SOPHIA COLLEGE FOR WOMEN (AUTONOMOUS)

Affiliated to the University of Mumbai

Programme: Sciences

Chemistry

MSc Part II

Syllabus for the Academic Year 2024-2025

based on the National Education Policy 2020

SOPHIA COLLEGE (AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

COURSE DETAILS:

	SEMESTER 3		SEMESTER 4
TITLE	**QUALITY IN ANALYTICAL CHEMISTRY**		**ADVANCED INSTRUMENTAL TECHNIQUES**
TYPE OF COURSE	**Discipline Specific Course**		**Discipline Specific Course**
CREDITS	**6**		**6**
TITLE	**ADVANCED INSTRUMENTAL TECHNIQUES**		**INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS**
TYPE OF COURSE	**Discipline Specific Course**		**Discipline Specific Course**
CREDITS	**6**		**4**
TITLE	**BIOANALYTICAL CHEMISTRY**		**FORENSIC CHEMISTRY**
TYPE OF COURSE	**Discipline Specific Elective**		**Discipline Specific Elective**
CREDITS	**4**		**4**
TITLE	**RESEARCH PROPOSAL**		**RESEARCH PROJECT**
CREDITS	**4**		**6**

SOPHIA COLLEGE (AUTONOMOUS)

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

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 for 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.

Programme: Sciences Chemistry		**Semester – 3**	
Course Title: QUALITY IN ANALYTICAL CHEMISTRY		**Course Code: SCHE635MJ**	
COURSE OBJECTIVES: 1. To understand the criteria for method validation. 2. To understand the principle, instrumentation and applications of different chromatographic techniques. 3. To understand the different methods used to reduce signal to noise ratio 4. To understand the application of analytical chemistry from the perspective of pharmaceutical chemistry			
COURSE OUTCOMES: The learner will be able to: 1. Interpret the results and improve the quality of results 2. Describe methods used to reduce signal to noise ratio. 3. Explain supercritical fluid chromatography, affinity chromatography and ion-exchange in detail with applications. 4. Analyse various pharmaceutical materials.			
Lectures per week (4 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 QUALITY IN ANALYTICAL CHEMISTRY	1.1	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). (6L)	15 hours
	1.2	Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L)	
	1.3	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. (5L)	
UNIT 2 CHROMATOGRAPHIC TECHNIQUES – I	2.1	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)	15 hours
	2.2	Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L)	
	2.3	Exclusion chromatography: Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers (5L)	
UNIT 3 CHROMATOGRAPHIC TECHNIQUES –II	3.1	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)	15 hours
	3.2	Affinity Chromatography: principle, instrumentation and applications (4L)	

	3.3	2D TLC: Preparative TLC, Multi development TLC (3L)	
UNIT 4: PHARMACEUTICAL CHEMISTRY	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)	15 hours
	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 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

PRACTICAL **Course Title: QUALITY IN ANALYTICAL CHEMISTRY**	**Course Code: SCHE635MJP**

SOPHIA COLLEGE (AUTONOMOUS)

COURSE OUTCOMES:
The learner will be able to:

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

Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	1.Estimation of drugs by non-aqueous titration: a) Glycine b) Sodium Benzoate c) Pyridoxine hydrochloride d) Mebendazole.	60 hours
	2	To determine the amount of Aspirin in a commercial sample by spectrophotometry.	
	3	Estimation of Ca in Ca-pentathonate/ calcium lactate tablets.	
	4	To determine the amount of iron in a tablet sample titrimetrically.	
	5	Determination of the pK value of an indicator.	
	6	Determination of percentage purity of methylene blue indicator by titrimetry.	

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.

Programme: Sciences **Chemistry**		**Semester – 3**	
Course Title: ADVANCED INSTRUMENTAL TECHNIQUES		**Course Code: SCHE636MJ**	
COURSE OBJECTIVES: 1. To understand the principle and working of various spectral methods 2. To understand the applications of the techniques discussed 3. To understand the concepts of the different techniques i.e spectroscopic/electro-analytical.			
COURSE OUTCOMES: The learner will be able to: 1. Differentiate and identify the appropriate technique of analysis for a sample. 2. Interpret the esr/ mossbauer spectrum. 3. Solve numericals based on the topics covered.			
Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Cintinuous Assessment	**--**	**50 marks**

UNIT 1 SPECTRAL METHODS- I	1.1	Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L)	15 hours
	1.2	Principle, instrumentation and applications of the following: A) Secondary Ion mass spectroscopy. (4L) B) Particle-Induced X-Ray Emission (5L) C) Low-Energy Ion Scattering and Rutherford Backscattering (5L)	
UNIT 2 SPECTRAL METHODS- II	2.1	Principle, Instrumentation, and Applications of: A) Electron Spin Resonance Spectroscopy (ESR) (5L) B) Mossbauer's Spectroscopy (5L) C) Atomic Emission Spectroscopy- based on plasma and electrical discharge sources. (5L)	15 hours
UNIT 3 ELECTROANALYTICAL TECHNIQUES	3.1	Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L)	15 hours
	3.2	Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry. (2L)	
	3.3	Potential Step method- Chronoamperometry (2L)	
	3.4	Controlled potential technique-Chronopotentiometry (2L)	
	3.5	Stripping Voltammetry- anodic, cathodic, and adsorption (3L)	
	3.6	Chemically and electrolytically modified electrodes and ultra-microelectrodes in voltammetry (3L)	
UNIT 4 INDUSTRIALLY IMPORTANT MATERIALS	4.1	Insecticides, Pesticides: definition, classification and biodegradation (2L)	15 hours
	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, 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. 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.

Programme: Sciences **CHEMISTRY**		**Semester – 3**	
PRACTICAL COURSE **ADVANCED INSTRUMENTAL TECHNIQUES**		**Course Code: SCHE636MJP**	
COURSE OUTCOMES: The learner will be able to : 1. Apply the knowledge to decide the most appropriate method of analysis based on requirements. 2. Use technical skills to work with various instruments			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	

	1	Estimation of fluoride in a toothpaste sample by spectrophotometry.	60 hours
	2	Determination of silica by molybdenum blue method by spectrophotometry.	
	3	Determination of copper and bismuth in mixture by photometric titration.	
	4	Estimation of strong acid, weak acid and salt in the given mixture conductometrically	
	5	Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pHmetry	
	6	Estimation of Na^+ in dairy whitener by flame photometry.	
	7	Determination of nicotine content in tobacco using potentiometry.	
	8	Determination of iron in iron wire using $KMnO_4$	

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.

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<table>
<tr><td colspan="2">Programme: Sciences

Chemistry</td><td colspan="2">Semester – 3</td></tr>
<tr><td colspan="2">Course Title: BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS</td><td colspan="2">Course Code: SCHE633E</td></tr>
<tr><td colspan="4"><u>COURSE OBJECTIVES:</u>

1. To understand the application of analytical chemistry in the chemical and biological fields
2. To understand immunological methods and food analysis using a variety of experimental technique.
3. To introduce quality assessment of dairy products and species</td></tr>
<tr><td colspan="4"><u>COURSE OUTCOMES</u>:

The learner will be able to:

1. Explain the principle of methods used for the analysis of biological sample, food and food additives.
2. Differentiate and identify the techniques of analysis
3. Apply the knowledge for estimating dairy products</td></tr>
<tr><td colspan="2">Lectures per week (1 Lecture is 60 minutes)</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Total number of Hours in a Semester</td><td colspan="2">30</td></tr>
<tr><td colspan="2">Credits</td><td colspan="2">2</td></tr>
<tr><td rowspan="2">Evaluation System</td><td>Summative Assessment</td><td>-</td><td>-</td></tr>
<tr><td>Continuous Assessment</td><td>--</td><td>50 marks</td></tr>
</table>

UNIT 1 BIOANALYTICAL CHEMISTRY AND IMMUNOLOGICAL METHODS	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)	15 hours
	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)	
UNIT 2 FOOD ANALYSIS	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)	15 hours
	2.2	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)	
	2.3	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)	

REFERENCES

1 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

Programme: Sciences **CHEMISTRY**	**Semester – 3**
PRACTICAL COURSE **BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS**	**Course Code: SCHE633EP**
COURSE OUTCOMES: The learner will be able to : 1. Apply the knowledge to decide the most appropriate method of analysis based on requirements. 2. Use technical skills to work with various instruments	
Lectures per week (1 Lecture is 60 minutes)	**2**
Total number of Hours in a Semester	**60**
Credits	**2**

Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

	1	1. Total reducing sugars before and after inversion in honey using: Cole's Ferricyanide method	60 hours
	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

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **Chemistry**	**Semester – 3**
Course Title: ENVIRONMENTAL CHEMISTRY	**Course Code: SCHE633E**

COURSE OBJECTIVES:

1. To introduce learners to different types of pollution, analysis of pollutants and environmental laws and regulations.
2. To provide them with a scientific background for understanding environmental problems, monitoring and controlling the pollution

COURSE OUTCOMES:

The learner will be able to:

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

Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 ENVIRONMENTAL POLLUTION	1.1	Sampling and analysis of air pollutants: Particulate matter, aerosols, ammonia and organic vapors. (2L)	15 hours
	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.(3L)	

	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. (4L)	
	1.5	Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification (4L)	
UNIT 2 WATER QUALITY STANDARDS	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)	15 hours
	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 (2L)	

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.

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).

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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)

Programme: Sciences **CHEMISTRY**		**Semester – 3**	
PRACTICAL COURSE **ENVIRONMENTAL CHEMISTRY**		**Course Code: SCHE633EP**	
COURSE OUTCOMES: The learner will be able to : 1. Apply the knowledge to decide the most appropriate method of analysis based on requirements. 2. Use technical skills to work with various instruments			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

	1	1.To determine the acidity and alkalinity of the given water sample.	60 hours
	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^{2+} 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.

Programme: Sciences **CHEMISTRY**	**Semester – 3**
RESEARCH PROPOSAL	**Course Code: SCHE631RP**

COURSE OUTCOMES:

The learner will be able to :

1. Apply the knowledge to decide the most appropriate method of analysis based on requirements.

2. Use technical skills to work with various instruments			
Hours per week		**8**	
Total number of Hours in a Semester		**120**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**-**	**50**
	Continuous Assessment	**--**	**50**

Programme: Sciences Chemistry	**Semester – 4**
Course Title: ADVANCED INSTRUMENTAL TECHNIQUES	**Course Code: SCHE647MJ**

COURSE OBJECTIVES:

1. To understand various methods of separation used in pre-treatment of samples.
2. To understand the principle, instrumentation and applications of selective chromatographic techniques
3. To understand the principles and instrumentation of the spectral methods
4. To understand the concepts and applications of the techniques discussed

COURSE OUTCOMES:

The learner will be able to:

1. Explain in detail the application of solvent extraction in analytical chemistry
2. Discuss analytical techniques in nanotechnology and selective chromatographic techniques

3. Differentiate and identify the appropriate technique of analysis for a sample. 4. Interpret the spectrum and solve numericals based on the topics covered			
Lectures per week (4 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 SEPARATION SCIENCE-I	1.1	Membrane separation processes: operating principles and applications of microfiltration, ultrafiltration, reverse osmosis, dialysis and electro-dialysis. (8L)	15 hours
	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.. (12L)	
UNIT 2 SEPARATION SCIENCE –II	2.1	Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers). (2L)	15 hours
	2.2	Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotachophoresis and micellar electrokinetic capillary chromatography, instrumentation, detection and applications. (8L)	
	2.3	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)	
UNIT 3 SPECTRAL METHODS- III	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)	15 hours
	3.2	Radio waves in imaging- principle instrumentation and applications of MRI (2L)	
	3.3	Radio waves in imaging- principle instrumentation and applications of MRI (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)	
UNIT 4: RADIOCHEMICAL AND HYPHENATED TECHNIQUES	4.1	Activation analysis- radiometric titrations and radio-release methods. (5L)	15 hours
	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, 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)
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 1st 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

PRACTICAL **Course Title: ADVANCED INSTRUMENTAL TECHNIQUES**		**Course Code: SCHE647MJP**	
COURSE OUTCOMES: The learner will be able to: 1. To enable to apply the knowledge and choose an appropriate method for analysis based on requirements 2. Learners will be equipped with technical skills to work with various instruments.			
Lectures per week (1 Lecture is 120 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**2**	**50 marks**

		Hours	
	Continuous Assessment	**--**	

	1	To analyze Pyrolusite for:Fe by colorimetry and / or Mn by volumetry	60 hours
	2	Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry)	
	3	Determination of copper by extractive photometry using diethyldithiocarbamate.	
	4	Spectrophotometric determination of pH of buffer solution.	
	5	Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method	
	6	Determination of purity of crystal violet.	
	7	To analyze Magnelium for Mg by complexometry.	
	8	To analyze Brass for Zn by complexometric 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.

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **Chemistry**	**Semester – 4**
Course Title: INTELLECTUAL PROPERTY RIGHTS AND CHEMINFORMATICS	**Course Code: SCHE648MJ**

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

The learner will be able to:

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

Lectures per week (1 Lecture is 60 minutes)		**4**	
Total number of Hours in a Semester		**60**	
Credits		**4**	
Evaluation System	**Summative Assessment**	**2 Hours**	**50 marks**
	Cintinuous Assessment	**--**	**50 marks**

UNIT 1 INTRODUCTION	1.1	Historical Perspective, Different types of IP, Importance of protecting IP. (2L)	15 hours

TO INTELLECTUAL PROPERTY	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)	
UNIT 2 TRADE AGREEMENTS	2.1	Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. (2L)	15 hours
	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	2.5.1Different 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 v) Paris Convention 2.5.2WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity. Hague Agreement, Lisbon Agreement WIPO performances and Phonogram Treaty (5L)	
	2.6	Indian IP Regime: Overview of IP laws in India, Major IP Laws in India, International treaties signed by India.	
UNIT 3 INTRODUCTION TO CHEMINFORMATICS	3.1	History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. (5L)	15 hours
	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)	
UNIT 4 APPLICATIONS OF CHEMINFORMATICS	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)	

REFERENCES

1. Andrew R. Leach & Valerie J. Gillet (2007) An Introduction to Cheminformatics. Springer:

The Netherlands.

2. Gasteiger, J. & Engel, T. (2003) Cheminformatics: A textbook. Wiley–VCH

3. Gupta, S. P. QSAR and Molecular Modeling. Springer-Anamaya

Pub.: New Delhi. (1980)

SOPHIA COLLEGE (AUTONOMOUS)

<table>
<tr><td colspan="2">Programme: Sciences
Chemistry</td><td colspan="2">Semester – 4</td></tr>
<tr><td colspan="2">Course Title: FORENSIC CHEMISTRY</td><td colspan="2">Course Code: SCHE644E</td></tr>
<tr><td colspan="4"><u>COURSE OBJECTIVES:</u>
1. To introduce students to the fundamental concepts and principles of forensic science.
2. To explore the different sub disciplines of forensic chemistry, like fingerprint analysis, DNA analysis, toxicology and trace evidence analysis</td></tr>
<tr><td colspan="4"><u>COURSE OUTCOMES</u>:
The learner will be able to:
1. Explain the role of forensic science in society.
2. Describe proper methods for crime scene investigation and evidence collection.</td></tr>
<tr><td colspan="2">Lectures per week (1 Lecture is 60 minutes)</td><td colspan="2">2</td></tr>
<tr><td colspan="2">Total number of Hours in a Semester</td><td colspan="2">30</td></tr>
<tr><td colspan="2">Credits</td><td colspan="2">2</td></tr>
<tr><td rowspan="2">Evaluation System</td><td>Summative Assessment</td><td>-</td><td>-</td></tr>
<tr><td>Continuous Assessment</td><td>--</td><td>50 marks</td></tr>
</table>

UNIT 1 FORENSIC CHEMISTRY-I	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)	15 hours
	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)	
UNIT 2 FORENSIC CHEMISTRY-II	2.1	Forensic Chemistry in Heavy Metal Toxicity (1L)	15 hours
	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

Programme: Sciences **CHEMISTRY**		**Semester – 4**	
PRACTICAL COURSE **FORENSIC CHEMISTRY**		**Course Code: SCHE644EP**	
COURSE OUTCOMES: The learner will be able to : 1. Analyse various types of forensic evidence using appropriate methods. 2. Interpret the results of forensic analysis and draw conclusions about a case.			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

	1	Forensic Blood Analysis - presumptive tests	60 hours
	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	

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

SOPHIA COLLEGE (AUTONOMOUS)

Programme: Sciences **Chemistry**		**Semester – 4**	
Course Title: GREEN CHEMISTRY		**Course Code: SCHE644E**	
COURSE OBJECTIVES: 1. To introduce analysis of herbal based products and their standardizations 2. To emphasize the importance of Green Chemistry.			
COURSE OUTCOMES: The learner will be able to: 1. Describe qualitative and quantitative estimations of herbal based formulations and interpret the results. 2. Identify and use green reactions/synthesis in future.			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**30**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

UNIT 1 SEPARATION, ANALYSIS AND STANDARDIZATION OF HERBAL BASED PRODUCTS	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)	15 hours
	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)	
UNIT 2 GREEN CHEMISTRY	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)	15 hours
	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.

Programme: Sciences **CHEMISTRY**		**Semester – 4**	
PRACTICAL COURSE **GREEN CHEMISTRY**		**Course Code: SCHE644EP**	
COURSE OUTCOMES: The learner will be able to : 1. Design a green method of synthesis/analysis. 2. Choose an appropriate green method for the experiment.			
Lectures per week (1 Lecture is 60 minutes)		**2**	
Total number of Hours in a Semester		**60**	
Credits		**2**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**50 marks**

	1	Microwave: Microwave assisted one-pot synthesis of some of the organic derivatives	60 hours
	2	Atom economy: Calculation of atom economy of the following reactions: Preparation of propene by two methods- from tertiary amines and propene.	
	3	Use of enzymes as catalysts- Benzoin condensation using Thyamine hydrochloride as a catalyst instead of cyanide.	
	4	Alternative sources of energy- Photoreduction of benzophenone to benzopinacol in the presence of sunlight.	
	5	Synthesis of acetyl derivative of amines/phenols using grind stone method.	
	6	Assay of Riboflavin in tablets using uv-vis spectrophotometer.	
	7	Determination of paracetamol using colorimetery.	
	8	Determination of sulpha drug in thE given sample.	

REFERENCES:

1. Vogel, A.I., Tatchell, A.R.,Furnis B.S. Hanaford, A.J..J &Smith P.W.G, Textbook of Practical Organic Chemisry, Prentice-Hall, 5th Edition, 1996.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3. Ahluwalia, V.K. &Aggrawal, R. Comprehensive Practical Organic Chemistry, University Press

Programme: Sciences **CHEMISTRY**	**Semester – 4**
RESEARCH PROJECT	**Course Code: SCHE642RP**

SOPHIA COLLEGE (AUTONOMOUS)

COURSE OUTCOMES:

The learner will be able to :

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

Hours per week		**12**	
Total number of Hours in a Semester		**180**	
Credits		**6**	
Evaluation System	**Summative Assessment**	**-**	**-**
	Continuous Assessment	**--**	**-**

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]