

Rayat Shikshan Sanstha's

**YASHAVANTRAO CHAVAN INSTITUTE OF SCIENCE,
SATARA**

(An Autonomous College)

Reaccredited by NAAC with 'A+' Grade

New Syllabus For

Master of Science

Part - II

**Analytical Chemistry
Syllabus**

To be implemented from June, 2022 onward

Structure of Course

M.Sc. Part II Semester III

Theory			
Course No. and Course code	Title of Course	No. of lectures Per week	Credits
MACT-301	Fundamentals Of Analytical Chemistry	4	4
MACT-302	Advanced Analytical Techniques	4	4
MACT-303	Organo- Analytical Chemistry	4	4
Elective Course			
MACT-304A Or MACT- 304B	Electro Analytical Techniques In Chemical Analysis Or Modern Separation Methods in Analysis	4	4
Practical			
MACP 305	Practical course V: Lab V	16	4
MACP 306	Practical course VI: Lab VI	16	4
		48	24

M.Sc. Part II Semester IV

Theory			
Course No. and Course code	Title of Course	No. of lectures Per week	Credits
MACT-401	Techniques in forensic science and microbiological analysis	4	4
MACT-402	Environmental chemical analysis and control	4	4
MACT-403	Applied industrial analysis	4	4
Elective Course			
MACT-404A or MACT- 404B	Quality Assurances and quality control Or Industrial Analytical Chemistry	4	4
Practical			
MACP 405	Practical course V: Lab VII	16	4
MACP 406	Practical course VI: Lab VIII	16	4
		48	24

M.Sc. II: Evaluation structure

Semester III and IV

Paper code	Theory	Practical	Total				
	ESE	ISE	Total	ESE	ISE	Total	
Theory paper - I	60	ISE-I = 10 ISE-II = 10 (Online test) Activity = 20 (Book review) Total = 40	100	--	--	--	100
Theory paper - II	60	ISE-I = 10 ISE-II = 10 (Online test) Activity = 20 (Home assignment) Total = 40	100	--	--	--	100
Theory Paper - III	60	ISE-I = 10 ISE-II = 10 (Online test) Activity = 20 (Survey/Seminar) Total = 40	100	--	--	--	100
Theory paper - IV	60	ISE-I = 10 ISE-II = 10 (Online test) Activity = 20 (Group discussion / Innovative idea presentation) Total = 40	100	--	--	--	100
Practical paper - I	--	--	--	60	Journal = 10 Student performance = 10 Activity = 20 (case study/survey report) Total = 40	100	100
Practical paper - II	--	--	--	60	Journal = 10 Student performance = 10 Activity = 20 (model presentation/project) Total = 40	100	100
Total	240	160	400	120	80	200	600

M.Sc. Part- II (Semester-III)

MACT 301: Fundamentals of Analytical Chemistry

Course Objectives: Student will be able to

1. understand various separation method like Precipitation, Distillation, and Extraction.
2. understand idea about Basic concepts of chromatography.
3. study the basic knowledge of chemical equilibria.
4. study the idea about analytical data and statistical analysis.

Credits=4	SEMESTER-III MACT 301: Fundamentals of Analytical Chemistry	No. of hours per unit/ credits
Credit-I UNIT I	Introduction to Analytical separation.	(15)
	Separation by Precipitation, Separation by species by distillation, Separation by extraction, Derivation of equation, Separation by ions by ion exchange, Home water softeners, Chromatographic separation, Source of the Team Plate and Plate Height, Derivation of Equation.	
Credit-I UNIT II	Principles of Chromatography	(15)
	Non-Chromatographic methods of separation, Membrane separation methods, Chromatography as the method of separation, Historical Development, Classification of Chromatographic Methods, Fundamentals of Chromatography, Techniques in Chromatography, Dynamics of Chromatography Van Demeter's Equation, Resolution of Mixtures, Separations Characteristics, Special Features of Chromatographic Methods, Solved Problems.	
Credit-I UNIT III	Aqueous Solution and Chemical Equilibria	(15)

	The Chemical Composition of aqueous Solutions, Chemical Equilibrium, Stepwise and overall Formation Constant for complex Ions, relative strength of Conjugate acid and bases pairs, The method of successive Approximations 9C Buffer solutions. The Henderson-Hasselbalch Equation. Acid rain and the Buffer Capacity of lakes, buffer capacity, polyprotic acids, buffer for biological and clinical measurements.	
Credit-I UNIT IV	Reliability of Analytical Data and Statistical Analysis	(15)
	Statistical analysis, Criteria for rejection of results Q-test, Presentation of data, Confidence limit, Q test for rejection of result, Standard t-test. Confidence Interval, Statistical Aids to Hypothesis testing, Analysis of Variance, Detection of Gross Errors.	

Course Outcomes: Student should be able to

1. Understand different separation methods of Precipitation, distillation, extraction, ion exchange.
2. differentiate the basic principles, classification of chromatography.
3. understand the Chemical Composition of aqueous Solutions and relative strength of Conjugate acid and bases pairs.
4. analyze the concepts of Statistical analysis, Presentation of data, Analysis of Variance.

References:-

1. D. A. Skoog and D. M. West, James Holler and Stanley R.Crouch, Fundamental of Analytical Chemistry, 9th Edition, Cengage learning EMEA(2019) (Unit I, III and IV)
2. D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, 7th Edition (Saunders College Publishing, Philadelphia, Holt, London 1996) (Unit I)
3. G. D. Christian Analytical chemistry, sixth Edition, Wiley publications.(1807)(Unit III)
4. S.M. Khopkar Basic Concepts of Analytical Chemistry New Age International publisher(2008) (Unit IV).
5. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, John Wiley & Sons, New York (1976).

MACT 302: Advanced Analytical Techniques.

Course Objectives: Student will be able to

1. understand Supercritical fluid chromatography and Ultra Performance Liquid Chromatography.
2. Study advanced instrumentation techniques like SEM, TEM, EDAX, STM, AFM.
3. study radiochemical methods in activation analysis.
4. understand about various Ion source and detectors in Mass Spectrometry.

Credits=4	SEMESTER-III MACT 302: Advanced Analytical Techniques.	No. of hours per unit/ Credits
Credit-I UNIT I	Supercritical fluid chromatography	(15)
	Introduction, SFC Advantages, Supercritical Fluids, Instrumentation, Supercritical Mobile Phase, Injectors, Ovens and Pumps, Columns, Detectors, SFC for the separation of polymers and of pesticides. Ultra Performance Liquid Chromatography (UPLC).	
Credit-I UNIT II	Advanced Instrumentation Techniques	(15)
	Scanning Electron Microscope (SEM) - Introduction, principle, instrumentation, applications Transmission Electron Microscope (TEM) -Introduction, principle, instrumentation, applications Energy Dispersive X-ray Analysis (EDAX) - Introduction, principle, instrumentation, Applications. Scanning Tunneling Microscopy (STM) - Introduction, principle, instrumentation, applications. Atomic Force Microscopy (AFM) - Introduction, principle, instrumentation, applications. Practical applications and examples.	
Credit-I UNIT III	Radio-analytical Chemistry	(15)
	Introduction, Activation analysis, basic principles, fast neutron activation analysis, radiochemical methods in activation analysis, Applications if Geo-chemistry, oxygen in metals. Isotope dilution analysis: Principles and applications. Sub-stoichiometric determination of traces of metals: Principles, techniques and experimental methods in	

	the determination of As, Pb and Hg..	
Credit-I UNIT IV	Advances in Mass Spectrometry	(15)
	Introduction to Mass spectrometry, diagram of a mass spectrometer and instrumentation, principles, history, concept of ion free path, classification of mass spectrometry based on nature of compound to be analyzed and the ion sources viz. Electron impact (EI), chemical ionization (CI), Fast ion or atom bombardment ionization (FID/FAB), field desorption (FD), laser desorption ionization (LDI), plasma desorption ionization (PDI), thermospray ionization (TSI), electrospray (ESI), atmospheric pressure ionization, Inductively couple plasma (ICP) etc. Mass Analyzers, Quadrupolar Analyzers, Quadrupole ion trap or Quistor, Ion trap detector, development of high –Mass, High-resolution ion trap, tandem mass spectrometry in the ion trap, time of flight analyzer, magnetic and electromagnetic analyzer, ion cyclotron resonance and FTMS, and detectors.	

Course Outcome: Student should be able to

1. Understand the instrumentation of Supercritical fluid chromatography, Supercritical Mobile Phase, Injectors, Ovens and Pumps, Columns, Detectors.
2. demonstrate instrumentation, applications (SEM), (TEM).
3. differentiate the activation analysis, Sub-stoichiometric determination of traces of metals.
4. solve the mass spectrometry problem.

REFERENCE BOOKS:

1. S.M. Khopkar Basic Concepts of analytical chemistry, New Age International publisher (2008) (Unit I)
2. D. A. Skoog and D. M. West, Fundamental of Analytical Chemistry, International Edition, 7th Edition Saunders College Publishing, Philadelphia, Holt, London (1996) (Unit II and IV)
3. H. H. Willard; L. L. Merit; J. A. Dean & F. A. Settle, Instrumental Methods of Analysis CBS publisher (2004) (Unit III).
4. R. L. Pecsok, L.D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, 2nd John Wiley & Sons, New York (1976) .

MACT 303: Organo -Analytical Chemistry.

Course Objectives: Student will be able to

1. understand food, food additives and their analysis.
2. study drugs, their classification, sources of impurities in pharmaceutical raw material
3. study the composition and analysis of paints.
4. study the analysis of oils, fats, soaps & detergents.

Credits=4	SEMESTER-III MACT 303: Organo -Analytical Chemistry.	No. of hours per unit/ Credits
Credit-I UNIT I	Analysis of Food & Food Additive	(15)
	A) Food Analysis- Food flavors, food colors, food preservatives, analysis of milk and milk products, adulterants in milk and their identification, analysis of honey, jam and their major component. Practical applications and examples. B)Food Additive Analysis- Additives in animal food stuff: Antibiotics: penicillin, chloro tetracyclin, oxytetracyclin in diet supplements; Identification and estimation of growth promoting drugs such as- sulfaquinoxaline, methyl benzoate, sulfanilamide, pyrimethamine, nitrovin, nitrofurazone, acinitrazole, etc	
Credit-I UNIT II	Pharmaceutical Analysis	(15)
	Introduction to drugs, their classification, sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. Limit tests: Limit test for impurities for Pb, As, Fe, Se, etc. Estimation of moisture (K-F method), halide (Schnoiger's oxygen flask method), sulfate, boron, etc. Analysis of commonly used drugs such as antihistamines, sulfa drugs, barbiturates, etc. using non-aqueous titrations, sodium nitrite titrations, differential UV methods, colorimetric and fluorimetric methods of analysis.	

Credit-I UNIT III	Analysis of Paints	(15)
	Composition of paint, preliminary inspection of sample, test on the total coating, separation and estimation of pigments, binder and thinner of latex paints; modification of binder, flashpoint of paints. Practical applications and example.	
Credit-I UNIT IV	Analysis of Oils, Fats and Soaps & Detergents	(15)
	Analysis of oils and fats: softening point, Congent point, Titre point, cloud point, Iodine, saponification, acid, hydroxyl, R-M and Polenske value, Elaiden test. Introduction to soaps, analysis of soap (saponifiable, unsaponifiable) and for un- saponified matter in soaps, Estimation of free alkali and phenol in soap. Classification of detergents (in Brief): Analysis of active ingredients from detergents (methylene blue and Hyamine-1622 method); Estimation of Critical Micelle Concentration (CMC), Chlorides, total phosphates etc.	

Course Outcomes: Student should be able to

1. Understand analysis of milk and milk products, analysis of honey, jam.
2. demonstrate Limit test for impurities for Pb, As, Fe, Se, etc. Estimation of moisture (K-F method).
3. differentiate preliminary inspection of sample, binder and thinner of latex paints, modification of binder, flashpoint of paints.
4. analyze softening point, Congent point, Titre point, cloud point, Iodine, saponification, acid, hydroxyl, R-M, analysis of soap.

References: -

1. D. Pearson: Laboratory techniques in food analysis. John Wiley and Sons (1973) (Unit I)
2. S. N. Mahindru: Food additives Characteristics, Detection and Estimation APH Publishing Corporation (2012) (Unit I)
3. Nicholls: Aids to the analysis of foods and drugs. Bailliere, Tindall and Cox Publisher (1942) (Unit II)
4. Henry A. Gardner, The Analysis Of Paints And Painting Materials Read Books (2008) (Unit III).
5. G. F. Longonan: the analysis of detergents and detergent products (JW). John Wiley and Sons (1976)

(Unit IV)

Elective Papers:

MACT 304A: Electro Analytical Techniques in Chemical Analysis

Course Objectives: Student will be able to: -

1. study ion selective electrodes & electrochemical sensors.
2. study particle size analysis.
3. understand various types of voltammetry techniques.
4. study of techniques in electrophoresis.

Credits= 4	SEMESTER-III MACT 304 A: Electro Analytical Techniques in Chemical Analysis	No. of hours per unit/ Credits
Credit-I UNIT I	Ion selective electrodes & Electrochemical sensors	(15)
	Introduction, types and construction of electrodes, glass electrode, solid state and precipitate electrodes, liquid – liquid membrane electrodes, enzyme and gas electrodes, Chemically modified electrode, Enzyme based electrode, catalytic electrodes, ultramicro electrodes and applications.	
Credit-I UNIT II	Particle Size Analysis	(15)
	Introduction, Low angle LASER light scattering: Instrumentation, theoretical models, Mie-theory, Fraunhofer diffraction theory, particle size distribution analysis, Applications. Dynamic Light Scattering: Introduction, Instrumentation, photo detector sample cell and sample handling, Applications, Photo sedimentation: Setting velocity and particle size, Stokes equation, Instrumentation, sedimentation modes, Particle size distribution analysis, photometric measurements and applications. Comparison with particle size measurements using XRD, SEM and TEM. Practical applications in analytical chemistry.	
Credit-I UNIT III	Voltammetry Techniques	(15)
	Introduction, Principle, excitation signals in voltammetry, basic instrumentation based on operational amplifiers, voltammetric electrodes Cyclic Voltammetry: instrumentation, Determination of analyses using cyclic voltammetry, Applications. Pulse voltammetry: Introduction,	

	Normal Pulse Voltammetry, Reverse pulse voltammetry, Differential pulse voltammetry, Square wave voltammetry. Stripping voltammetry: Cathodic and Anodic stripping voltammetry, Electrode position step, Voltammetric completion of the analysis, adsorptive stripping methods, voltammetry with microelectrodes. Practical applications in analytical chemistry.	
Credit-I UNIT IV	Electrophoresis	(15)
	Introduction, Paper electrophoresis Principle, Factors governing migration of ions, Supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers)Techniques of electrophoresis: Low and high voltage, iso electric focusing, continuous electrophoresis, capillary electrophoresis, Zone, gel, iso electrophoresis and micelle electro kinetic capillary chromatography, instrumentation, detection and applications and numerical.	

Course Outcomes: Student should be able to

1. Understand types and construction of electrodes and electrochemical sensors
2. demonstrate instrumentation, applications XRD,SEM, TEM.
3. analyze the samples using cyclic voltammetry,pulse voltammetry, Stripping voltammetry,
4. understand the techniques of electrophoresis and its applications .

References: -

1. Jirm Koryta Karel Stulik, Ion selective electrodes, Cambridge university press(1983) (Unit I).
2. Douglas. A. Skoog, E.James Holler, Stanley R.Crouch Principles of Instrumental analysis engage Learning (2006) (Unit II and III)
3. Willard, Meritt, Dean and Settle, Instrumental methods of Analysis. CBS Publisher (2004) (Unit III).
4. S. M. Khopkar Basic Concepts of Analytical Chemistry. New age international publishers (2008) (Unit IV)

MACT 304 B : Modern Separation Methods in Analysis

Course Objectives: Student will be able to

1. study principal and applications of gas chromatography.
2. study of principles, instrumentation of HPLC, SCFC, GLC.
3. understand of principles, instrumentation of ion chromatography.
4. study the theoretical aspects of extraction chromatography, solvent extraction.

Credits=4	SEMESTER-III MACT 304 B: Modern Separation Methods in Analysis	No. of hours per unit/ credits
Credit-I UNIT I	Gas Chromatography	(15)
	Principles, Plate theory, Instrumentation and working of a Gas Chromatograph, Detectors, programmed, temperature G.C., Applications.	
Credit-I UNIT II	High Performance Liquid Chromatography	(15)
	Principles, Instrumentation, Stationary support in HPLC, Applications, Super Critical Fluid Chromatography (SCFC), Characteristics, Instrumentation and Applications. Comparison of HPLC and GLC with SCFC.	
Credit-I UNIT III	Ion Chromatography	(15)
	Principles, Structure and characteristics of resins, eluent, suppressor columns and detectors used in Ion Chromatography, analytical applications, environmental speciation by Ion Chromatography.	
Credit-I UNIT IV	Extractive Chromatographic Separations	(15)
	Introduction, Theoretical aspects of extraction chromatography, solvent extraction and extraction chromatography with chelating ligands, extraction chromatography by ion pair formation, extraction chromatography by solvation, extraction equilibria, nature of stationary phase in extraction chromatography, inert support, techniques in extraction Chromatography, extraction chromatography with tributyl phosphate and other Applications.	

Course Outcomes: Student should be able to

1. understand instrumentation and working of a gas chromatography.
2. demonstrate instrumentation, stationary support in high performance liquid chromatography.
3. demonstrate structure and characteristics of resins and analyse the samples by using ion chromatography.
4. Understand the theoretical aspects of extraction chromatography.

References:-

1. B.K. Sharma Instrumental Methods of Chemical analysis, Krishna Prakash media, (2014) (Unit I)
2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis. CBS Publisher. (2004) (Unit II)
3. S. M. Khopkar, Basic Concepts in Analytical Chemistry, New age international publishers(2008) (Unit III and IV).
4. LR. Shyder and C.H.Harvath, An Introduction to separation Science. Wiley Interscience.(2010)(Unit IV)

MACP 305: PRACTICAL COURSE V: LAB V

Course Objectives: Student will be able to

1. understand analysis of alloys.
2. study the estimations of pharmaceutical tablets, food samples.
3. understand the analysis of copper fungicide, vitamin-C in juices and squashes.
4. study the analysis of Barium ions by turbidimetry.

Credits-4	SEMESTER-III MACP 305: PRACTICAL COURSE V: LAB V	No. of hours (60)
	A) Major:	
	<ol style="list-style-type: none">1. Analysis of alloy (volumetric, gravimetric or colorimetric techniques can be used).2. Estimation of Ca and Fe from milk powder.3. Analysis of Benzoic acid and salicylic acid from medicated powder.4. Estimation of Aspirin.5. Analysis of Lindane in BHC powder.6. To study the complex formation between Fe (III) and salicylic acid and determine the stability constants of the complex by Job's variation method.	

	7. To determine the dissociation constant of ortho-phosphoric acid by titrating with it standard NaOH solution.	
	B) Minor:	
	<ol style="list-style-type: none"> 1. Analysis of plaster of Paris for calcium content 2. Determination of Barium ions by Turbidimetry. 3. Analysis of soda ash. 4. To determine relative strength of acetic acid by chloro-acetic acid measuring K_a value. 5. Identification of organic compounds by their IR spectra 6. Determination of chloride content from saline water by potentiometry. 7. Estimation of lactose in given milk sample. 8. Estimation of vitamin B2 in the medicinal tablets fluorimetrically. 9. Determination of pK of given dibasic acid pH-metrically. <p>(Any other suitable experiment may be added when required.)</p> <p>C) Case Study</p>	

Course Outcome: Student should be able to

1. Understand analysis of alloys.
2. calculate the estimations of pharmaceutical tablets, food samples.
3. Understand and calculate the analysis of copper fungicide, vitamin-C in juices and squashes.
4. analyze of Barium ions by turbidimetry.

Reference books:

- 1.H. T. Clarke :Handbook of Quantitative and Qualitative Analysis, 4th edition, CBS Publishers (2021).
2. A.I. Vogel : A Textbook of Practical Organic Chemistry, 5th Edition, Pearson India (2016)
3. Revised by J.A. Kitchner (Vedition): Findlay's Practical Chemistry, Laxmi Publication(2019)
4. A.I. Vogel: Book of Quantitative inorganic analysis, 5th Edition, Longman Scientific and Technical (1989)
5. S.W.Rajbhoj and T.K.Chondhekar : Systematic Experimental Physical Chemistry, Chemistry,New age International Private Limited 1st edition (2001)

MACP 306: PRACTICAL COURSE VI: LAB VI

Course Objectives: Student will be able to

1. study the analysis of ore.
2. understand determine sap-value from oil sample.
3. study the estimate aspirin.
4. understand fertilizer analysis.

Credits =4	SEMESTER-III MACP 306: PRACTICAL COURSE VI: LAB VI	No. of hours (60)
	A) Major:	
	<ol style="list-style-type: none"> 1. Analysis of ore. 2. To determine sap-value from oil sample. 3. Estimation of Aspirin. 4. Analysis of Lindane in BHC powder. 5. To study the complex formation between Fe (III) and salicylic acid and determine the stability constants of the complex by Job's variation method. 6. To determine the dissociation constant of ortho-phosphoric acid by titrating with it standard NaOH solution. (Any other suitable experiment may be added when required.) 	
	B) Minor:	
	<ol style="list-style-type: none"> 1. Fertilizer analysis for P (colorimetrically), K (Flame photometrically). 2. Determination of Barium ions by Turbidimetry. 3. Analysis of soda ash. 4. To determine relative strength of acetic acid by chloro-acetic acid measuring k_a value. 5. Identification of organic compounds by their IR spectra 6. Determination of chloride content from saline water by potentiometry. 7. Estimation of lactose in given milk sample. 8. Estimation of vitamin B2 in the medicinal tablets fluorimetrically. conductometrically. 9. Determination of pK of given dibasic acid pH-metrically. (Any other suitable experiment may be added when required.) <p>C) Research project Work</p>	

Course Outcome: Student should be able to

1. analyze the different ores.
2. calculate sap-value from oil sample.
3. Understand estimation of aspirin.
4. Analyze the different fertilizer samples

Reference books:

1. H. T. Clarke : *Handbook of Quantitative and Qualitative Analysis*, , 4th edition, CBS Publishers (2021)
2. A. I. Vogel : *A Textbook of Practical Organic Chemistry*, 5th Edition, Pearson India (2016)
3. Revised by J.A. Kitchner (Vedition): *Findlay's Practical Chemistry*, Laxmi Publication(2019)
4. A.I. Vogel: *Book of Quantitative inorganic analysis*, 5th Edition, Longman Scientific and Technical (1989)
5. S.W.Rajbhoj and T.K.Chondhekar : *Systematic Experimental Physical Chemistry*. Chemistry,New age International Private Limited 1st edition (2001)

M. Sc. II : SEMESTER IV

MACT 401: Techniques in Forensic Science and Microbiological Analysis.

Course Objectives: Student will be able to

1. understand analysis of body fluid and clinical analysis body fluid analysis.
2. understand analysis of biomolecules like carbohydrates, proteins, vitamins, lipids.
3. study classification and analysis of pesticides.
4. study special features of forensic analysis and classification of poisons.

Credits=4	SEMESTER-IV MACT 401: Techniques in Forensic Science and Microbiological Analysis.	No. of hours per unit/ credits
Credit-I UNIT I	Analysis of Body fluid and Clinical analysis	(15)
	<p>A) Body fluid analysis. Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum) Blood-Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.</p> <p>B) Clinical Analysis Biological significance, analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum). Blood- Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin, Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.</p>	
Credit-I UNIT II	Analysis of Biomolecules	(15)
	<p>A) Carbohydrates- Recapitulation of Carbohydrates. Analysis of total carbohydrates by Anthrone method, starch using Anthrone reagent, pectin by gravimetric method, and crude fibres.</p> <p>B) Proteins- Recapitulation of Proteins. Analysis protein by Kjeldhal</p>	

	<p>method and Lowry method, total free amino acids, methionine in food grain.</p> <p>C) Vitamins- Recapitulation of Vitamins. Analysis of Retinol, Vitamin D3, Vitamin E, Vitamin B1, Vitamin B2, Vitamin B6, Nicotinic acid, Niacin and Vitamin C.</p> <p>D) Lipids- Recapitulation of Lipids. Analysis of free fatty acids, saponification value, iodine value and peroxide value.</p>	
Credit-I UNIT III	Pesticides Analysis	(15)
	<p>Introduction, classification of pesticides, sampling, sample pretreatment and processing, analysis of Parathion, gammexane, endosulphan, ziram, malathion, thiram, thiometon, simazine and chloridane. Applications of colorimetric and chromatographic techniques (GC-MS, HPLC-MS) in analysis of pesticide residue. Introduction to EPA regulatory body. Practical applications and examples in analytical chemistry and research</p>	
Credit-I UNIT IV	Forensic Analysis	(15)
	<p>Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 and LC-50. General discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples. Practical applications and examples in analytical chemistry.</p>	

Course Outcomes: Student should be able to

1. Understand analysis of Body fluid and Clinical analysis
2. demonstrate analysis of biomolecules like protein, carbohydrates, vitamins etc.
3. understand applications of chromatographic techniques for pesticide analysis.
4. analyze the poisonous materials such as lead, mercury and arsenic in biological samples.

References:-

1. Mansi E. L. Fermentation Microbiology and Biotechnology (2nd Edition), CRC Press (2011) (UNIT I, II).
2. Patil S.C. Industrial Microbiology, S. Chand and Company (2010) (UNIT II).
3. Casida J.R. Industrial Microbiology, New Age International Pvt. Ltd. (2016) (UNIT III)
6. Intellectual Property Rights in India, Shodhganga, (UNIT IV).
7. WIPO Intellectual Property Handbook 2nd Edition, (2004)(Unit I and II)

MACT 402: Environmental chemical analysis and control

Course Objectives: Student will be able to

1. understand air and water Pollutant Analysis.
2. understand different type of pollution like Soil pollution, Noise Pollution and Thermal pollution.
3. study the Organic Pollutants and Their Analysis.
4. study Environmental protection Policy.

Credits=4	<p style="text-align: center;">SEMESTER-IV MACT 402: Environmental chemical analysis and control</p>	<p style="text-align: center;">No. of hours per unit/ Credits</p>
<p style="text-align: center;">Credit-I UNIT I</p>	<p style="text-align: center;">Air and Water Pollutant Analysis</p>	<p style="text-align: center;">(15)</p>
	<p>Chemistry of Air pollutants, characterization. Source, methods of analysis of air pollutants; CO, CO₂, NO_x, NH₃, H₂S, SO₂ etc. Monitoring Instruments, Potable and Industrial water, major and minor components, dissolved oxygen (DO) Chemical oxygen demand (COD) Biochemical oxygen demand (BOD) and their measurements. Analysis of Pd, Cd, Hg, Cr, As and their physiological manifestations. Quality of industrial waste water analysis for organic and inorganic constituents. Chemistry of odour and its measurements.</p>	
<p style="text-align: center;">Credit-I UNIT II</p>	<p style="text-align: center;">Other Types of Pollution</p>	<p style="text-align: center;">(15)</p>
	<p>A) Soil pollution and soil analysis : Source 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.</p> <p>B) Noise Pollution: Sources, effects, methods of measurements and control measures.</p> <p>C) Thermal pollution: Definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy.</p>	

Credit-I UNIT III	Organic Pollutants and Their Analysis	(15)
	Sources, disposal, treatment and analysis of phenolic residues, methods of recovery of phenols from liquid effluents, Organomercurials and its analysis, Analysis of organochlorine pesticides, volatile organic pollutants and their analysis.	
Credit-I UNIT IV	Environmental protection Policy	(15)
	Introduction, Environmental Legislation: Status in India, Some Indian Environmental Law-The water (Prevention and control of pollution) Act 1974, The Air (Prevention and control of pollution) Act 1981, The Environmental (Protection) Act 1986, Environmental Legislation: Status in USA.	

Course Outcomes: Student should be able to

1. analyze quality of industrial waste water.
2. understand analysis of soil.
3. understand the analysis of phenolic residues, organochlorine pesticides.
4. differentiate environmental protection policy and environmental legislation.

References:-

1. A. K. De: Standard Methods of Waste and Waste water analysis APHA publications. (2012) (Unit I)
2. S. M. Khopkar, Environmental Chemistry; Environmental pollution analysis. New Age International publishers(2004) (Unit II)
3. M. S. Creos and Morr, Environmental Chemical Analysis, American publication (1988)
4. A. K. De, Environmental Chemistry, New Age International publishers. (2016) (Unit III)
5. S.C.Santra, Environmental Science New Central Book Agency (2011)(Unit IV)

MACT 403: Applied Industrial Analysis

Course Objectives: Student will be able to

1. study the analysis of pesticides, insecticides and fungicides.
2. Understand the analysis of crèmes, lotion ,face powder in cosmetics.
3. study Composition and analysis of petroleum products and biofuels.
4. understand analysis of cement and glass ceramics.

Credits=4	SEMESTER-IV MACT 403: Applied Industrial Analysis	No. of hours per unit/ Credits
Credit-I UNIT I	Analysis of Agrochemicals	(15)
	Introduction, Classification, Analysis of insecticides : DDT, BHC, Aldrin, Endosulfon, Malathion, Parathion. Herbicides: 2, 4- dichloro phenoxy acetic acid, dalapon, paraquat, Banalin, Butacarb .Fungicides : Boardeaux mixture, Copper oxychloride, Zineb,, Benomyl (Benlte) Analysis of pesticide residue and toxicological effects.	
Credit-I UNIT II	Analysis of cosmetics	(15)
	Composition of creams and lotions: Determination of water, porpylene glycol non-volatile matter and ash content. Determination of borates, carbonates sulphate, phosphate, chloride, titanium and Zinc oxide. Analysis of face powder: Estimation of boric acid, Mg, Ca, Zn, Fe, Al and Ba. Analysis of ingredients of hair dye.	
Credit-I UNIT III	Analysis of Petroleum products	(15)
	Analysis of petroleum products Introduction, constituents and petroleum fractionation, quality control; - specific gravity, viscosity, Cloud point, pour point, flash point, vapor pressure, Doctor test, sulphuric acid absorption, aniline point, and colour determination, cloud point, pour point. Determination of water, neutralization value (acid and base numbers), ash content, sulphur and mercaptan sulphur. Determination of lead in petroleum; Analysis of Biofuel, coal and coke: Types, composition, preparation of sample, proximate and ultimate analysis calorific value by Bomb Colorimetry.	

Credit-I UNIT IV	Analysis of cement and ceramics	(15)
	<p>A) Cement: Loss on ignition, insoluble residue, total silica, sesquioxides, lime, magnesia, ferric oxide, sulphuric anhydride, air and dust pollution from cement plants, and atmospheric dispersion of pollutants in cements industry.</p> <p>B) Glass and Glass-Ceramics-Introduction, composition, method of analysis-sampling and sample preparation, composition analysis-preliminary testing, decomposition, chemical method for the individual constituents-Si, B, Pb, Al, Ca.</p>	

Course Outcomes: Student should be able to

1. Understand analysis of pesticide residue like insecticides, herbicides.
2. determine estimation of boric acid, Mg, Ca, Zn, Fe, Al and Ba from face powder.
3. analyze petroleum products and biofuels.
4. analyze the cement and ceramics.

References:-

- 1) O.P.Shukla, Omkar and A.K. Kulshrestha Pesticides , Man and Biosphere APH Publishing Corporation(1998) (Unit I)
- 2) M. Ash and L. Ash: *A formulary of cosmetic preparations*. (G. Goodwin) Chemical Publishing company (1977)(Unit II)
- 3) Speight J G, John Wiley Handbook Of Petroleum Product Analysis 2nd Edition(2015) (Unit III)
- 4) Anjan Kumar Chatterjee , Taylor & Francis, Cement Production Technology Principles And Practice. CRC Press.(2020) (Unit IV)
- 5) Michel Barsoum Fundamentals of Ceramics 2nd Edition CRC Press (2020) (Unit IV)

Elective Course

MACT 404 A: Quality Assurances and Quality control.

Course Objectives: Student will be able to

1. study the quality control and quality assurance.
2. study documentation for quality assurance.
3. study management of raw data in quality assurance
4. study Laboratory Accreditation, Quality Management and ISO.

Credits=4	SEMESTER-IV MACT 404 A: Quality Assurances and Quality control.	No. of hours per unit/ Credits
Credit-I UNIT I	Quality Assurance	(15)
	Introduction to Quality Control and quality assurance: Concepts and significance. Quality control and statistical techniques: Quality control charts, the X-quality control chart, the R-quality control chart and its interpretation, spiked sample control charts, use of blind samples in quality control, use of proficiency evaluations in quality control. Calibration and maintenance of Instruments / Equipment: Instrument calibration – linear calibration curves, equipment calibration, frequency of calibration, calibration of common laboratory instrument and equipment (Analytical balances, volumetric glassware, ovens, furnaces, UV / Visible spectrophotometer, pH meter, conductivity meter, IR spectrophotometers, AAS, GC, HPLC etc.,). Maintenance of instruments and equipment.	
Credit-I UNIT II	Documentation for Quality Assurance: Introduction of Raw Data	(15)
	Type of notebooks, control of notebook distribution and data entry. General Reagents and volumetric reagents. Sampling – sampling methods, sample labelling, and sample login/register. Sample analysis, reporting, recording and personal training. Instrument calibration and maintenance. Analytical report, Personnel, training, records - professional personnel, technician personnel. Filing quality assurance documentation. Material Safety Data Shift (MSDS), Good laboratory practices and personnel, Quality Program, Instrument and Organization calibration, Customer Satisfaction.	

Credit-I UNIT III	Documentation for Quality Assurance: Management of Raw Data	(15)
	Computers and quality assurance: Sample handling. Data Acquisition. Quality control data and calculations. Computer generated analytical reports. Security considerations. Hardware and software. Establishing a Quality Assurance program: Management commitment. Define the quality assurance program. Writing standard operating procedures. Topics for standard operating procedures. Consolidating the program. Monitoring the program – monitoring quality assurance data, reporting quality assurance problems. Writing the quality assurance manuals.	
Credit-I UNIT IV	Quality Accreditation	(15)
	Laboratory Accreditation: Need for laboratory accreditation. International aspects of laboratory accreditation and in India. Criteria for laboratory accreditation. Benefits of laboratory accreditation, Evolution and significance of Quality Management, Background to ISO 9000, comparison between ISO-9001, ISO-9002 & ISO-9003., ISO 9000-2000 series of standards on quality management system, evolution of series of standards, introduction to ISO organization, and Registration / certification- benefits of QMS certification. Structure of ISO 9000-2000 family of standards. Advantages of ISO 9000-2000. Requirements of ISO 9001-2000 QMS and applications, Steps for effective implementations. Significance of ISO - 9001, 9002, 9003 & 9004. Requirements of ISO9000 / IS14001. Concepts of OHSMS (BS 8800) Quality Management Principles in QMS, QMS documentation, Quality Manual, Quality policy, conformities and Nonconformities	

Course Outcomes: Student should be able to

1. Understand basic concepts of quality assurance and calibration of instruments.
2. Differentiate distribution and data entry, sample labelling, and MSDS.
3. Demonstrate Documentation for Quality Assurance
4. Understand the benefits of laboratory accreditation, and ISO process.

Reference books:

1. George W. Roberts, Quality Assurance in Research and Development. CRC Press (1983)(Unit I).

2. Evan Aksen, Quality Assurance and Technical Documentation Createspace Independent publishing Platform (2012) (Unit II).
3. Doopanti Gajjar, Ashish Budhrani, Dr. Md. Rageeb Md. Usman, Dr. Dilpreet Singh, A text Book of Quality Control and Quality Assurance Books PV (2010) (Unit III).
4. Proe Satish Kumar Soni Preparing for Accreditation of Quality Assurance of Professional Educational Services Partridge Publishing India (2014) (Unit IV)

MACT 404 B : INDUSTRIAL ANALYTICAL CHEMISTRY.

Course Objectives: Student will be able to

1. understand analysis of metals and alloys.
2. study spectrochemical methods of analysis.
3. study analysis of commercial materials.
4. study analysis of soil and fertilizers.

Credits=4	SEMESTER-IV MACT 404 B : INDUSTRIAL ANALYTICAL CHEMISTRY.	No. of hours per unit/ Credits
Credit-I UNIT I	Analysis of metals and alloys	(15)
	Foundry materials, ferroalloys, and special steels, slags, fluxes. Analysis of alloys, bronze, brass, Alnico and Nichrom.	
Credit-I UNIT II	Spectrochemical Methods of Analysis	(15)
	Introduction to spectrochemical methods. Electronic spectra and molecular structure, NIR Spectrometry for nondestructive testing. Solvents for spectrometry, FTIR spectrometer, fluorometry, optical sensors. Analysis of ores –bauxites, dolomites, monazites. Analysis of Portland cement.	
Credit-I UNIT III	Analysis of Commercial materials	(15)
	Analysis of explosive materials, TNT, RDX, lead azide, EDNA (ethylene dinitramine). Analysis	

	of conducting polymer, resins and rubber. Analysis of luminescent paints, Analysis of lubricants and adhesive.	
Credit-I UNIT IV	Analysis of soil and fertilizers	(15)
	Method of soil analysis, soil fertility its determination, determination of inorganic constituents of Plant materials, Chemical analysis as measure of soil fertility, analysis of fertilizers.	

Course Outcomes: Student should be able to

1. understand quality control and quality assurance analysis of alloys, bronze, brass, alnico and nichrom.
2. demonstrate FTIR spectrometer, fluorometry, optical sensors.
3. Understand analysis of explosive materials, TNT, RDX, lead azide, EDNA.
4. analyze soil and fertilizer.

Reference books:

- 1) Hillebrand Lhundel, Bright and Hoffiman, Applied Inorganic Analysis, John Wiley,(1953)
- 2) Snell and Biffen, Commercial Methods of Analysis, Revised Edition, Chemical Publishing Company (1964)(Unit III)
- 3) P.G. Jeffery, Chemical Methods of Rock Analysis, Pergamon, 3Rd Edition, Butterworth-Heinemann (2012) (Unit I)
- 4) Buchel, Chemistry of Pesticides. J Wiley-Blackwell (1983) (Unit IV)

MACP 405 PRACTICAL COURSE – VI: LAB VI

Course Objectives: Student will be able to

1. study analysis of ore.
2. understand analysis of milk, pesticides, insecticides, cements, soil etc
3. understand salicylic acid, copper, urea etc.
4. study different instrumentation techniques.

Credits=4	SEMESTER-III MACP 405 PRACTICAL COURSE – VI: LAB VI	No. of hours (60)
	A) Major	
	1. Cement analysis. 2. Analysis of ore. 3. Estimation of amount of copper (II) with EDTA spectrophotometrically. 4. Analysis of some common pesticides, insecticides, plastics and detergents. 5. To estimate amount of Mn from Tea Powder. 6. Agricultural analysis of soil sample, animal feeds, soil micronutrients, milk powder for Ca, Fe and P content. 7. To determine the percentage of Calcium from given chalk sample.	
	B) Minor	
	1. Estimation of Fe from soil sample. 2. Determination of chemical oxygen demand of water sample (dye solution). 3. Determination of amount of H ₃ BO ₃ by Conductometrically. 4. Estimation of Zn in the given solution fluorimetrically. 5. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically. 6. To determine the dissociation constant of dibasic acid by using potentiometrically. (Any other suitable experiment may be added when required.) C) Case Study	

Course Outcome: Student should be able to

1. Understand analysis of ore.
2. analyze of milk, pesticides, insecticides, cements, soil etc.
3. Understand estimations of salicylic acid, copper, urea etc.
4. Demonstrate different instrumentation techniques

References:-

- 1) H. T. Clarke: Handbook of Quantitative and Qualitative Analysis, 4th edition, CBS Publishers (2021)
- 2) A. I. Vogel: A Textbook of Practical Organic Chemistry, 5th Edition, Pearson India (2016)
- 3) Revised by J.A. Kitchner (Vedition): Findlay's Practical Chemistry, Laxmi Publication (2019)
- 4) A.I. Vogel: Text Book of Quantitative inorganic analysis. 5th Edition, Longman Scientific and Technical (1989)
- 5) S.W. Rajbhoj and T.K. Chondhekar: Systematic Experimental Physical, Chemistry, New age International Private Limited 1st edition (2001)

MACP 406 PRACTICAL COURSE – VII: LAB VII

Course Objectives: Student will be able to

1. understand spectrophotometric determination of Cr and Mn.
2. understand percentage of iron from the given iron tablet by calorimetrically.
3. study analysis of Na and K from soil sample.
4. study different instrumentation techniques.

Credits=4	SEMESTER-III MACP 406 PRACTICAL COURSE – VII: LAB VII	No. of hours (60)
	A) Major	
	<ol style="list-style-type: none">1. Analysis of alloy.2. Estimation of salicylic acid and zinc oxide from medicated powder.3. Simultaneous spectrophotometric determination of Cr and Mn.4. To estimate percentage of iron from the given iron tablet by calorimetrically.5. Studies on the effect of substituent at ortho position of benzoic acid, salicylic acid and Sulphosalicylic acid on its equilibrium constant pH metrically.6. Determination of pK of dibasic acid, by potentiometry.	
	B) Minor	
	<ol style="list-style-type: none">1. Analysis of Na and K from soil sample.2. Determination of flash point of oil/fuel.3. Determination of dissociation constant of weak acid pH- metrically.	

	<p>4. Determination of critical micelle concentration of given surfactants conductometrically.</p> <p>5. To determine the acid base dissociation constant and isoelectric point of amino acid pH metrically. (Any other experiments may be added when/if required)</p> <p>C) Research Project Work</p> <p>D) Study Tour</p>	
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Course Outcomes: Student should be able to

1. interpret spectrophotometric determination of Cr and Mn.
2. calculate estimate percentage of iron from the given iron tablet by calorimetrically.
3. Understand analysis of Na and K from soil sample.
4. Demonstrate different instrumentation techniques.

References:-

- 1) H. T. Clarke: Handbook of Quantitative and Qualitative Analysis. , 4th edition, CBS Publishers (2021)
- 2) A. I. Vogel: A Textbook of Practical Organic Chemistry, 5th Edition, Pearson India (2016)
- 3) Revised by J.A. Kitchner (Vedition):Findlay's Practical Chemistry, Laxmi Publication(2019)
- 4) A.I. Vogel: Text Book of Quantitative inorganic analysis, 5th Edition, Longman Scientific and Technical (1989)
- 5) S.W.Rajbhoj and T.K.Chondhekar: Systematic Experimental Physical Chemistry, Chemistry,New age International Private Limited 1st edition (2001)