



**SOPHIA COLLEGE FOR WOMEN,  
(EMPOWERED AUTONOMOUS)**

Affiliated to

**UNIVERSITY OF MUMBAI**

Programme: Science

Programme Code: SCHE6

MSc-Part II

(Syllabus for the Academic Year 2024-2025  
based on the National Education Policy 2020)

**Programme Outline: MSc (SEMESTER III)**

Course Code	Unit No	Name of the Unit	Credits
SCHE635MJ		QUALITY IN ANALYTICAL CHEMISTRY	4
	1	Quality in Analytical Chemistry	
	2	Chromatographic Techniques - I	
	3	Chromatographic Techniques - II	
	4	Pharmaceutical Chemistry	
SCHE636MJ		ADVANCED INSTRUMENTAL TECHNIQUES	4
	1	Spectral Methods – I	
	2	Spectral Methods - II	
	3	Electroanalytical Techniques	
	4	Industrially Important materials	
SCHE635MJP		QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL	2
SCHE636MJP		ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL	2
SCHE633E		BIOANALYTICAL CHEMISTRY	2
	1	Bioanalytical Chemistry and Immunological methods	
	2	Food Analysis	
SCHE633EP		BIOANALYTICAL CHEMISTRY PRACTICAL	2
SCHE631RP		Research Project	4

**Programme Outline: MSc (SEMESTER IV)**

Course Code	Unit No	Name of the Unit	Credits
SCHEP647MJ		ADVANCED INSTRUMENTAL TECHNIQUES	4
	1	Separation Science	
	2	Chromatographic Techniques – III	
	3	Spectral Methods-III	
	4	Radiochemical and Hyphenated Techniques	
SCHE648MJ		INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS	4
	1	Introduction to Intellectual Property	
	2	Trade Agreements	
	3	Introduction to Cheminformatics	
	4	Applications of Cheminformatics	
SCHE647MJP		ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL	2
SCHE644E		FORENSIC CHEMISTRY	2
	1	Forensic Chemistry-I	
	2	Forensic Chemistry-II	
SCHE644EP		FORENSIC CHEMISTRY PRACTICAL	2
SCHE631RP		Dissertation	6

## Preamble:

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

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

## PROGRAMME SPECIFIC OUTCOMES

<b>PSO 1</b>	<b>Critical thinking:</b> 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.
<b>PSO 2</b>	<b>Skills in research and industrial field:</b> Students will build a scientific temper through research, develop entrepreneurial skill and will get an exposure to work in an industrial set up.
<b>PSO 3</b>	<b>Personality Development:</b> 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	SCHE635MJ	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

#### COURSE OBJECTIVES:

CO 1.	To understand the 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 understand the application of analytical chemistry from the perspective of pharmaceutical chemistry

#### COURSE LEARNING OUTCOMES: The learner will be able to

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

<b>UNIT 1</b>	<b>QUALITY IN ANALYTICAL CHEMISTRY</b>	<b>15L</b>
1.1	<b>Selection of the Method:</b> 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).	6L
1.2	<b>Measurement of uncertainty:</b> Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results.	4L
1.3	<b>Signal to noise:</b> Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction.	5L
<b>UNIT 2</b>	<b>CHROMATOGRAPHIC TECHNIQUES –I</b>	<b>15L</b>
2.1	<b>Ion exchange chromatography:</b> Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins and their applications for separation of inorganic and organic compounds.	8L
2.2	<b>Ion chromatography:</b> Principle, instrumentation with special reference to separation and suppressor columns, applications.	2L
3.3	<b>Exclusion chromatography :</b> Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers	5L
<b>UNIT 3</b>	<b>CHROMATOGRAPHIC TECHNIQUES –II</b>	<b>15L</b>
3.1	<b>Supercritical fluid Chromatography:</b> Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis.	8L
3.2	<b>Affinity Chromatography:</b> principle, instrumentation and applications	4L
3.3	<b>2D TLC:</b> Preparative TLC, Multi development TLC	3L
<b>UNIT 4</b>	<b>PHARMACEUTICAL CHEMISTRY</b>	
4.1	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
4.2	Sources of impurities in pharmaceutical products and raw materials.	4L
4.3	Standardization of finished products and their characteristics, official methods of quality control.	4L

#### 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 Weinheim 1995.

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, Saunders, 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 2<sup>nd</sup> 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	SCHE635MJP	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE EXAMINATION
TOTAL MARKS	-	50
PASSING MARKS	-	20

### **COURSE OBJECTIVES:**

CO 1.	To acquaint learners with spectroscopic techniques
CO 2.	To learn how to analyse drug samples

### **COURSE LEARNING OUTCOMES: The learner will be able to**

CLO 1.	Apply the knowledge to decide the most appropriate method of analysis based on requirements.
CLO 2.	Analyse various drug samples using a suitable method.

<b>QUALITY IN ANALYTICAL CHEMISTRY PRACTICAL</b>	
	<p>1. Estimation of drugs by non-aqueous titration:</p> <p>a) Glycine b) Sodium Benzoate c) Pyridoxine hydrochloride d) Mebendazole.</p> <p>2. To determine the amount of Aspirin in a commercial sample by spectrophotometry.</p> <p>3. Estimation of Ca in Ca-pentathionate/ calcium lactate tablets.</p> <p>4. To determine the amount of iron in a tablet sample titrimetrically.</p> <p>5. Determination of the pK value of an indicator.</p> <p>6. Determination of percentage purity of methylene blue indicator by titrimetry.</p>

**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	SCHE636MJ	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20



## COURSE OBJECTIVES:

CO 1.	To understand the principle and working of various 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: The learner will be able to

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

<b>UNIT 1</b>	<b>SPECTRAL METHODS- I</b>	<b>15L</b>
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
<b>UNIT 2</b>	<b>SPECTRAL METHODS- II</b>	<b>15L</b>
	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
<b>UNIT 3</b>	<b>ELECTROANALYTICAL TECHNIQUES</b>	<b>15L</b>
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
<b>UNIT 4</b>	<b>INDUSTRIALLY IMPORTANT MATERIALS</b>	<b>15L</b>
4.1	Insecticides, Pesticides: definition, classification and biodegradation	2L
4.2	Soaps and Detergents: classification and composition, qualitative and quantitative analysis of detergents - alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents	4L
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.	4L
4.4	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.	4L
4.5	Role of organosilicones in paints and their impact on environment.	1L

### REFERENCES

1. Analytical Chemistry, G. D. Christian, 4<sup>th</sup> 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, 5<sup>th</sup> Edition (1998)
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6<sup>th</sup> Ed CBS (1986)
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr 7<sup>th</sup> 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, 2<sup>nd</sup> 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. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester

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

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES PRACTICAL	
CLASS	MSC	
COURSE CODE	SCHE636MJP	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	50
PASSING MARKS		20

### COURSE OBJECTIVES:

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

### COURSE LEARNING OUTCOMES: The learner will be able to

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 INSTRUMENTAL TECHNIQUES PRACTICAL	
	<ol style="list-style-type: none"> <li>1. Estimation of fluoride in a toothpaste sample by spectrophotometry.</li> <li>2. Determination of silica by molybdenum blue method by spectrophotometry.</li> <li>3. Determination of copper and bismuth in mixture by photometric titration.</li> <li>4. Estimation of strong acid, weak acid and salt in the given mixture conductometrically.</li> <li>5. Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pHmetry.</li> <li>6. Estimation of Na<sup>+</sup> in dairy whitener by flame photometry.</li> </ol>

	7. Determination of nicotine content in tobacco using potentiometry. 8. Determination of iron in iron wire using $KMnO_4$	
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**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.

NAME OF THE COURSE	BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS	
CLASS	MSC	
COURSE CODE	SCHE633E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	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: The learner will be able to**

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

<b>UNIT 1</b>	<b>BIOANALYTICAL CHEMISTRY AND IMMUNOLOGICAL METHODS</b>	<b>15L</b>
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	General processes of immune response, antigen antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.	5L
1.3	Estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.	5L
<b>UNIT 2</b>	<b>FOOD ANALYSIS</b>	<b>15L</b>
2.1	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.	2L
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.	2L
4.3	Food packaging – Introduction, types of packing materials, properties and industrial requirements. Processing and Quality requirements of Milk and milk products(cheese, butter and ice cream), vegetables and fruits, meat and meat products. Analysis of Milk – Fat content, proteins, acidity, bacteriological quality and milk adulterants. Analysis of Oils and Fats – acid value, sap value, iodine value, determination of rancidity and antioxidants. Analysis of spices (cloves, cinnamon, pepper, mustard), determination of volatile oils and fixed oils.	11L

#### REFERNCES:

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. Food Analysis, Edited by S. Suzanne Nielsen, Springer
7. Analytical Biochemistry, D, J. Homes and H. Peck, Longman (1983)
8. 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	SCHE633EP	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	20	-

### COURSE OBJECTIVES:

CO 1.	To acquaint learners with spectroscopic techniques and separation techniques.
CO 2.	To learn how to analyse food samples.

### COURSE LEARNING OUTCOMES: The learner will be able to

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

	<b>BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS PRACTICAL</b>	
	1. Total reducing sugars before and after inversion in honey using: Cole's Ferricyanide method 2. Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method 3. Iodine value of oil /fat- Wijs Solution 4. Analysis of Calcium, Iron and phosphorus in milk powder.	

5. Determination and identification of given oil using SAP value.	
6. Estimation of Aldehyde in lemon grass oil / Cinnamon oil	
7. Estimation of Glucose by Folin-Wu method	
8. Estimation of Ni in tea powder.	

**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 CHEMISTRY	
CLASS	MSC	
COURSE CODE	SCHE633E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	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

**COURSE LEARNING OUTCOMES: The learner will be able to**

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

<b>UNIT 1</b>	<b>ENVIRONMENTAL POLLUTION</b>	<b>15L</b>
1.1	Sampling and analysis of air pollutants: Particulate matter, aerosols, ammonia and organic vapors.	2L
1.2	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.	2L
1.3	Carbon credit and global issues related to air pollution.	2L
1.4	Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC.	3L
1.5	Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification	3L
<b>UNIT 2</b>	<b>WATER QUALITY STANDARDS</b>	<b>15L</b>
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

## REFERNCES

1. Environmental Chemistry, A. K. De, 2<sup>nd</sup> 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.
8. Guidelines for drinking-water quality, Third edition, (incorporating first and second addenda). WHO report.



9. Soil pollution, S.G. Misra and Dinesh Mani, APH Publishing Corporation, (2009).
10. Soil Pollution: origin, monitoring and remediation, Abraham Mirsal, Springer (2010).
11. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).
12. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication , (2003).
13. Environmental law in India, Mohammad Naseem, Wolters Kluwer.
14. 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)

NAME OF THE COURSE	ENVIRONMENTAL CHEMISTRY PRACTICAL	
CLASS	MSC	
COURSE CODE	SCHE633EP	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
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: The learner will be able to**

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

<b>ENVIRONMENTAL CHEMISTRY PRACTICAL</b>	
	1. To determine the acidity and alkalinity of the given water sample. 2. To determine the total solids, total dissolved solids, total suspended solids in the given water sample. 3. To determine the salinity of the water sample. 4. Determination of sulphate. (by Benzidine method) 5. To determine the chemical oxygen demand of the given water sample. 6. Determination of Cr(VI) in industrial effluent. 7. Estimation of Mn <sup>2+</sup> in water by colorimetric method. 8. Determination of pK value of phosphoric acid potentiometrically.

#### 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	PROJECT WORK	
CLASS	MSC	
COURSE CODE	SCHE631RP	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF HOURS PER SEMESTER	120	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	-
PASSING MARKS	-	-

### SEMESTER 4

NAME OF THE COURSE	ADVANCED INSTRUMENTAL TECHNIQUES	
CLASS	MSC	
COURSE CODE	SCHE647MJ	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
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 understand the principle, instrumentation and applications of selective chromatographic techniques
CO 3.	To understand the principles and instrumentation of the spectral methods
CO 4	To understand the concepts and applications of the techniques discussed

#### COURSE LEARNING OUTCOMES: The learner will be able to

CLO 1.	Explain in detail the application of solvent extraction in analytical chemistry
CLO 2.	Discuss analytical techniques in nanotechnology and selective chromatographic techniques
CLO 3	Differentiate and identify the appropriate technique of analysis for a sample.
CLO 4	Interpret the spectrum and solve numericals based on the topics covered

<b>UNIT 1</b>	<b>SEPARATION SCIENCE</b>	<b>15L</b>
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, solvent extraction in sample preparation and pre-treatment steps, solvent extraction as a means of analytical determination.	7L
<b>UNIT 4</b>	<b>CHROMATOGRAPHIC TECHNIQUES –III</b>	<b>15L</b>
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, isotachopheresis and micellar 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
<b>UNIT 3</b>	<b>SPECTRAL METHODS- III</b>	<b>15L</b>
3.1	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)	6L
3.2	Radio waves in imaging- principle instrumentation and applications of MRI	2L
3.3	Application of NMR to other nuclei C <sup>13</sup> , P <sup>31</sup> and F <sup>19</sup> spectroscopy	1L
3.4	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	3L
3.5	Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy	3L
<b>UNIT 4</b>	<b>RADIOCHEMICAL AND HYPHENATED TECHNIQUES</b>	<b>15L</b>
4.1	Activation analysis- radiometric titrations and radio-release methods	5L
4.2	Concept of hyphenation, need for hyphenation, possible hyphenations.	1L
4.3	Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS, MALDI and ESI	9L

**REFERENCES:**

1. Analytical Chemistry, G. D. Christian, 4<sup>th</sup> Ed. John Wiley, New York (1986)
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J Holler Holt-Saunders 6<sup>th</sup> Edition (1998)
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann 5 Ed.
4. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A.
5. Principles and Practices of X-ray spectrometric Analysis, 2 Ed E. P. Bertain, Plenum Press, NY, (1975)
6. Nuclear Analytical Chemistry, D. Bane, B. Forkman, B. Persson, Chartwell - Bratt Ltd (1984)
7. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, A series of volumes
8. A Complete Introduction to Modern NMR Spectroscopy 1<sup>st</sup> Edition by Roger S. Macomber
9. Spectrometric Identification of Organic Compounds Hardcover – by Robert M.Silverstein Wiley
10. Encyclopedia of Analytical Science, Editors-in-Chief: Paul Worsfold, Alan Townshend, and Colin Poole ISBN: 978-0-12-369397-6
11. Encyclopedia of Analytical Chemistry: Applications, Theory, and Instrumentation. Meyers Robert A Meyers
12. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
13. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
14. Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978.
15. Supercritical fluid extraction, Larry Taylor Wiley publishers N.Y. 1996
16. Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963
17. Ion exchange chromatography, Ed H.F Walton Howden, Hutchenson and Rossing 1976
18. Chromatographic and electrophoresis techniques, I Smith Menemann Interscience 1960

NAME OF THE COURSE	ADVANCED ANALYTICAL TECHNIQUES PRACTICAL	
CLASS	MSC	
COURSE CODE	SCHE647MJP	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	50

PASSING MARKS		20
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### COURSE OBJECTIVES:

CO 1.	To learn treatment ore/alloy samples and determine its constituent metals quantitatively
CO 2.	To acquaint learners with spectroscopic techniques
CO 3.	To familiarize students with the SOPs and train them in handling

### 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.

<b>ADVANCED ANALYTICAL TECHNIQUES PRACTICAL</b>	
	<ol style="list-style-type: none"> <li>1. To analyze Pyrolusite for:Fe by colorimetry and / or Mn by volumetry</li> <li>2. Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry)</li> <li>3. Determination of copper by extractive photometry using diethyldithiocarbamate.</li> <li>4. Spectrophotometric determination of pH of buffer solution.</li> <li>5. Simultaneous determination of <math>Ti^{3+}</math> and <math>V^{5+}</math> spectrophotometrically by <math>H_2O_2</math> method</li> <li>6. Determination of purity of crystal violet.</li> <li>7. To analyze Magnesium for Mg by complexometry.</li> <li>8. To analyze Brass for Zn by complexometric method</li> </ol>

### 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	SCHE648MJ	
NUMBER OF CREDITS	4	
NUMBER OF LECTURES PER WEEK	4	
TOTAL NUMBER OF LECTURES PER SEMESTER	60	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
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

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

### **COURSE LEARNING OUTCOMES:**

<b>UNIT 1</b>	<b>INTRODUCTION TO INTELLECTUAL PROPERTY</b>	<b>15L</b>
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.	3L
1.3	Drafting of Chemistry patents (Product and Process); Novelty Check. Understanding the importance of patents from a chemistry point of view and its future scope. Drug discovery, development and patents.	2L
1.4	Industrial Designs: Definition, How to obtain, features, International design registration.	2L
1.5	Copyrights: Introduction, How to obtain, Differences from Patents.	2L
1.6	Trademarks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc.	2L
1.7	Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.	2L
<b>UNIT 2</b>	<b>TRADE AGREEMENTS</b>	<b>15L</b>
2.1	Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.	2L
2.2	Integrated Circuit Layout Design Act	2L
2.3	IP Infringement issue and enforcement: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc.	2L
2.4	Economic Value of Intellectual Property: Intangible assets and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer.	2L
2.5 2.5.1	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	5L
2.5.2	WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity. Hague Agreement, Lisbon Agreement WIPO performances and Phonogram Treaty	
2.6	Indian IP Regime: Overview of IP laws in India, Major IP Laws in India, International treaties signed by India.	2L



<b>UNIT 3</b>	<b>INTRODUCTION TO CHEMINFORMATICS</b>	<b>15L</b>
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 Sdf Files, Libraries and toolkits.	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
<b>UNIT 4</b>	<b>APPLICATIONS OF CHEMINFORMATICS</b>	<b>15L</b>
4.1	Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building.	2L
4.2	Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand based and Structure based Drug design.	4L
4.3	Application of Cheminformatics in Drug Design.	2L
4.4	4.4.1. Python 3 basics, Important difference between python 2.x and python 3.x with example, Keywords in Python, Namespaces and Scope in Python, Statement, Indentation and Comment in Python 4.4.2. Structuring Python Programs, How to assign values to variables in Python and other languages, Decision making, Taking input in Python Taking input from console in Python, Taking multiple inputs from user in Python, Output using print() function and Output Formatting, File handling in python 4.4.3. Introduction to Nodemcu and Raspberry pi and Various IoT controllers 4.4.4. Installation, and Input output basics of in Raspberry pi and nodemcu	7L

## REFERNCES

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.

NAME OF THE COURSE	FORENSIC CHEMISTRY	
CLASS	MSC	
COURSE CODE	SCHE644E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	20	-

### COURSE OBJECTIVES:

CO 1.	To introduce students to the fundamental concepts and principles of forensic science.
CO 2.	To explore the different sub disciplines of forensic chemistry, like fingerprint analysis, DNA analysis, toxicology and trace evidence analysis

### COURSE LEARNING OUTCOMES: The learner will be able to

CLO1	Explain the role of forensic science in society.
CLO2	Describe proper methods for crime scene investigation and evidence collection.

UNIT 1	FORENSIC CHEMISTRY-I	15L
1.1	1.1.1. General Introduction to Chemistry in Forensic Science 1.1.2. Forensic Analysis of Blood evidences 1.1.3. DNA profiling	3L
1.2	General Introduction to Analytical Forensic Toxicology	1L
1.3	Forensic Toxicology branches	1L
1.4	Drugs of Abuse-structure, metabolism, identification 1.4.1. Narcotics - heroin, morphine 1.4.2. Stimulants - amphetamines, caffeine, cocaine 1.4.3. Hallucinogens - LSD, cannabis 1.4.4. Depressants - benzodiazepenes, barbiturates, mandrax 1.4.5. Performance enhancing hormones, drugs 1.4.6. Forensic Analysis of Alcohol intoxication	7L
1.5	Classification & Analysis of Poisons	2L
1.6	Preparation of post-mortem samples for Forensic Analysis	1L

<b>UNIT 2</b>	<b>FORENSIC CHEMISTRY-II</b>	<b>15L</b>
2.1	Forensic Chemistry in Heavy Metal Toxicity	1L
2.2	Fire Investigation	2L
2.3	Explosives Analysis	2L
2.4	Forensic analysis of Food Adulterants	2L
2.5	Trace Evidence Analysis - soil, glass, paint	2L
2.6	Introduction to Impression Evidence Analysis	1L
2.7	Questioned Document investigation	1L
2.8	Fingerprint analysis	2L
2.9	Ballistics	2L

### REFERENCES:

1. Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
2. Forensic Chemistry, David E Newton, Infobase Publishing, 2007.
3. Criminalistics - an Introduction to Forensic Science, Richard Saferstein, Prentice Hall Publication, 2011

NAME OF THE COURSE	FORENSIC CHEMISTRY PRACTICAL	
CLASS	MSC	
COURSE CODE	SCHEP644E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	20	-

### COURSE OBJECTIVES:

CO 1.	To provide students with hands-on experience in laboratory techniques used in forensic chemistry.
CO 2.	Develop critical thinking and problem solving skills necessary to analyse evidence and draw conclusions

CLO1	Analyse various types of forensic evidence using appropriate methods.
CLO2	Interpret the results of forensic analysis and draw conclusions about a case.

**COURSE LEARNING OUTCOMES: The learner will be able to**

	<b>FORENSIC CHEMISTRY PRACTICAL</b>	
	1. Forensic Blood Analysis - presumptive tests 2. Forensic Saliva Analysis - amylase test 3. Thin Layer Chromatography of drugs of abuse 4. Colorimetry for Alcohol estimation in blood 5. Screening Tests for Food Adulterants 6. Soil Analysis - pH, colour, particle size distribution 7. Paper Chromatography of Pen Inks in Document analysis 8. Chemical methods for Fingerprint analysis	

NAME OF THE COURSE	GREEN CHEMISTRY	
CLASS	MSC	
COURSE CODE	SCHE644E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	20	-

**COURSE OBJECTIVES:**

CO 1.	To introduce analysis of herbal based products and their standardizations
CO 2.	To emphasize the importance of Green Chemistry.

**COURSE LEARNING OUTCOMES: The learner will be able to**

CLO1	Describe qualitative and quantitative estimations of herbal based formulations and interpret the results.
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CLO2	Identify and use green reactions/synthesis in future.
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<b>UNIT 1</b>	<b>SEPARATION, ANALYSIS AND STANDARDIZATION OF HERBAL BASED PRODUCTS</b>	<b>15L</b>
1.1	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
1.2	Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.	3L
1.3	Standardization of herbal formulation and herbal extracts: Standardization of herbal extracts as per WHO cGMP guidelines, Physical, Chemical, Spectral and toxicological standardization, qualitative and quantitative estimations.	6L
<b>UNIT 2</b>	<b>GREEN CHEMISTRY</b>	<b>15L</b>
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

## REFERENCES:

1. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
2. Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978.
3. Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH verlag GmbH & co.

NAME OF THE COURSE	GREEN CHEMISTRY PRACTICAL	
CLASS	MSC	
COURSE CODE	SCHEP644E	
NUMBER OF CREDITS	2	
NUMBER OF LECTURES PER WEEK	2	
TOTAL NUMBER OF LECTURES PER SEMESTER	30	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	50	-
PASSING MARKS	20	-

## COURSE OBJECTIVES:

CO 1.	To provide a basic introduction to greener methods
CO 2.	To make the students aware of the different methods

CLO1	Design a green method of synthesis/analysis.
CLO2	Choose an appropriate green method for the experiment.

## COURSE LEARNING OUTCOMES: The learner will be able to

	<b>GREEN CHEMISTRY PRACTICAL</b>	
	<ol style="list-style-type: none"><li>1. Microwave: Microwave assisted one-pot synthesis of some of the organic derivatives</li><li>2. Atom economy: Calculation of atom economy of the following reactions Preparation of propene by two methods- from tertiary amines and propene.</li><li>3. Use of enzymes as catalysts- Benzoin condensation using Thiamine hydrochloride as a catalyst instead of cyanide.</li><li>4. Alternative sources of energy- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.</li><li>5. Synthesis of acetyl derivative of amines/phenols using grind stone method.</li><li>6. Assay of Riboflavin in tablets using uv-vis spectrophotometer.</li><li>7. Determination of paracetamol using colorimetry.</li><li>8. Determination of sulphadiazine in the given sample.</li></ol>	

## REFERENCES:

1. Vogel, A.I., Tatchell, A.R., Furnis B.S. Hanaford, A.J.J & Smith P.W.G, *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5<sup>th</sup> Edition, 1996.
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, University Press

NAME OF THE COURSE	DISSERTATION	
CLASS	MSC	
COURSE CODE	SCHE601RP	
NUMBER OF CREDITS	6	
NUMBER OF LECTURES PER WEEK	6	
TOTAL NUMBER OF HOURS PER SEMESTER	180	
EVALUATION METHOD	CONTINUOUS ASSESSMENT	SUMMATIVE ASSESSMENT
TOTAL MARKS	-	-
PASSING MARKS	-	-

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

### **CONTINUOUS ASSESSMENT (50 marks)**

#### **For Major Papers**

- **One activity to be conducted of 25 marks**  
Activities could be Test/ assignment/ project
- **One test of 25 M each**

### **SUMMATIVE ASSESSMENT (50 marks)**

#### **For Major Papers**

- Q.1. Unit 1 : Attempt any two of the following. (2 out of 4) [10marks]  
 Q.2. Unit 2 : Attempt any two of the following. (2 out of 4) [10marks]  
 Q.3. Unit 3 : Attempt any two of the following. (2 out of 4) [10marks]  
 Q.4. Unit 4 : Attempt any two of the following. (2 out of 4) [10marks]  
 Q.5. Attempt any two of the following (2 out of 4) [10 marks]  
 (1 question from each unit)

### **PRACTICAL ASSESSMENT (50 marks) (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

**CONTINUOUS ASSESSMENT (50 marks)**

**For Elective Papers**

**Two Tests of 25M each**

Subjective test

Attempt any five of the following (5 out of 8) [25 marks