of methods used for the analysis of biological sample, food and food additives.

UNIT 1	**BIOANALYTICAL CHEMISTRY**	**15L**
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
1.2	Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals.	5L
1.3	Analytical techniques (including microbiological techniques) for vitamins.	5L
UNIT 2	**IMMUNOLOGICAL METHODS**	**15L**
2.1	General processes of immune response, antigen antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.	8L
2.2	Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.	7L
UNIT 3	**FOOD ANALYSIS – I**	**15L**
3.1	Fuel value of food and importance of food nutrients.	2L
3.2	Food Additives – General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colors, 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 4	**FOOD ANALYSIS – II**	**15L**

4.1	Food packaging – Introduction, types of packing materials, properties and industrial requirements.	2L
4.2	Processing and Quality requirements of Milk and milk products (cheese, butter and ice cream), vegetables and fruits, meat and meat products.	6L
4.3	Analysis of Milk – Fat content, proteins, acidity, bacteriological quality and milk adulterants.	2L
4.1.4	Analysis of Oils and Fats – acid value, sap value, iodine value, determination of rancidity and antioxidants.	2L
4.1.5	Analysis of spices (cloves, cinnamon, pepper, mustard), determination of volatile oils and fixed oils.	3L

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

NAME OF THE COURSE	BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP303	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To acquaint learners with spectroscopic techniques
CO 2.	To be acquainted with separation techniques

CO 3.	To learn how to analyse drug and cosmetic samples
CO 4.	To familiarize students with the SOPs and train them in handling

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the knowledge to decide the most appropriate method of analysis based on requirements.
CLO 2.	Use technical skills to work with various instruments

	BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS PRACTICAL (GROUP C)	
	Total reducing sugars before and after inversion in honey using: (a)Cole's Ferricyanide (b) Lane - Eynon method. 2. Analysis of lactose in milk 3. Estimation of Caffeine in tea 4. Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method 5. Iodine value of oil / fat 6. Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation.	

REFERENCES:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.

NAME OF THE COURSE	ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIALS	
CLASS	MSC	
COURSE CODE	SMSCHE304	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To introduce learners to different types of pollution, analysis of pollutants and environmental laws and regulations.
CO 2.	To provide them with a scientific background for understanding environmental problems, monitoring and controlling the pollution
CO 3.	To understand the application of analytical chemistry from the perspective of pharma

COURSE LEARNING OUTCOMES:

CLO 1.	Interpret quality parameters, Environmental regulations with reference to air, soil and water.
CLO 2.	Apply Sampling techniques and analyses of various environmental material
CLO 3.	Analyse various industrial and pharmaceutical materials

UNIT 1	**AIR POLLUTION**	**15L**
1.1	Sources, classification, pollutants and permissible limits.	2L
1.2	Sampling methods for air, flue gas ,Industrial Exhaust, stag samples etc.	2L
1.3	Importance of automobile exhaust control and its limits	2L
1.4	Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors.	3L
1.5	Carbon credit and global issues related to air pollution.	3L
1.6	Greenhouse gases and their substitutes.	1L
1.5	Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC.	2L
UNIT 2	**WATER QUALITY STANDARDS**	15L
2.1	Water: quality and requirements of potable water, direct and indirect pollutants in potable water reservoirs, quality of potable water from natural sources.	6L
2.2	Bore well water quality and analytical parameters. Quality of bottled mineral water	3L
2.3	Process of purification of bore well water to bottled mineral water	2L
2.4	Regulatory requirements for packaged drinking water	4L
UNIT 3	**OTHER TYPES OF POLLUTION**	**15L**

3.1	Soil pollution and Soil Analysis : sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long term effect on soil quality.	6L
3.2	Noise Pollution : sources, effects, methods of measurements and control measures.	2L
3.3	Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy.	3L
3.4	Radioactive pollutants: source, exposure hazards, precautions in handling and safety, Long term effects.	2L
3.5	Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification	2L
UNIT 4	**INDUSTRIAL METHODS**	**15L**
4.1	Insecticides, Pesticides: definition, classification of insecticides, pesticides. Biodegradation of insecticides and pesticides	5L
4.2	Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents	5L
4.3	Petrochemical products: crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, corrosion test, carbon residue and impact on environment	5L

REFERENCES

1. Environmental Chemistry, A. K. De, 2nd ED. Wiley (1989).
2. Environmental Pollution Analysis, S. M. Khopkar, John Wiely (1993).
3. Air Pollution Sampling And Analysis, Sharad Gokhale, IIT Guwahati, May 2009.
4. Environmental Pollution Analysis, S. M. Khopkar, New Age International publication (2011).

5. Water And Water Pollution (hand book) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N.York(1972)

6. Water pollution, Arvind kumar, APH publishing (2004)

7. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
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9. Soil pollution, S.G. Misra and Dinesh Mani, APH Publishing Corporation, (2009).
10. Soil Pollution: origin, monitoring and remediation, Abrahim Mirsal, Springer (2010).
11. Noise Pollution, Donald F Anthrop, Lexington Books, (1973)

12. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise (1981) Available at NCL laboratories e- Library.
13. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).

14. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication , (2003).

15. Environmental law in India, Mohammad Naseem, Wolters Kluwer.

16. Environmental Protection, Law And Policy In *India* Kailash Thakur google books (1997). 17. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002)

18. Pesticide Analysis Ed K. G. Das, Dekker (1981)

19. Analytical, Agricultural Chemistry S. L Chpra J.S Kanwar Kalyani publication

20. Soil and plant Analysis C.S Piper , Hans Publication

NAME OF THE COURSE	PHARMACEUTICAL AND ORGANIC ANALYSIS	
CLASS	MSC	
COURSE CODE	SMSCHE304	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the application of analytical chemistry from the perspective of pharma
CO 2.	To understand the applications of analytical techniques in Forensic Chemistry

COURSE LEARNING OUTCOMES:

CLO 1.	Analyse various industrial and pharmaceutical materials
CLO 2.	Apply the knowledge in the field of forensic chemistry

UNIT 1	PHARMACEUTICAL ANALYSIS	15L
1.1	General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations,	7L

	classification of dosage forms. Role of FDA in pharmaceutical industries.	
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 2	**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	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.	7L
UNIT 3	**OTHER TYPES OF POLLUTION**	**15L**
3.1	Analytical Chemistry in Forensic Science: General idea.	2L
3.2	Forensic Analysis: Blood, DNA profiling, Hair analysis, Alcohol in body fluids, systematic drug identification.	5L
3.3 3.3.1 3.3.2 3.3.3 3.3.4 3.3.5 3.3.6	Analytical Toxicology: Isolation, identification and determination of: Narcotics: Heroin, morphine and cocaine. Stimulants: Amphetamines and caffeine. Depressants: Benzodiazepines, Barbiturates and Mandrax. Hallucinogens: LSD and Cannabis. Metabolites of drugs in blood and urine of addicts. Viscera, stomach wash, vomit and postmortem blood for poisons like – cyanide, arsenic, mercury, insecticides and pesticides.	8L
UNIT 4	**COSMETIC ANALYSIS**	**15L**
4.1	Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis.	2L
4.2	Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.	2L
4.3	Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).	3L

4.4	Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers	
4.5	Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy)	
4.6	Lipsticks: General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents.	

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2. Bioanalytical Chemistry, Susan R Mikkelesen and Eduardo Cotton, John Wiley and Sons, 2004.
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5. Formulation and Function of Cosmetics, Joseph Stefan Jellinek, Wiley Interscience, 1971.
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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.
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13. Food Processing and Preservation, B Sivasankar, Prentice - Hall of India Private Limited, 2007.
14. Food Additives, R M Pandey and S K Upadhyay, INTECH, Open Science/Open Minds.
15. Food Science, B Srilakshmi, New Age International (P) Ltd. Publishers, 2003.
16. Food Contaminants: Sources and Surveillance, Edited by C Creaser, R Purchase, Elseiver, 1991.
17. The Chemical Analysis of Food and Food Products, Morris B Jacobs.
18. 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.
19. Fundamentals of Urine and Body Fluid Analysis, Nancy A Brunzel, Elsevier health Sciences, 2013.
20. Lab Manual on Blood analysis and Medical Diagnostics, Dr Gayatri Prakash, S Chand and Company Ltd, New Delhi.
21. Manual of Medical Laboratory Techniques, S Ramakrishnan and K N Sulochana, Jaypee BrothersMedical Publishers (P) Ltd, 2012.
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24. Forensic Chemistry, David E Newton, Infobase Publishing, 2007.

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AOAC Volume I and II.

NAME OF THE COURSE	PHARMACEUTICAL AND ORGANIC ANALYSIS PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP304	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To acquaint learners with spectroscopic techniques
CO 2.	To learn how to check the purity of various samples
CO 3.	To familiarize students with the SOPs and train them in handling
CO 4.	To acquaint learners with spectroscopic techniques

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the knowledge to decide the most appropriate method of analysis based on requirements.
CLO 2.	Use technical skills to work with various instruments

	ANALYTICAL CHEMISTRY PRACTICAL	
	1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry. 2. To analyze Magnelium for Mg by complexometry. 3. Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry) 4. Analysis of water sample: Total hardness and salinity. 5. Analysis of water sample: Acidity and sulphate(Benzidine method).	

REFERENCES:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.

5. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",PartII,4thEd.,A Wiley InterscicencePublication,New York,1978.

SEMESTER 4

NAME OF THE COURSE	QUALITY IN ANALYTICAL CHEMISTRY	
CLASS	MSC	
COURSE CODE	SMSCHE401	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand various methods of separation used in pre-treatment of samples.
CO 2.	To introduce analysis of herbal based products and their standardizations
CO 3.	To emphasize the importance of Green Chemistry.
CO 4	To understand the principle, instrumentation and applications of selective chromatographic techniques

COURSE LEARNING OUTCOMES:

CLO 1.	Explain in detail the application of solvent extraction in analytical chemistry
CLO 2.	Describe qualitative and quantitative estimations of herbal based formulations and interpret the results.
CLO 3	Identify and use green reactions/synthesis in future.
CLO 4	Discuss analytical techniques in nanotechnology and selective chromatographic techniques

UNIT 1	**SEPARATION SCIENCE**	**15L**
1.1	Membrane separation processes: operating principles and applications of microfiltration, ultrafiltration, reverse osmosis, dialysis and electro-dialysis.	8L
1.2	Applications of solvent extraction in Analytical Chemistry. Recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry,	7L

	solvent extraction in sample preparation and pre-treatment steps, solvent extraction as a means of analytical determination.	
UNIT 2	**SEPARATION, ANALYSIS AND STANDARDIZATION OF HERBAL BASED PRODUCTS**	**15L**
2.1	Herbs as a raw material: Definition of herb, herbal medicine, herbal medicinal products, herbal drug preparation, sources of herbs, selection, identification and authentication of herbal materials, drying and processing of herbal raw materials.	6L
2.2	Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.	3L
2.3	Standardization of herbal formulation and herbal extracts: Standardization of herbal extracts as per WHO cGMP guidelines, Physical, Chemical and Spectral and toxicological standardization, qualitative and quantitative estimations.	6L
UNIT 3	**GREEN CHEMISTRY**	**15L**
3.1	Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity	4L
3.2	Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents	4L
3.3	Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis	4L
3.4	Designing Greener Processes: Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring.	3L
UNIT 4	**CHROMATOGRAPHIC TECHNIQUES –II**	**15L**
4.1	Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers)	2L
4.2	Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis and miceller electrokinetic capillary chromatography, instrumentation, detection and applications.	8L
4.3	Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, electronic structure, optical properties) one dimensional nanomaterials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots).	5L

REFERENCES:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
4. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
5. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
6. Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978.
7. Supercritical fluid extraction, Larry Taylor Wiley publishers N.Y. 1996
8. Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963
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10. Chromatographic and electrophoresis techniques, I Smith Menemann Interscience 1960
11. Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH verlag GmBH & co.
12. Sustainable residential development: planning and design for green neighborhoods. Avi Friedman, McGraw Hill professional

NAME OF THE COURSE	QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP301	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To learn treatment ore/alloy samples and determine its constituent metals quantitatively
CO 2.	To familiarize students with the SOPs and train them in handling various instruments.

COURSE LEARNING OUTCOMES:

CLO 1.	To enable to apply the knowledge and choose an appropriate method for analysis based on requirements
CLO 2.	Learners will be equipped with technical skills to work with various instruments.

	QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP A)	
	1. Determination of pK value of H_3PO_4 potentimetrically 2. Estimation of Na+ in dairy whitener by flame photometry 3. Spectrophotometric determination of pH of buffer solution. 4. Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method 5. To analyze Bronze for Zn by complexometric method	

REFERENCES:

Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education

Standard methods of chemical analysis, F. J. Welcher

Standard Instrumental Methods of Chemical Analysis, F. J. Welcher

W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.

E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",PartII,4thEd.,A Wiley InterscienceePublication,New York,1978.

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES	
CLASS	MSC	
COURSE CODE	SMSCHE402	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the principles and instrumentation of the spectral methods
CO 2.	To understand the applications of the techniques discussed
CO 3.	To understand the concepts of the different techniques i.e. spectroscopic/electro-analytical.

COURSE LEARNING OUTCOMES:

CLO 1.	Differentiate and identify the appropriate technique of analysis for a

	sample.
CLO 2.	Interpret the esr/ mossbauer spectrum.
CLO 3.	Solve numericals based on the topics covered

UNIT 1	SPECTRAL METHODS- III	15L
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 2	**SPECTRAL METHODS- II**	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 3	**RADIOCHEMICAL AND THERMAL METHODS**	**15L**
3.1	Activation analysis- NAA ,radiometric titrations and radio-release methods	7L
3.2	Thermal analysis- Principle, Interfacing, instrumentation and Applications of (a)Simultaneous Thermal Analysis- TG-DTA and TG-DSC (b) Evolved gas analysis- TG-MS and TG-FTIR	8L
UNIT 4	**HYPHENATED TECHNIQUES**	**15L**
4.1	Concept of hyphenation, need for hyphenation, possible hyphenations.	2L
4.2	Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS.	13L

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 (1998)
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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, 3rd Edition W. W. Wendlandt, John Wiley, N.Y. (1986) nd

7. Principles and Practices of X-ray spectrometric Analysis, 2 Ed E. P. Bertain, Plenum Press, NY, (1975)
8. Nuclear Analytical Chemistry, D. Bane, B. Forkman, B. Persson, Chartwell - Bratt Ltd (1984)
9. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, A series of volumes
10. A Complete Introduction to Modern NMR Spectroscopy 1st Edition by Roger S. Macomber
11. Spectrometric Identification of Organic Compounds Hardcover – by Robert M.Silverstein Wiley
12. Tandem Techniques (Separation Science Series) 1st Edition by Raymond P. W. Scott John Wiley & Sons Ltd, 1997
13. Encyclopedia of Analytical Science, Editors-in-Chief: Paul Worsfold, Alan Townshend, and Colin Poole ISBN: 978-0-12-369397-6
14. Encyclopedia of Analytical Chemistry: Applications, Theory, and Instrumentation. Meyers Robert A Meyers
15. Introduction to Thermal Analysis Techniques and Applications Edited by Michael E. Brown
16. Principles and Applications of Thermal Analysis Edited by Paul Gabbott

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP402	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO 1.	To learn to analyse drug samples
CO 2.	To familiarize students with the SOPs and train them in handling various instruments.

COURSE LEARNING OUTCOMES:

CLO 1.	To enable to apply the knowledge and choose an appropriate method for analysis based on requirements
CLO 2.	Learners will be equipped with technical skills to work with various instruments.

	ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL (GROUP B)	
	1. Analysis of drugs by non aqueous titration: Glycine , Sodium Benzoate 2. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity 3. Determination of the purity of crystal violet 4. Estimation of Ca in Ca-pantothenate/calcium lactate tablets 5. Canned food: Limits test for tin/zinc	

REFERENCE:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.
5. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",PartII,4thEd.,A Wiley InterscienceePublication,New York,1978.

NAME OF THE COURSE	SELECTED TOPICS IN ANALYTICAL CHEMISTRY	
CLASS	MSC	
COURSE CODE	SMSCHE403	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To impart knowledge of effluent treatments and recovery of metals from effluents, recycling and reuse of effluent water.
CO 2.	To impart knowledge of solid waste management
CO 3.	To understand the applications of analytical techniques in analysis of polymers, paints and pigments and metallurgy

COURSE LEARNING OUTCOMES:

CLO 1.	Apply the concepts of waste management in day to day life
CLO 2.	Analyze and apply the appropriate methods of analysis for polymers, paints, ores and alloys.

UNIT 1	**EFFLUENT TREATMENT**	**15L**
1.1	Effluent treatment plant general construction and process flow charts	3L
1.2	Treatment and disposal of Sewage.	3L
1.3	Effluent parameters for metallurgical industry.	2L
1.4	Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent.	2L
1.5	Recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange etc.	3L
1.6	Recycle and reuse of process and treated (effluent) water	2L
UNIT 2	**SOLID WASTE MANAGEMENT**	**15L**
2.1	Solid waste management: objectives, concept of recycle, reuse and recovery	3L
2.2	Methods of solid waste disposal.	2L
2.3	Treatment and disposal of sludge / dry cake	3L
2.4	Managing non-decomposable solid wastes	2L
2.5	Bio- medical waste : Introduction , Classification and methods of disposal	5L
UNIT 3	**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 the environment as a pollutant.	2L
3.4	Paints and pigments: Types of paints and pigments, determination of volatile and non - volatile components, Flash point (significance and method of determination), separation and analysis of pigments, binders and thinners.	2L
3.5	Role of Organo silicones in paints and their impact on the environment.	5L
UNIT 4	**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, Magnelium, 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

REFERENCES:

1. Environmental Pollution Analysis, S. M. khopkar, New Age International publication (2011).
2. Water and water pollution (hand book) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N.Y.(1972)
3. Water pollution, Arvind kumar, APH publishing (2004)
4. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
5. Solid waste management, K Sasikumar and Sanoop Gopi Krishna PHI publication (2009)
6. Solid waste management, Surendrakumar Northen Book Center (2009)rd
7. Handbook of chemical technology and pollution control 3 Edn Martin Hocking AP Publication (2005).
8. Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005
9. Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
10. 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.
11. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
12. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology & Engineering (1960).

NAME OF THE COURSE	BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS PRACTICAL	
CLASS	MSC	
COURSE CODE	SMSCHEP403	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

COURSE OBJECTIVES:

CO1	To learn analysis of various food and water samples qualitatively and quantitatively
CO2	To familiarize students with the SOPs and train them in handling various instruments.

COURSE LEARNING OUTCOMES

CLO1	To enable learners to analyse commercial samples .
CLO2	To enable to apply the knowledge and choose an appropriate method for analysis based on requirements
CLO3	Learners will be equipped with technical skills to work with various instruments.

	SELECTED TOPICS IN ANALYTICAL CHEMISTRY PRACTICAL (GROUP C)	
	1. Analysis of Calcium, Iron and phosphorous in milk. 2. Determination of SAP value of oil. 3. Estimation of Aldehyde in lemon grass oil / Cinnamon oil 4. Estimation of Glucose by Folin-Wu method 5. Analysis of water sample : Mn^{2+} by colorimetric method	

REFERENCES:

1. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearson education
2. Standard methods of chemical analysis, F. J. Welcher
3. Standard Instrumental Methods of Chemical Analysis, F. J. Welcher
4. W.W.Scott."Standard methods of Chemical Analysis",Vol.I, Van Nostrand Company,Inc.,1939.
5. E.B.Sandell and H.Onishi,"Spectrophotometric Determination of Traces of Metals",PartII,4thEd.,A Wiley IntersciencePublication,New York,1978.

NAME OF THE COURSE	**INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS**
CLASS	MSC
COURSE CODE	SMSCHE404
NUMBER OF CREDITS	4
NUMBER OF LECTURES PER WEEK	4

TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To achieve a common understanding of IPR laws in India and its economic value.
CO 2.	To encourage innovation at the college level and encourage the filing of patents
CO 3.	To provide a basic introduction to fundamentals and applications of cheminformatics
CO 4.	Introduce students to python, RPi, IoT to understand working of IoT controlled sensors

COURSE LEARNING OUTCOMES:

CLO1	It will bridge the gap between industry and academia and facilitate technology transfer.
CLO2	Understanding IP issues around knowledge transfer can help get discoveries from the lab to the marketplace.
CLO3	Explain basic concepts of cheminformatics and will be able to implement computation of molecular descriptors and chemical similarity.
CLO4	Use Python for understanding cheminformatics software, IoT, Design various application based experiments using sensors

UNIT 1	**INTRODUCTION TO INTELLECTUAL PROPERTY**	**15L**
1.1	Historical Perspective, Different types of IP, Importance of protecting IP.	2L
1.2	Patents: 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.	5L
1.3	Industrial Designs:Definition, How to obtain, features, International design registration.	2L
1.4	Copyrights:Introduction, How to obtain, Differences from Patents.	2L
1.5	Trademarks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc.	2L
1.6	Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.	2L

UNIT 2	TRADE AGREEMENTS	15L
2.1	Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.	2L
2.2	IP Infringement issue and enforcement: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc.	2L
2.3	Economic Value of Intellectual Property: Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer.	2L
2.4 2.4.1 2.4.2	Different International agreements: World Trade Organization (WTO): i)General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement. ii) General Agreement on Trade Related Services (GATS) Madrid Protocol. iii) Berne Convention iv) Budapest Treaty Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity.	11L
UNIT 3	**INTRODUCTION TO CHEMINFORMATICS**	**15L**
3.1	History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation.	5L
3.2	Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.	5L
3.3	Searching Chemical Structures: Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	5L
UNIT 4	**APPLICATIONS OF CHEMINFORMATICS**	**15L**
	Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries,	

	Ligandbased and Structure based Drug design, Application of Cheminformatics in Drug Design.	

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
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NAME OF THE COURSE	**RESEARCH METHODOLOGY**	
CLASS	MSC	
COURSE CODE	SMSCHE404	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	Understanding the purpose of different types of research.
CO 2.	Understand the importance of research ethics
CO 3.	Learn to communicate research findings in an appropriate manner

COURSE LEARNING OUTCOMES:

CLO 1.	Explainkey concepts and principles of research
CLO 2.	Present research findings effectively in an appropriate format.
CLO 3.	Analyse and interpret data using appropriate statistical treatment.

UNIT 1	**RESEARCH METHODOLOGY**	**15L**
1.1	Print: Primary, Secondary and Tertiary sources	7L
1.2	Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.	4L
1.3	Digital Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet,	4L

	E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus.	
1.4	Information Technology and Library Resources: The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	
UNIT 2	**DATA ANALYSIS**	15L
2.1	The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments.	8L
2.2	Analysis and Presentation of Data: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	7L
UNIT 3	**METHODS OF SCIENTIFIC RESEARCH AND WRITING SCIENTIFIC PAPERS**	**15L**
3.1	Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.	2L
3.2	Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	5L
UNIT 4	**CHEMICAL SAFETY & ETHICAL HANDLING OF CHEMICALS**	**15L**
	Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressur, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**2L**

REFERENCES

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), *Practical skills in Chemistry,* 2nd Ed., Prentice Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data Analysis for Chemistry* Oxford University Press.

3. Topping, J., (1984) *Errors of Observation and their Treatment* 4th Ed., Chapman Hill, London.
4. Harris, D. C. (2007) *Quantative Chemical Analysis* 6th Ed., Freeman Chapters 3-5
5. Levie, R. De. (2001) *How to use Excel in Analytical Chemistryand in general scientific data analysis* Cambridge Universty Press.
6. Chemical Safety matters – IUPAC-IPCS, (1992) Cambridge University Press. OSU Safety manual 1.01

NAME OF THE COURSE	PROJECT WORK	
CLASS	MSC	
COURSE CODE	SMSCHEP404	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	INTERNAL ASSESSMENT	SEMESTER END EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS		20

ASSESSMENT DETAILS:(this will be same for all the theory papers)

Internal Assessment (50 marks)

Part 1: Project Work (**40 Marks**)

- At the beginning of the semester, students should be assigned project topics drawn from Unit 1 to Unit 4.
- Students work individually.
- Project Marks will be divided as written submission:15 Marks; Presentation, content & Viva: 15 marks; 10 Marks for active participation)

2. Two tests of 10 Marks was conducted and average of the marks was considered

Semester End Examination – External Assessment (50 marks)

Semester III
Online Examination
Pattern: MCQ for 30 marks
The test paper will consist of 1 and 2 mark questions equal distribution from all units
Subjective type for 20 marks.
One 5M question from each of the 4 units

Semester IV
Online Examination
Pattern: MCQ for 50 marks

The test paper will consist of 1 and 2 mark questions equal distribution from all units

Practical Assessment (for papers with practicals)

Practical examination of each paper for 50 marks will be held for three and half hours

Practical	40M
Journal	5M
Viva-voce	5M
Total	50M