



Shri Vaishnav Vidyapeeth Vishwavidyalaya

M.Sc. (Analytical Chemistry)

Choice Based Credit System (CBCS) (Batch 2021 -2023)

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY		PRACTICAL		
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
MSAN 401	DC	Physical methods in chemistry	3	0	0	3	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

*Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To provide theoretical and practical knowledge of spectroscopy and diffraction techniques
2. Student will learn about the different optical instrumentation methods further its applications in the analysis of biological samples
3. Apply knowledge about electronic and mass spectroscopy techniques and to determine the structure of unknown compounds
4. To develop the understanding of double resonance and pulse techniques of NMR, practical applications of TGA, DTA, DSC and X-ray fluorescence spectroscopy.

Course Outcomes: After completion of this course the students are expected to demonstrate following knowledge, skills, and attitudes. The student can be able to demonstrate the following.

CO1. To aware of different types of spectroscopy techniques and students will learn theory and principles of photoelectron spectroscopy, ESCA

CO2. To learn the practical importance of FTNMR, NMR of P and F containing molecules

CO3. Apply and demonstrate the uses of X-ray diffraction and Mossbauer spectroscopy. Students will gain the practical applications of Thermal methods analysis

CO4. Acquire the practical knowledge by doing experiments on the Flame emission spectroscopy, Scanning electron spectroscopy and Surface analytical techniques for biological molecules

Syllabus:


Unit I Electronic spectroscopy:

Theory and principles, application of group theory, formaldehyde butadiene, dissociation energy of diatomic molecules, Photoelectron Spectroscopy, ESCA.

Unit II NMR:

Principles, theory, chemical shift, spectra of organic molecules, coupling constants, Karplus curve, J values, ^{13}C -NMR-decoupling - double resonance techniques - NOE, and pulse techniques, FTNMR, NMR of phosphorous and Fluorine containing molecules.


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Unit III Mass spectra:

Introduction, theory and instrumentation. Molecular ion peak, meta stable peak, techniques, Application in determining structure of compounds. ESR-g-value, anisotropy, simple organic radicals, transition metals and coordination compounds.

Unit IV Analytical techniques:

X-ray diffraction - Bragg equation, space groups and point groups, diffraction methods. Mossbauer spectroscopy -theory and applications, Fe and Sn systems, Thermal methods of analysis - TGA, DTA and DSC - Principle and applications. Atomic absorption spectroscopy and Induced couple plasma spectroscopy.


Unit V Optical instrumentation methods for analysis of biological samples:

Principle, instrumentation, and relevant applications of Spectro fluorometry, UV-Visible and FTIR, Flame emission spectroscopy. Surface analytical techniques for biological samples: Scanning Electron microscopy and X-ray Fluorescence spectroscopy.

Text & Reference books:

1. Principles of Instrumental Analysis - 5th edition - Skoog, Holler, Nieman
2. Hobert.H. Willard D. L Meritt and J.K.A. Dean Instrumentation -C.B.S. Publisheres
3. Instrumental methodology, chemical analysis - Ewing
4. Infrared and Raman spectra of Inorganic and coordination compounds, Kazuo Nakamoto, 5th edition, John Wiley & Sons, 1955.
5. Mass Spectrometry for Chemists and Bio-Chemists,Robert A.W.Johnstone and Malcolm. E.Rose,2nd Edition.


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- Handbook for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle Prentice Hall, New Jersey, USA (1997).
- Analytical chemistry, Gary D.Christian, Sixth edition, John Wiley and Sons. New York, 1994.
- Analytical chemistry, Skoog & West, 6th edition.
- Instrumental methods of Analysis, Chatwal Anand.
- Instrumental methods of Analysis-B.K.Sharma,Goel Publishing House,Meerut.
- Mass Spectrometry Principles & Applications, Hoffman & Stroobant, 2nd Ed.(Wiley) 20003.
- Analytical NMR Ed.Ld.Field and S.Stern hill, John Wiley and Sons. New York, 1989.
- Organic Spectroscopy, P.S .Kalsi,New-age International publication., 2007
- Organic Spectroscopy, Y.R.Sharma,S.Chand publication, 2014

List of Practical's: (If Practical Credit Shown in Syllabus)
Guidelines for Practical:

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							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
MSAN 402	DC	Advances in Analytical Techniques	3	0	0	3	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

*Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To develop the understanding of Analytical procedures involved in environmental monitoring and Analysis of metal and radioactive pollutants in effluents.
2. To give basic knowledge of different physical methods of analysis used in the analysis of cement, alloys and BOD, COD, DO, TOC of different water samples
3. Enable students to learn the experimental procedures and techniques used in Government environmental labs
4. Impart training in the analysis of food samples, analysis of pesticide residues in food grains

Course Outcomes: After completion of the course student can be able to demonstrate following skills and attitudes

- CO1. Theoretical understanding of LLE, SPE, purge and trap for volatile organics in samples
- CO2. To recognize the importance of Solid phase micro extraction, SPMEGC, SPME-HPLC-MS
- CO3. Students will learn the Ultrasound-assisted procedure of estimation of VOC. Students will learn about theoretical and practical knowledge on Bioremediation, Bioventing.
- CO4. Impart the training for removal of toxic metals and SO₂ by Coagulation, Ion exchange, DAF, and other methods as Ion Floatation (IF), Membrane Filtration, Electro Deposition.

Syllabus:


Unit I Aqueous and Solid phase extraction:


Classical approach for aqueous extraction - Introduction, Liquid-Liquid extraction (LLE). Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples. Solid Phase extraction (SPE)- Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE.

Unit II Micro and Microwave assisted extraction:

Solid phase micro-extraction- Introduction, theory, principle, and experimental methods of analysis: SPMEGC, Methods of analysis: SPME-HPLC-MS, Automation of SPME, New development in micro extraction (liquid micro extraction, membrane micro extraction).


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MEAN 402	DC	Advances in Analytical Techniques	3	0	0	3	40	20	20	0	0

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Microwave assisted extraction- Introduction, instrumentation, Applications. (LLE) Liquid-Liquid extraction (Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples.

Unit III Ultrasound assisted extraction and techniques:

Ultrasound – principle and general applications, Recent studies in the environmental applications- general procedure for the determination of contaminants in food and soil samples. Ultrasound-assisted procedure for fast screening of Volatile Organic Contaminants (VOC) and Toxic metals in soil. Water purification using ultrasound waves-application and challenges. Bioremediation and Bioventing.

Unit IV Removal of Heavy Toxic Metals:

Types of heavy metals and their effects - Chromium, Mercury, Lead, Cadmium, Arsenic. Analytical methods of determination of Metal pollutants, Treatments of waste to remove heavy metals, recovery techniques. Removal of Particulate matters, Coagulation, Ion exchange, Dissolved Air Flotation (DAF), Ion Flootation (IF), Membrane Filtration, Electro Deposition. Particulate matter in Gas stream, Industrial method of separation, safety of workers analysis of particulate matter.

Unit V Removal of sulphur dioxide and nitrogenous materials:

Origin of SO₂ and its hazards, analysis of SO₂ control methods, desulphurization of flue gas, Indian coal, and Indian crude oil. Economics of SO₂ control measures. NO_x, dissolved NO_x, Nitrites, Ammonia, Urea and other nitrogen compounds in the effluent fertilizers, explosive, industrial effluents, effluents from nitro aromatic industries, analytical methodology and photochemistry of air pollution.

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MSAN 402	DC	Advances in Analytical Techniques	3	0	0	3	60	20	20	0	0

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Textbooks:

1. Introduction to Instrumental Analysis by R. D. Broun, Mc Graw Hill (1987)
2. Instrumental methods of chemical analysis by H. Willard, L. Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986)
3. Fundamentals of Analytical Chemistry, 6th edition, D.A. Skoog, D.M. West and F.J. Holler, Saunders college publishing.
4. Vogel's Textbook of Quantitative analysis 6th Ed.
5. Separation methods by M.N. Sastri, Himalaya Publishing Company, Mumbai.
6. Air pollution control and design handbook by P.N. Chennsiof and R.A. Young.
7. Resources recovery and recycling handbook and industrial wastes, M. Sitting (NDS).
8. Sulphur in environment by J.O. Niagh, Vol. I and II.
9. Toxic and hazardous waste disposal by R.B. Pojasele, Vol. I, (AAS).
10. Environmental pollution analysis by S.M. Khopkar.
11. Environmental pollution analysis by A.K. Dee.
12. Inorganic chemistry by J.E. Huheey et al, 1993


Reference Books:


1. Separation methods by J.A Dem
2. Pollution control in processes industries, S.P. Mahajan (J.W).
3. Refuse, Recycling and Recovering (J.W).
4. The Industry/EPA confrontation, P.S. Minor (MGH).
5. Industrial safety handbook by W. Handley.

List of Practical's: (If Practical Credit Shown in Syllabus)

Guidelines for Practical:

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MISAN 403 (A)	DE	Important topics of Modern Analytical chemistry	3	0	0	3	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

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Course Objectives:

1. To provide a broad foundation of Modern analytical chemistry which stresses scientific reasoning and solving the analytical problem with the industrial applications
2. To provide the basic knowledge of membrane separation processes, microfiltration, and ultra-filtration. Student will learn the standardization of herbal formulation, and cGMP guidelines.
3. To learn theory and practical applications of Capillary electrophoresis and Isotachophoresis
4. Making students to learn about the preparation of one-, two-, three- dimensional nanomaterials, quantum dots and study the toxicological health effects of nanoparticles, its risk assessment.

Course Outcomes: The student can be able to deliver the following

- CO1. Recall theory and practical concepts of Reverse Osmosis, Dialysis and Electro Dialysis
- CO2. Apply and demonstrate the practical uses of SDS-Page, Kinetic capillary chromatography
- CO3. Practical utility, industrial applications of nanomaterials, nanoparticles, and quantum dots
- CO4. Will gain the practical knowledge on engineered nanomaterials and nanoparticle toxicology

Syllabus:

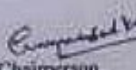
Unit I Separation Science:


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. Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis, and electro-dialysis.

Unit II Extraction, Analysis and Standardization of Herbal based products:

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, drying and processing of herbal raw material. Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principle involved in extraction.


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MSAN 403 (A)	DE	Important topics of Modern Analytical chemistry	3	0	0	3	60	20	20	0	0

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Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical, Spectral, and toxicological standardization, qualitative and quantitative estimation.

Unit III Advanced Techniques:

Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) Techniques of Electrophoresis: low and high voltage, SDS-Page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotachophoresis and micellar electro kinetic capillary chromatography, instrumentation, detection and applications.

Unit IV Role of Nanotechnology in Analytical chemistry:

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).


Unit V Environmental impacts of nanotechnology:


Introduction, engineered nanomaterials in the human body, routes of entry, toxicity and mechanism of action, environmental implications of nanoparticles, toxicological health effects, relevant parameters in nanoparticle toxicology, integrated concept of risk assessment of nanoparticles.

Textbooks:

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. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
4. Solvent extraction and ion exchange, J Marcus, and A. S. Kertes Wiley-INC 1969.


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MSAN 403 (A)	DE	Important topics of Modern Analytical chemistry	3	0	0	3	60	20	20	0	0

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5. Extraction Chromatography, T. Braun, G. Gherse, Elsevier Publications 1978.
6. Super critical fluid extraction, Larry Taylor Wiley publishers N.Y. 1996
7. Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963

Reference Books:


1. Ion exchange chromatography, Ed H.F Walton Howden, Hutchenson and Rossing 1976
2. Chromatographic and electrophoresis techniques, I Smith Menemann Interscience 1960
3. Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH Verlag GmbH & co.
4. Sustainable residential development: planning and design for green neighbour hoods. Avi Friedman, McGraw Hill professional.
5. How to Research by Loraine Blaxter, Christina Hughes and Malcolm Tight, Viva Books Pvt.Ltd., New Delhi

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MSAN 403 (H)	DE	Chemistry of Nanomaterials	3	0	0	3	60	10	10	0	0

Legend: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit.

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Course Objectives:

1. To give an in-depth account of Nanomaterials with respect to different synthetic approach, various characterization, and their unique applications in the field of R & D, Technology
2. To recognize principle and develop skills of various Spectroscopy and Powder XRD techniques
3. To expose the students in the field of Electronic and Photonic molecular Nanomaterials
4. Impart training in the development and implementation of renewable energy technologies

Course Outcomes: After completion of this course the students are expected to demonstrate following knowledge, skills, and attitudes. The student can be able to demonstrate the following.

CO1. To understand the synthesis of SWNT, MWNT, and Gas phase synthesis of Nanomaterials

CO2. Recall the practical concepts of CVD, DLS, SEM, TEM, AFM, and their specific uses

CO3. Demonstrate the Industrial applications of LEDs based Nanotubes, Nanowires, and OLEDs

CO4. Will gain the practical skills of Energy transport, Storage, Drug delivery, and Bio-imaging

Syllabus:

Unit I Introduction to Nanomaterials:


Size Effects - difference between bulk and Nanomaterials - Definition of Nanomaterial - Classification Nanomaterials: Nanoparticles, Nanocrystal, 0-D Quantum dots, Nanostructured material (1-D Wire and rods, 2-D thin film, 3-D structures) - Carbon nanotubes (CNTs): Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs) - Graphene. Influence of Nano structuring on mechanical (Abrasion and wear resistance, Super elasticity, Nanotribology), optical, electronic, magnetic, and chemical properties.


Unit II Synthesis and Characterisation of Nanomaterials:

Synthesis of Nanomaterials: Bottom Up and Top-Down approach - Gas Phase synthesis of Nanomaterials - Wet chemical synthesis - Chemical Vapour Deposition (CVD). Characterization of Nanomaterials using UV-Visible Spectroscopy, Fluorescence Spectroscopy, Powder XRD, Particle size analysis by Dynamic Light Scattering (DLS), SEM, TEM, AFM techniques.

Unit III Electronic and Photonic Molecular Nanomaterials:

Optical luminescence and Fluorescence from direct, bandgap semiconductor nanoparticles-White


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MSAN 403 (B)	DE	Chemistry of Nanomaterials	3	0	0	3	60	20	20	0	0

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LEDs - LEDs based on nanowires - LEDs based on nanotubes- LEDs based on nanorods - High Efficiency Materials for OLEDs -High Efficiency Materials for OLEDs.

Unit IV Use of Nanomaterials for energy technology:

Energy challenges, development, and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies -Nanomaterials and devices for energy transport, conversion, and storage.

Unit V Nanomaterials in Medicine:

Introduction to Nanocarriers, Interactions of nanocarriers with blood stream, cellular targeting, Biological and chemical reagents for cell-specific targeting - Biodistribution of liposomes, dendrimers and Nanoparticles, Toxicity of nanocarriers, drug delivery, tissue regeneration, cancer detection, Luminescent nanoparticle probes for bio-imaging and diagnostics.

Textbooks:

1. Textbook of Nanoscience and Nanotechnology, B.S. Murty, Universities Press, 2011
2. Nanochemistry: A chemical approach to Nanomaterials, Ozin Geoffrey A. and Andre C. Arsenault, Royal Society of Chemistry Publication, 2005.
3. Nano: The Essentials", T. Pradeep, Tata McGraw Hill, 2007
4. Renewable Energy Resources, J. Twidell and T. Weir, E & F N Spon Ltd, 1986.


Reference Books:


1. Introduction to nanotechnology by C.P. Poole, Jr & F. J. Owens, John Wiley and Sons (2009).
2. Nanobiotechnology by Subbiah Balagi, MJP Publishers, India (2010).

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MSAN 403 (C)	DE	Food technology, pharmaceutical & environmental analysis	3	0	0	3	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

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Course Objectives:

1. To provide a clear and incisive treatment of Analysis of Food, additives, Pesticide residues and quantitative estimation of added dyes in Foods
2. To provide the practical knowledge of Preformulation of drugs & study of properties of a drug
3. To develop the practical understanding of Process quality control tests – principles and steps
4. Impart training in the Stability testing. Analysis of air, water, solid wastes, and analysis of soil

Course Outcomes: The student will be able to deliver the following

- CO1. Theoretical and practical understanding of analysis of dairy products, coffee, and food dyes
 CO2. Enable to gain the practical knowledge of Preformulation, and quality control tests of drugs
 CO3. To learn the methods of chemical analysis of primary and secondary air pollutants
 CO4. Impart practical experiments in the determination of Cr (III), Cr (VI), pH, and TDS


Syllabus:

Unit I Analysis of Food, Additives and Pesticide residues and Analysis of Food:

Determination of starch by saccharimeter method in flour. Analysis of dairy products, Analysis of caffeine in Tea and Coffee. Analysis of chemical additives: colour additives (Coal – tar dyes, vegetable, and mineral colours), Chromatographic identification of colours. Analysis of Food Additives: Chemical preservatives and synthetic sweetening agents (organic – ether extractable and non-ether extractable) SO₂, Sodium Benzoate, Sorbic acid, Benzoic acid. Antioxidants: Types of Antioxidants used in foods- Butylated Hydroxy Toluene (BHT) by TLC & GC. Analysis of Pesticide residues: Endosulfan, endrin, BHC, 2,4- D, 2,4,5-T by HPLC.

UNIT II Preformulation:

Goals of Preformulation, solid state manipulation and characterization. pH dependent solubility of drug, equilibrium solubility, intrinsic dissolution of drug, particle size distribution. Flow of Powders: Physical properties and importance. Angle of repose, Car's index, compressibility, bulk density, tapped density.


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							THEORY		PRACTICAL		
							END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*
MSAN 403 (C)	DE	Food technology, pharmaceutical & environmental analysis	3	0	0	3	60	20	20	0	0

Legends: L - Lecture; T - Tutorial/Teacher Guided Student Activity; P - Practical; C - Credit;

*Teacher Assessment shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

UNIT III Process quality control tests:

Process quality control tests for Oral solid dosages forms (Tablets, capsules etc.,) and parenteral (Injection etc.,) Hard Gelatin Capsules; General principles and steps involved in the production of drug loaded hard gelatin capsules, filling operation, filling of powders, granules, and pellets. Tablets: Types of tablets, granulation methods, highlighting operations such as mixing, drying, milling, blending, lubrication and compression, disintegration, dissolution.

Unit IV Stability testing and Analysis of Air:

Chemical degradation and preventive measures. Various stability testing conditions and use of stabilizers in packing. Analysis of Air: Air pollutants, Chemical analysis of Air pollutants Primary air pollutants: Carbon compounds (CO&CO₂) Sulphur compounds (SO₂, SO₃&H₂S) Nitrogen compounds (NO&NO₂) Hydrocarbons (Aliphatic hydrocarbons, Polycyclic Aromatic hydro carbons) Secondary air pollutants: Ozone, Peroxy Acetyl Nitrate (PAN).

Unit V Analysis of water, solid wastes, and soils:

Analytical methods and analysis of following ions, Determination pH and TDS Anions: carbonate, bicarbonate, fluorine, chlorine, Bromine and Iodine, sulphate, phosphate, nitrate, cyanide. Cations: Na, K, Fe-(II), Fe-(III), Ca-(II), Mg-(II), Cr-(III), Cr-(VI). Analysis of solid wastes, soils: Sampling, determination of moisture, soil adsorption ratio. Analysis of environmental samples (soil and solid wastes for inorganic and organic pollutants): volatile and semi volatile hydrocarbons, Poly Aromatic Hydrocarbons (PAHs) and chlorinated pesticides and inorganic cations and anions utilizing appropriate separation methods followed by analysis using GC and HPLC.


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Shri Vaishnav Vidyapeeth Vishwavidyalaya

M.Sc. (Analytical Chemistry)

Choice Based Credit System (CBCS) (Batch 2021 -2023)

COURSE CODE	CATEGORY	COURSE NAME	L	T	P	CREDITS	TEACHING & EVALUATION SCHEME				
							THEORY		PRACTICAL		
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MSAN 403 (C)	DE	Food technology, pharmaceutical & environmental analysis	3	0	0	3	60	20	20	0	0

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Textbooks & References:


1. Environmental Pollution Analysis – S.M.Khopkar, Wiley Eastern Limited
2. Environmental Chemistry –B.K.Sharma – H.Kaur
3. Pharmaceutical chemistry, Instrumental techniques Vol-2, Edited by Leslie.G.Chatten.
4. Textbook of Pharmaceutical analysis – Kenneth. A.Connors
5. Handbook of analytical control of Iron and steel production,Harrison John, wiley 1979.
6. Standar mehdods of Chemical Analysis, Welcher
7. Technical Methods of Analysis,Griffin,Mc GRaw Hill
8. Environmental Analysis – Chatwal
9. Aquatic Environmental Chemistry – Alan G.Howard
10. Environmental Analysis – C.S.Rao or S.M. khopkar(IIT Bombay)
11. A text book of Environmental Control & Pollution – S.S.Dara.
12. Biochemical methods – 2nd edition. S.Sadasivan, A.Manickam
13. Handbook of analysis and quality control for fruit and vegetables products- S.Ranganna.
14. Practical pharmaceutical chemistry, A.H.Beckett and J.B.Stenlake, III edition Vol 1 & Vol2.
15. Pharmaceutical analysis. P.Parimoo.
16. Environmental Chemistry – 4th edition – Anil Kumar.De Wiley Eastern Ltd.
17. Hand Book in Analysis and quality control for fruit and vegetable products-S.Ranganna.

List of Practical's: (If Practical Credit Shown in Syllabus)

Guidelines for Practical:

A two-credit lab is to be conducted by covering the most relevant and useful topics from mentioned syllabus.


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