



Vivekanand Education Society's College of Arts, Science and Commerce

(Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

*Accredited by NAAC "A Grade" in 3rd Cycle - 2017
Best College Award – Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) and STAR College Grant (DBT)*

**Affiliated to the
University of Mumbai**

Syllabus for

**Program: M.Sc. (Analytical Chemistry)
(Program code: VESPSCHA)**

**As per Choice Based Semester and Grading System (CBSGS)
with effect from Academic Year 2023 - 2024**

Program Outcomes (PO):

A learner completing M.Sc. Analytical Chemistry will be able to:

- PO1 Exercise their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability
- PO2 Make choices based on the values upheld by the college, and have the readiness and know-how to preserve the environment and work towards sustainable growth and development.
- PO3 Demonstrate professional behavior of being unbiased, and truthful in all aspects of work as an individual as well as team.
- PO4 Develop an ethical view of life, and have a broader (global) perspective transcending the provincial outlook.
- PO5 Explore new knowledge independently for the development of the nation and the world and are able to engage in a lifelong learning process.

Program Specific Outcomes (PSO's)

On completion of M.Sc. Analytical Chemistry program, learners will be enriched with knowledge and be able to

- PSO1 Improve theoretical and practical knowledge in the field of analytical chemistry
- PSO2 Explain the basic scientific concepts effectively and solve the problems systematically and analytically.
- PSO3 Apply the principles of chemistry in industry, agriculture, medicine and Environment.
- PSO4 Design projects in different fields of analytical chemistry and develop research aptitude.
- PSO5 Apply their understanding in Analytical Chemistry to design solutions to unfamiliar problems in Chemistry and those involving other related disciplines.
- PSO6 Demonstrate an awareness of the relevance of chemistry in a wider multi-disciplinary context.
- PSO7 Ability to identify, design and conduct appropriate experiments, interpret data obtained, draw pertinent conclusions and communicate all these effectively.

**M.Sc. (ANALYTICAL CHEMISTRY)
(SEMESTER III)**

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 301	Paper 01 Quality In Analytical Chemistry	60	4
	Unit I : Quality in analytical chemistry - I	15 Lectures	
	Unit II: Quality in analytical chemistry - II	15 Lectures	
	Unit III : Chromatographic techniques - I	15 Lectures	
	Unit IV : Chromatographic techniques - II	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 302	Paper 02 Advance Instrumental Techniques	60	4
	Unit I : Spectral Methods I	15 Lectures	
	Unit II: Spectral Methods – II	15 Lectures	
	Unit III : Electroanalytical Methods	15 Lectures	
	Unit IV : Miscellaneous Techniques	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 303	Paper 03 Bioanalytical Chemistry and Food Analysis	60	4
	Unit I : Bioanalytical chemistry	15 Lectures	
	Unit II: Immunological Methods	15 Lectures	
	Unit III : Food Analysis - I	15 Lectures	
	Unit IV : Food Analysis - II	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHAEC-I 304	Paper 04 Environmental and Certain Industrially Important Matrials	60	4
	Unit I : Air Pollution	15 Lectures	
	Unit II: Water Quality Standards	15 Lectures	
	Unit III : Other Types Of Pollution	15 Lectures	
	Unit IV : Industrial Materials	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHAEC-II 304	Paper 04 Environmental and Certain Industrially Important Matrials	60	4
	Unit I : Pharmaceutical Analysis	15 Lectures	
	Unit II: Drugs	15 Lectures	
	Unit III : Forensic Science	15 Lectures	
	Unit IV : Cosmetic Analysis	15 Lectures	

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 01 Quality in analytical chemistry

Course code: VESPSCHA301

Objective: To understand and develop competence in use of Quality in analytical chemistry

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Students will learn about the concept sample and importance of sampling, type and treatment of sample.
- LO2 Students will learn about aspect of Measurement of uncertainty and signal to noise ratio and they are also knowing how software methods is used to reduce noise.
- LO3 Students will learn about Ion exchanger chromatography technique. Types of exchanger, chelating resins and their applications for separation of inorganic and organic compounds.
- LO4 Students will understand Supercritical Fluid Chromatography technique and Theory, concept of critical state of matter and supercritical state. They also know the concept of Affinity Chromatography and Optimum pressure liquid chromatography.

M.SC. ANALYTICAL CHEMISTRY SEMESTER – III PSCHA301 Quality In Analytical Chemistry		
UNIT I	Quality In Analytical Chemistry – I	15L
	1.1 Sampling: Definition, types of sample, sampling plan, quality of sample, subsampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of samples. Pre-treatment of samples: soil, food and cosmetics. (8L)	
	1.2 Selection of the Method: sources of methods, factors to consider when selecting a method, performance criteria for methods used, reasons for incorrect analytical results, method validation, and quality by design (PAT).(7L)	

UNIT II	Quality In Analytical Chemistry - II	15L
	<p>2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L)</p> <p>2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction. (6L)</p> <p>2.3 Pharmaceutical Legislation: introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration. (5L)</p>	
UNIT III	Chromatographic Techniques -I	15
	<p>3.1 Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins and their applications for separation of inorganic and organic compounds. (8L)</p> <p>3.2 Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L)</p> <p>3.3 Exclusion chromatography : Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers, (5L)</p>	
UNIT IV	Chromatographic Techniques -II	15
	<p>4.1 Supercritical fluid Chromatography: Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis. (8L)</p> <p>4.2 Affinity Chromatography: principle, instrumentation and applications (4L)</p> <p>Optimum pressure liquid chromatography (OPLC) (3L)</p>	

List of books and references:

1. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y 1997.
2. Quality assurance in analytical Chemistry, W Funk, V Dammann, G. Donnevert VCH 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
5. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saunders, College publication.
6. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
7. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
8. Analytical Chemistry, G. D. Christain, Wiley
9. Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978.
- 10 Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996
11. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2nd ed 1963
- 12 Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976
13. Chromatographic and electrophoresis techniques I Smith Menemann Interscience 1960

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 02 Advance Instrumental Techniques

Course code: VESPSCHA 302

Objective: To understand and develop competence in use of Advance Instrumental Techniques

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Students will learn about surface analytical technique. How to Prepare surfaces, difficulties involved in the surface analysis.
- LO2 Students will understand the principle, instrumentation and application of SIMS, PIXE, ESR, Mossbauer spectroscopy, AES.
- LO3 Students will learn about electroanalytical technique, Normal and Differential PulsePolarography. Stripping Voltammetry- anodic, cathodic, and adsorption.

Course title: Chemistry Paper 2

Course code: VESPSCHA 302

UNIT I	Spectral Methods I	15
	1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L) 1.2 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy. (4L) b. Particle-Induced X-Ray Emission (5L) c. Low-Energy Ion Scattering and Rutherford Backscattering (5L)	
UNIT II	Spectral Methods – II	15
	Principle, Instrumentation, and Applications of 2.1 Electron Spin Resonance Spectroscopy (ESR) (5L) 2.2 Mossbauer's Spectroscopy (5L) 2.3 Atomic Emission Spectroscopy- based on plasma and electrical discharge sources (5L)	
UNIT III	Electroanalytical Methods	15
	Advanced Electroanalytical Techniques:- 3.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L) 3.2 Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry. (3L) 3.3 Potential Step method- 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-microelectrodes in voltammetry (3L)	

UNIT IV	Miscellaneous Techniques	15
	Principle, Instrumentation and Applications of: 4.1 Chemiluminescence techniques (3L) 4.2 Chiroptical Methods : ORD, CD (5L) 4.3 Photoacoustic spectroscopy (3L) 4.4 Spectroelectrochemistry (4L)	

List of books and references:

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

Detailed Syllabus: Unit wise with number of lectures**Course title: Chemistry Paper 03 Bioanalytical Chemistry and Food Analysis****Course code: VESPSCHA 303****Objective:** To understand and develop competence in use of food analysis and bioanalytical**Learning Outcomes (LO):**

On successful completion of this course students will be able to:

LO1	Understand bio-analytical concept, composition of body fluids, Physiological and nutritional significance of vitamins.
LO2	To study General processes of immune response concept of antigen-antibody and different types of assays
LO3	To Understand Fuel value of food and importance of food nutrients and concept of food additive.
LO4	To understand analysis of milk, oils, fats and spices.

Course title: Chemistry Paper 3**Course code: VESPSCHA 303**

UNIT I	Bioanalytical chemistry	15
	1.1 Body Fluids 1.1.1 Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases. (5L) 1.1.2 Physiological and nutritional significance of vitamins (watersoluble and fat soluble) and minerals. (5L) 1.1.3 Analytical techniques (including microbiological techniques) for vitamins. (5L)	
UNIT II	Immunological Methods	15
	2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.(8L)	
	2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.(7L)	
UNIT III	Food Analysis - I	15
	3.1 Fuel value of food and importance of food nutrients (2L)	
	3.2 Food Additives – General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour. (5L)	

	3.3 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. (8L)	
UNIT IV	Food Analysis - II	15
4.1	4.1.1 Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L) 4.1. 2 Processing and Quality requirements of Milk and milk products(cheese, butter and ice cream), vegetables and fruits, meat and meat products. (6L)	
	4.2 Analysis of Milk – Fat content, proteins, acidity, bacteriological quality and milk adulterants.(2L)	
	4.3 Analysis of Oils and Fats – acid value, sap value, iodine value. Determination of rancidity and antioxidants.(2L)	
	4.4 Analysis of spices (cloves, cinnamon, pepper, mustard) Determination of volatile oils and fixed oils.(3L)	

List of books and References:

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

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 04 Environmental and Certain Industrially Important Materials

Course code: VESPSCHAEC-I 304

Objective: To understand and develop competence in use of **Environmental and Certain Industrially Important Materials**

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To know the Sources, classification, pollutants and permissible limits. Sampling methods for air concept of Greenhouse gases and their substitutes.
- LO2 To understand quality and requirements direct and indirect pollutants of potable water.
- LO3 To study Soil pollution and Soil Analysis and get idea about noise pollution

Course code: VESPSCHAEC-I 304

UNIT I	Air Pollution	15
	1.1 Sources, classification, pollutants and permissible limits. (2L) 1.2 Sampling methods for air, flew gas, Industrial Exhaust, stag samples etc. (2L) 1.3 Importance of automobile exhaust control and its limits(2L) 1.4 Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors. (3L) 1.5 Carbon credit and global issues related to air pollution. (3L) 1.6 Greenhouse gases and their substitutes. (1L) 1.7 Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC. (2L)	

UNIT II	Water Quality Standards	15
	<p>2.1 Water: quality and requirements of potable water, direct and indirect pollutants for potable water reservoirs, quality of potable water from natural sources. (6L)</p> <p>2.2 Bore well water quality and analytical parameters. Quality of bottled mineral water (3L)</p> <p>2.3 Process of purification of bore well water to bottled mineral water. (2L)</p> <p>2.4 Regulatory requirements for packaged drinking water (4L)</p>	
UNIT III	Other Types Of Pollution	15
	<p>3.1 Soil pollution and Soil Analysis : sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long term effect on soil quality. (6L)</p> <p>3.2 Noise Pollution : sources, effects, methods of measurements and control measures.(2L)</p>	
	<p>3.3 Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy (3L)</p> <p>3.4 Radioactive pollutants: source, exposure hazards, precautions in handling and safety, Long term effects. (2L)</p> <p>3.5 Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification (2L)</p>	
UNIT IV	Industrial Materials	15
	<p>4.1 Insecticides, Pesticides: definition, classification of insecticides pesticides. Biodegradation of insecticides and pesticides (5L).</p> <p>4.2 Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents (5L)</p> <p>4.3 Petrochemical products: crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, corrosion test, carbon residue and impact on environment. (5L)</p>	

List of Books and References:

1. Environmental Chemistry, A. K. De, 2nd ED. Wiley (1989).
2. Environmental Pollution Analysis, S. M. Khopkar, John Wiley (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. Noise Pollution, Donald F Anthrop, Lexington Books, (1973)
12. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise (1981) Available at NCL laboratories e- Library.
13. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).
14. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication , (2003).
15. Environmental law in India, Mohammad Naseem, Wolters Kluwer.
16. Environmental Protection, Law And Policy In *India* Kailash Thakur google books (1997).
17. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002)
18. Pesticide Analysis Ed K. G. Das, Dekker (1981)
19. Analytical, Agricultural Chemistry S. L Chpra J.S Kanwar Kalyani publication
20. Soil and plant Analysis C.S Piper , Hans Publication

	3.3 Analytical Toxicology: Isolation, identification and determination of: 3.3.1 Narcotics: Heroin, morphine and cocaine. 3.3.2 Stimulants: Amphetamines and caffeine. 3.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax. 3.3.4 Hallucinogens: LSD and Cannabis. 3.3.5 Metabolites of drugs in blood and urine of addicts. 3.3.6 Viscera, stomach wash, vomit and postmortem blood for poisons like – cyanide, arsenic, mercury, insecticides and pesticides. (8L)	
UNIT IV	Cosmetic Analysis	15
	4.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis.(2L)	
	4.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.(3L)	
	4.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L)	
	4.4 Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers)(3L)	
	4.5 Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (2L)	
	4.6 Lipsticks: General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents.(2L)	

References

- 1) Analytical Biochemistry, David J Holmes and Hazel Peck, Longman, 1983.
- 2) Bioanalytical Chemistry, Susan R Mikkelesen and Eduardo Cotton, John Wiley and Sons, 2004.
- 3) Analysis of food and beverages, George Charalanbous, Academic press, 1978.
- 4) Harry's Cosmetology, 7th Ed, Longman Scientific Co.
- 5) Formulation and Function of Cosmetics, Joseph Stefan Jellinek, Wiley Interscience, 1971.
- 6) Cosmetic Technology, Edward Sagarin, Interscience Publishers, 1957.
- 7) Modern Cosmetics, Edgar George Thommsen, Francis Chilson, Drug and Cosmetic Industry, 1947.
- 8) Encyclopedia of Industrial Chemical Analysis, Foster Dee Snell et al, Interscience Publishers, 1967.
- 9) Government of India Publications of Food, Drug and Cosmetic Act and Rules.
- 10) The Handbook of Drug Laws, M L Mehra, University Book Agency, Ahmedabad, 1997.
- 11) Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
- 12) Text book of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
- 13) Food Processing and Preservation, B Sivasankar, Prentice - Hall of India Private Limited, 2007.
- 14) Food Additives, R M Pandey and S K Upadhyay, INTECH, Open Science/Open Minds.

- 15) Food Science, B Srilakshmi, New Age International (P) Ltd. Publishers, 2003.
- 16) Food Contaminants: Sources and Surveillance, Edited by C Creaser, R Purchase, Elsevier, 1991.
- 17) The Chemical Analysis of Food and Food Products, Morris B Jacobs.
- 18) FSSAI (Food Safety and Standards Authority of India) Manuals of Methods of Analysis of Foods (Oils and Fats, Milk and Milk Products, Food Additives), Ministry of Health and Family Welfare, Government of India.
- 19) Fundamentals of Urine and Body Fluid Analysis, Nancy A Brunzel, Elsevier health Sciences, 2013.
- 20) Lab Manual on Blood analysis and Medical Diagnostics, Dr Gayatri Prakash, S Chand and Company Ltd, New Delhi.
- 21) Manual of Medical Laboratory Techniques, S Ramakrishnan and K N Sulochana, Jaypee Brothers Medical Publishers (P) Ltd, 2012. Indian Pharmacopeia, Volume I and II.
- 22) Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
- 23) Forensic Chemistry, David E Newton, Infobase Publishing, 2007.
- 24) Encyclopedia of Analytical Chemistry, Volume 3, Academic Press, 1995.
- 25) AOAC Volume I and II.

**SEMESTER-III
PRACTICALS**

Course title: Chemistry Paper 01

Course code: VESPSCHA3P1

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To understand the Pka value of indicator. How to find out the concentration of Cu and Bi in mixture and Cu with diethyldithiocarbamate using spectrophotometry.
- LO2 Using conductometry students will estimate strong acid weak acid and salt.
- LO3 Analysis of Na₂CO₃ and NaHCO₃ by pH metry

No	Aim of Experiments
1	Determination of the pK value of an indicator
2	Determination of copper and bismuth in mixture by photometric titration
3	Estimation of strong acid, weak acid and salt in the given mixture conductometrically
4	Analysis of mixture of carbonate and bicarbonate (present inppm range) using pHmetry.
5	Determination of copper by extractive photometry usingdiethyldithiocarbamate

Course title: Chemistry Paper 02

Course code: VESPSCHA3P2

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Estimation of Pyridoxine hydrochloride,Sulphamethoxazole types of drugs in non aqueous solvent.
- LO2 percentage purity of methylene blue indicator
- LO3 To find the concentration of fluoride ion in a tooth paste

No	Aim of Experiments
1	Estimation of drugs by non aqueous titration: Pyridoxine hydrochloride,Sulphamethoxazole
2	Determination of percentage purity of methylene blue indicator
4	Estimation of fluoride in a tooth paste.

Course title: Chemistry Paper 03

Course code: VESPSCHA3P3

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To calculate the amount of total reducing sugar using Cole's Ferricyanide method and Lane - Eynon method
- LO2 To calculate the amount of lactose in milk contains and vitamin C in lemon squash.
- LO3 To determine the iodine value using wiji's solution

No	Aim of Experiments
1	Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method
2	Analysis of lactose in milk
3	Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method
4	Iodine value of oil

Course title: Chemistry Paper 04

Course code: VESPSCHA3P4

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To analyze ore and alloys like Pyrolusite, Magnesium, Bauxite.
- LO2 To find the total hardness and salinity of water sample
- LO3 To find the total hardness and Acidity and sulphate of water sample

No	Aim of Experiments
	To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry
	To analyze Magnesium for Mg by complexometry
	Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry)
	Analysis of water sample: Total hardness and salinity
	Analysis of water sample: Acidity and sulphate (Benzidine method).

NOTE:

1. The candidate is expected to submit a journal certified by the Head of the Department / institution at the time of the practical examination.
2. A candidate will not be allowed to appear for the practical examination unless he / she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate. Use of non-programmable calculator is allowed both at the theory and the practical examination.

**M.Sc. (ANALYTICAL CHEMISTRY)
(SEMESTER IV)**

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 401	Paper 01 Quality In Analytical Chemistry	60	4
	Unit I : Separation Science	15 Lectures	
	Unit II: Separation, Analysis and Standardization of Herbal based products.	15 Lectures	
	Unit III : Green Chemistry	15 Lectures	
	Unit IV : Advanced Techniques	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 402	Paper 02 Advance Instrumental Techniques	60	4
	Unit I : Spectral Methods III	15 Lectures	
	Unit II: Spectral Methods IV	15 Lectures	
	Unit III : Radiochemical And Thermal Methods	15 Lectures	
	Unit IV : Hyphenated Techniques	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHA 403	Paper 03 Selected Topics in Analytical Chemistry	60	4
	Unit I : Effluent Treatment	15 Lectures	
	Unit II: Solid Waste Management	15 Lectures	
	Unit III : Plastics and Polymers	15 Lectures	
	Unit IV : Metallurgy	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHAOC-I 404	Paper 04 INTELLECTUAL PROPERTY RIGHTS & CHEMINFORMATICS	60	4
	Unit I : Introduction to Intellectual Property	15 Lectures	
	Unit II: Trade Secrets	15 Lectures	
	Unit III : Introduction to Cheminformatics	15 Lectures	
	Unit IV : Applications	15 Lectures	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESPSCHAOC-II 404	Paper 04 RESEARCH METHODOLOGY	60	4
	Unit I : Introduction to Intellectual Property	15 Lectures	
	Unit II: Data analysis	15 Lectures	
	Unit III : Methods of scientific research and writing scientific papers	15 Lectures	
	Unit IV : Chemical safety & ethical handling of chemicals	15 Lectures	

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 01 Quality in analytical chemistry

Course code: VESPSCHA401

Objective: To understand and develop competence in use of Basic of Quality in analytical chemistry

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To learn Membrane separation processes, Applications of Solvent extraction.
- LO2 Students will learn Extraction of herbal materials, Standardization of herbal formulation and herbal extracts as per WHO.
- LO3 Students will learn Principle and concepts of green chemistry. what is Organic solvents, supercritical fluids and Ionic liquids.
- LO4 Students will understand electrophoresis method and concept of nanotechnology

UNIT I	Separation Science	15
	1.1 Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, 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 pretreatment steps, solvent extraction as a means of analytical determination (7L)	
UNIT II	Separation, Analysis and Standardization of Herbal based products.	15
	2.1 Herbs as a raw material: Defination 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,drying and processing of herbal raw material.(6L)	

	<p>2.2 Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.(3L)</p> <p>2.3 Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical,Spectral and toxilological standardization,qualitative and quantitative esimations.(6L)</p>	
UNIT III	Green Chemistry	15
	<p>3.1 Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity (4L)</p> <p>3.2 Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents (4L)</p> <p>3.3 Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistryand electrochemical synthesis. (4L)</p> <p>3.4 Designing Greener Processes: Inherently Safer Designs (ISD), Processintensification (PI) in-process monitoring. (3L)</p>	
UNIT IV	Advanced Techniques	15
	<p>4.1 Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) (2L)</p> <p>4.2 Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis and miceller electro kinetic capillary chromatography, instrumentation, detection and applications. (8L)</p> <p>4.3 Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, electronic structure, optical properties) one dimensional nano materials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots). (5L)</p>	

List of Books and references:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
4. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
5. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
6. Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978.
7. Super critical fluid extraction, Larry Taylor Wiley publishers N.Y. 1996
8. Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963
9. Ion exchange chromatography, Ed H.F Walton Howden, Hutchenson and Rossing 1976
10. Chromatographic and electrophoresis techniques, I Smith Menemann Interscience 1960
11. Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH verlag GmbH & co.
12. Sustainable residential development: planning and design for green neighborhoods. Avi Friedman, McGraw Hill professional.

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 02 Advance Instrumental Techniques

Course code: VESPSCHA 402

Objective: To understand and develop competence in use Advance Instrumental Techniques

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Understand the NMR and its modification like FTNMR, 2D NMR (COSY, TOCSY, HETCOR) and its application.
- LO2 Students will learn about mass spectroscopy. interpretation of mass spectra, molecular identification, metastable peaks, Fragmentation Reactions. Raman spectroscopy
- LO3 Students will learn about Principle, Interfacing , instrumentation and Applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. Simultaneous Thermal Analysis, Evolved gas analysis

Course title: Chemistry Paper 2

Course code: VESPSCHA 302

UNIT I	Spectral Methods III	15
	NMR Spectroscopy 1.1 Theory and Instrumentation- recapitulation, FTNMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR) (9L) 1.2 Radio waves in imaging- principle instrumentation and applications of MRI (3L) 1.3 Application of NMR to other nuclei C ¹³ , P ³¹ and F ¹⁹ spectroscopy (3L)	
UNIT-II	Spectral Methods IV	15
	2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from mass spectra- molecular identification, metastable peaks, Fragmentation Reactions (9L) 2.2 Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)	

UNIT III	Radiochemical And Thermal Methods	15
	3.1 Activation analysis- NAA ,radiometric titrations and radio-release methods (7L) 3.2 Thermal analysis- Principle, Interfacing , instrumentation and Applications of (a) Simultaneous Thermal Analysis- TG-DTA and TG-DSC (b) Evolved gas analysis- TG-MS and TG-FTIR (8L)	
UNIT IV	Hyphenated Techniques	15
	4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2 L) 4.2 Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)	

List of Books and references:

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

Detailed Syllabus: Unit wise with number of lectures

Course title: Chemistry Paper 03 Selected Topics in Analytical Chemistry

Course code: VESPSCHA 403

Objective: To understand and develop competence in use of Selected Topics in Analytical Chemistry

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 To understand treatment and disposal of Sewage. Process of Effluent treatment plant. Recycle and reuse of process and treated (effluent) water. different method use for Recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange
- LO2 To get clear idea about Solid waste management: objectives, concept of recycle, reuse and recovery. Methods of solid waste disposal. Treatment and disposal of sludge / dry cake as well as Bio- medical waste.
- LO3 Students will learn brief discussion on plastic like classification of plastic, determination of additives, molecular weight distribution, analysis of plastic and polymers. They also know the concept of Paints and pigments.
- LO4 To study about Ores and minerals. Students will also know the Chemical analysis of ores like : Galena, Pyrolusite, Bauxite, Hematite, Monazite, and same for the alloy like Cupronickel, Magnesium, Steel And Stainless Steel, Bronze, Gun metal.

Course title: Chemistry Paper 3

Course code: VESPSCHA 403

UNIT I	Effluent Treatment	15
	1.1 Effluent treatment plant general construction and process flow charts(3L) 1.2 Treatment and disposal of Sewage.(3L) 1.3. Effluent parameters for metallurgical industry.(2L) 1.4 Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent.(2L) 1.5 Recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange etc.(3L) 1.6 Recycle and reuse of process and treated (effluent) water(2L)	
UNIT – II	Solid Waste Management	15
	2.1 Solid waste management: objectives, concept of recycle, reuse and recovery (3L) 2.2 Methods of solid waste disposal.(2L) 2.3 Treatment and disposal of sludge / dry cake (3L) 2.4 Managing non-decomposable solid wastes(2L) 2.5 Bio- medical waste : Introduction , Classification and methods of disposal	

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

List of Books and References:

1. Environmental Pollution Analysis, S. M. khopkar, New Age International publication (2011).
2. Water and water pollution (hand book) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N.Y.(1972)
3. Water pollution, Arvind kumar, APH publishing (2004)
4. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
5. Solid waste management, K Sasikumar and Sanoop Gopi Krishna PHI publication (2009)
6. Solid waste management, Surendrakumar Northen Book Center (2009)
7. Handbook of chemical technology and pollution control 3rd Edn Martin Hocking AP Publication (2005).
- 8 Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005
9. Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
10. Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines, 1979.

Detailed Syllabus: Unit wise with number of lectures Course title:

INTELLECTUAL PROPERTY RIGHTS & CHEMINFORMATICS

Course code: VESPSCHAEC- I 404

Objective: To understand and develop intellectual property rights and cheminformatics.

- LO1 To learn various terms and terminology involved in intellectual property rights
LO2 To study trade secrets and economic value of intellectual property.
LO3 To know the evolution of cheminformatics and its application.

Unit no.	Details of topics	No of lectures
1	<p>Introduction to Intellectual Property: Historical Perspective, Different types of IP, Importance of protecting IP. 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. Industrial Designs: Definition, How to obtain, features, International design registration.</p> <p>Copyrights: Introduction, How to obtain, Differences from Patents.</p> <p>Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.</p>	15 Lectures
2	<p>Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. IP Infringement issue and enforcement: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property: Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer.</p> <p>Different International agreements: (a) 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 (b) Paris Convention [6L] WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity</p>	15 Lectures
3	<p>Introduction to Cheminformatics: History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. Searching Chemical</p>	15 Lectures

	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.	
4	Applications: Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligandbased and Structure based Drug design, Application of Cheminformatics in Drug Design.	15 Lectures

REFERENCES

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

Detailed Syllabus: Unit wise with number of lectures

Course title: RESEARCH METHODOLOGY

Course code: VESPSCHAC-II 404

Objective: To understand research methodology and develop scientific attitude

LO1 To learn research methodology for research data analysis and scientific writing.

LO2 To study the chemical safety and ethical handling of chemicals.

LO3 To learn the writing skills in scientific research project/ practical work

Unit no.	Details of topics	No of lectures
1	Unit 1: Print: Primary, Secondary and Tertiary sources. Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples Digital: Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wikidatabases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	15 Lectures
2	The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. Analysis and Presentation of Data: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	15 Lectures
3	METHODS OF SCIENTIFIC RESEARCH AND WRITING SCIENTIFIC PAPERS Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation. Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	15 Lectures
4	CHEMICAL SAFETY & ETHICAL HANDLING OF CHEMICALS Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working	15 Lectures

	with gases at pressures above or below atmospheric pressure, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	
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REFERENCES

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), Practical skills in Chemistry, 2 nd Ed., Prentice Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) Data Analysis for Chemistry Oxford University Press.
3. Topping, J., (1984) Errors of Observation and their Treatment 4 th Ed., Chapman Hill, London.
4. Harris, D. C. (2007) Quantative Chemical Analysis 6 th Ed., Freeman Chapters 3-5
5. Levie, R. De. (2001) How to use Excel in Analytical Chemistry and in general scientific data analysis Cambridge Universty Press.
6. Chemical Safety matters – IUPAC-IPCS, (1992) Cambridge University Press.
7. OSU Safety manual 1.01

Course title: Chemistry Paper 01
Course code: VESPSCHA4P1

Semester IV

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Determination of pK value of Tribasic acid like H_3PO_4 using Potentiometrically
- LO2 Simultaneous determination of Ti^{3+} and V^{5+} and determination of pH of buffer solution by spectrophotometrically.
- LO3 To find the concentration of Na^+ from dairy whitener by flame photometry and Zn from Bronze alloy by complexometric method.

No	Aim of Experiments
1	Determination of pK value of H_3PO_4 potentiometrically.
2	Estimation of Na^+ in dairy whitener by flame photometry.
3	Spectrophotometric determination of pH of buffer solution.
4	Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method.
5	To analyze Bronze for Zn by complexometric method.

Course title: Chemistry Paper 02
Course code: VESPSCHA4P2

Semester IV

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Estimation of Glycine , Sodium Benzoate types of drugs in non aqueous solvent.
- LO2 To determine the percentage purity of crystal violet indicator
- LO3 Estimation of detergents to Analysis of Active detergent matter, alkalinity and Oxygen releasing capacity

No	Aim of Experiments
1	Estimation of drugs by non aqueous titration: Pyridoxine hydrochloride, Sulphamethoxazole.
2	Determination of the purity of crystal violet.
3	Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity
4	Estimation of Ca in Ca-pentathionate/calcium lactate tablets.

Course title: Chemistry Paper 03
Course code: VESPSCHA4P3

Semester IV

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Estimation of Glycine , Sodium Benzoate types of drugs in non aqueous solvent.
- LO2 To determine the percentage purity of crystal violet indicator
- LO3 Estimation of detergents to Analysis of Active detergent matter, alkalinity and Oxygen releasing capacity

No	Aim of Experiments
1	Analysis of Calcium, Iron and phosphorous in milk
2	Determination of SAP value of oil
3	Estimation of Aldehyde in lemon grass oil / Cinnamon oil
4	Estimation of Glucose by Folin-Wu method
5	Analysis of water sample : Mn^{2+} by colorimetric method

Course title: Chemistry Paper 04

Semester IV

Course code: VESPSCHA4P4

Learning Outcomes (LO):

On successful completion of this course students will be able to:

- LO1 Students will develop research mindset
- LO2 Students will get more exposure of advance instrument which is used in research like GC, Mass spectroscopy, IR.

Group – D: Project Evaluation

NOTE:

The candidate is expected to submit a journal certified by the Head of the Department / institution at the time of the practical examination.

A candidate will not be allowed to appear for the practical examination unless he / she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate.

Use of non-programmable calculator is allowed both at the theory and the practical examination.

Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part & by conducting the Semester End Examinations with 60% marks in the second part. Practical Examination will consist of End Sem examination.

Student will have to score 40% of marks in Internal assessment as well as End Sem examination to pass the course.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment : It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

A. Theory - Internal assessment 40%

40 marks

Sr No	Evaluation type	Marks
1.	Seminar presentation/internship/project	40

B. Theory - External examination - 60%

60 marks

Semester End Theory Assessment

Semester End Theory Assessment

Duration - Each paper shall be of 2.5 hours' duration.

1. Theory question paper pattern as per the university pattern : -
 - a. There shall be FIVE compulsory questions.
 - b. Question No 1, 2, 3 and 4 will be based upon Unit 01, Unit 02, Unit 03 and Unit 04 respectively.
 - c. Question No 05 will be based on Unit 01, 02 ,03 and 04. Two questions from each unit

Question no.	Details	Marks
Q1.	(Unit 01)	12M
	Attempt any three of the six A) /B) / C) /D) /E) /F)	
Q2.	(Unit 02)	12M
	Attempt any three of the six A)/ B)/C)/D)/E)/F)	
Q3.	(Unit 03)	12M
	Attempt any three of the six A)/B)/C)/D)/E)/F)	
Q4	(Unit 04)	12M
	Attempt any three of the six A)/B)/C)/D)/E)/F)	
Q5	(Unit 01, 02 ,03 and 04)	12M
	Attempt any four out of eight A)/B)/C)/D)/E)/F)/G)/H)	

C. For Each Semester Practical Assessment

	Section 1 Based on Paper 02	Marks
A	Experimental work	40
B	Viva	05
C	Journal	05
		50 Marks

PRACTICAL BOOK/JOURNAL

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

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department ; failing which the student will not be allowed to appear for the practical examination.

**Overall Examination and Marks Distribution Pattern
SEMESTER III**

Course	VESPSCHA301	VESPSCHA302	VESPSCHA303	VESPSCHAEC I-304	Grand Total
Theory	100	100	100	100	400
Course	VESPSCHO3P1	VESPSCHO3P2	VESPSCHO3P3	VESPSCHO3P4	Grand Total
Practical	50	50	50	50	200

SEMESTER IV

Course	VESPSCHA401	VESPSCHA402	VESPSCHA403	VESPSCHAEC -II 404	Grand Total
Theory	100	100	100	100	400
Course	VESPSCHA4P1	VESPSCHA4P2	VESPSCHA4P3	VESPSCHA4P4	Grand Total
Practical	50	50	50	50	200