Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara

(Autonomous)

Lead College

Of

Karmaveer Bhaurao Patil University, Satara

Department of Chemistry

Syllabus For

Master Of Science

Part – II

Analytical Chemistry

Syllabus to be implemented w.e.f. June 2024

As per NEP 2020

Syllabus for M.Sc. II

1. Title: Analytical Chemistry

2. Year of Implementation:

The syllabus will be implemented from June,2024 onwards.

3. Preamble:

This syllabus is framed to give advanced knowledge of Chemistry to post graduate students at first year of two years of M.Sc. degree course. The goal of the syllabus is to make the study of chemistry, interesting and encouraging to the students for higher studies including research. The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking in to consideration the level and capacity of students.

Credit Frame work for M.Sc. II

Structure of course M.Sc. II **Semester-III**

Level	Semester	Course Code	Course Title	No. of Lectures per week	Credits
		Discipline Specific Course (DSC) ***(Mandatory)***			
6.5	**III**	MACT 531	Fundamentals Of Analytical Chemistry	**4**	**4**
		MACT 532	Advanced Analytical Techniques	**4**	**4**
		MACT 533	Organo- Analytical Chemistry	**4**	**4**
		Discipline Specific Elective (DSE) (Choose any one among two)			
		MACT 534 E-I MACT 534 E-II	Electro Analytical Techniques in Chemical Analysis I Electro Analytical Techniques in Chemical Analysis II	**2**	**2**
		MACT 535	**Research Project**	**12**	**6**
		MACP 536	**Lab III (Based on MACT 531, MACT 532, MACT 533)**	**4**	**2**
		Total			**22**

Structure of course M.Sc. II **Semester-IV**

Level	Semester	Course Code	Course Title	No. of Lectures per week	Credits
		Discipline Specific Course (DSC) ***(Mandatory)***			
6.5	**IV**	MACT 541	Techniques in forensic science and microbiological analysis	**4**	**4**
		MACT 542	Environmental chemical analysis and control	**4**	**4**
		MACT 543	Applied industrial analysis	**4**	**4**
		Discipline Specific Elective (DSE) (Choose any one among two)			
		MACT 544 E-I MACT 544 E-II	Quality Assurances and quality control Industrial Analytical Chemistry	**4**	**4**
		MACT 545	**On Job Training**	**8**	**4**
		MACP 546	**Lab IV (Based on MACT 541, MACT 542, MACT 543)**	**4**	**2**
		Total			**22**

M.Sc. Part–II, Semester III

Discipline Specific Course (DSC) *(Mandatory)*

Credits 4	MACT 531: Fundamentals of Analytical Chemistry	Hours 60

Course Objectives: Student will be able to

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

Unit No	Title and Syllabus	Hours allotted
I	**Introduction to Analytical Separation.**	15
	1.1. Introduction, Principle 1.2 Separation by Precipitation, 1.3. Separation by species by distillation, 1.4. Separation by extraction, Derivation of equation, 1.5. Separation by ions by ion exchange, 1.6. home water softeners, 1.7. Chromatographic separation, 1.8. Source of the Team Plate and Plate Height, Derivation of Equation.	
II	**Principles of Chromatography**	15
	2.1Historical Development, Fundamentals of Chromatography, 2.2Techniques in Chromatography, 2.3Classification of Chromatographic Methods, 2.4. Non-Chromatographic methods of separation, 2.5. Membrane separation methods, 2.6. Chromatography as the method of separation, 2.7. Dynamics of Chromatography van Demeter's Equation, 2.8. Resolution of Mixtures, 2.9. Separations Characteristics, 2.10. Special Features of Chromatographic Methods, 2.11. Solved Problems.	
III	**Aqueous Solution and Chemical Equilibria**	15
	3.1. The Chemical Composition of aqueous Solutions, Chemical Equilibrium, 3.2. Stepwise and overall Formation Constant for complex Ions, 3.3. Relative strength of Conjugate acid and bases pairs, 3.4The method of successive Approximation 3.5 Buffer Solution, 3.6. The Henderson-Hasselbalch Equation. 3.7. Acid rain and the Buffer Capacity of lakes, buffer capacity,	

	polyprotic acids, buffer for biological and clinical measurements.	
IV	**Reliability of Analytical Data and Statistical Analysis**	**15L**
	4.1. Statistical analysis, 4.2. Criteria for rejection of results Q-test, 4.3. Presentation of data, 4.4. Confidence limit, 4.5.Q test for rejection of result, 4.6. Standard t-test. 4.7. Confidence Interval, 4.8. Statistical Aids to Hypothesis testing, 4.9. Analysis of Variance, Detection of Gross Errors.	

Course outcomes: Student should be able to

1) explain different separation methods of Precipitation, distillation, extraction, ion exchange.
2) illustrate the basic principles, classification of chromatography.
3) identify 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)
S.M. Khopkar Basic Concepts of Analytical Chemistry New Age International publisher (2008) (Unit IV)

[4] R. L. Pecsok, L. D. Shields, T. Cairns and L.C. McWilliam, Modern Methods of Chemical Analysis, John Wiley & Sons, New York (1976).

Credits 4	MACT 532: Advanced Analytical Techniques.	Hours 60

Course Objectives: Student will be able to

1.Distinguish Super critical fluid chromatography and Ultra Performance Liquid Chromatography.

2.Study advanced instrumentation techniques like SEM, TEM, EDAX, STM, AFM.

3.learn radiochemical methods in activation analysis.

4.understand about various Ion source and detectors in Mass Spectrometry.

Unit No	Title and Syllabus	Hours allotted
I	**Supercritical fluid chromatography**	15
	1.1. Introduction Supercritical Fluids, SFC Advantages, 1.2. SFC Instrumentation, Supercritical Mobile Phase, Injectors, Ovens And Pumps, Columns, Detectors, 1.3.SFC for the separation of polymers and of pesticides. 1.4. Ultra Performance Liquid Chromatography (UPLC), Principle, Instrumentation, Application	
II	**Advanced Instrumentation Techniques**	15
	2.1. Scanning Electron Microscope (SEM) - Introduction, principle, instrumentation, applications 2.2. Transmission Electron Microscope (TEM) -Introduction, principle, instrumentation, applications 2.3. Energy Dispersive X-ray Analysis (EDAX) - Introduction, principle, instrumentation, Applications. 2.4. Atomic Force Microscopy (AFM) - Introduction, principle, instrumentation, applications. Practical applications and examples.	
III	**Radio-analytical Chemistry**	15
	3.1. Introduction, basic principles of Activation analysis, 3.2. Fast neutron activation analysis, 3.3. Radiochemical methods in activation analysis, 3.4. Applications of Geo-chemistry, oxygen in metals. 3.5. Isotope dilution analysis: Principles and applications. 3.6. Sub-stoichiometric determination of traces of metals: Principles, techniques and experimental methods in the determination of As, Pb and Hg.	

IV	**Advances in Mass Spectrometry**	15
	4.1. Introduction to Mass spectrometry, 4.2. Instrumentation, principles, history, concept of ion free path, 4.3. classification of mass spectrometry based on nature of compound to be analyzed and the ion sources viz. 4.4. 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. 4.5. Mass Analyzers, Quadrupolar Analyzers, Quadrupole ion trap 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.Explain the instrumentation of Supercritical fluid chromatography, Super critical Mobile Phase, Injectors, Oven sand Pumps, Columns, Detectors.

2. Demonstrate instrumentation, applications (TEM), (SEM)

3. Clarify the activation analysis, Sub-stoichiometric determination of traces of metals.

4. Discuss and 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).

Credits 4	MACT 533: Organo -Analytical Chemistry.	Hours 60

Course objectives: Student will be able to

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

Unit No	Title and Syllabus	Hours allotted
I	**Analysis of Food & Food Additive**	15
	A) Food Analysis- 1.A.1. Food flavors, food colors, food preservatives, 1.A.2. Analysis of milk and milk products, adulterants in milk and them identification, 1.A.3. Analysis of honey, 1.A.4. Analysis of jam and their major component. 1.A.5. Practical applications and examples. **B) Food Additive Analysis-** 1B..1. Additives in animal food stuff: Antibiotics: penicillin, chloro tetracyclin, oxytetracyclin in diet supplements; 1.B.2. Identification and estimation of growth promoting drugs such as-sulfaquinoxaline, methyl benzoquate, sulfanitran, pyrimethamine, nitrovin, nitrofurazone, acinitrazole, etc.	
II	**Pharmaceutical Analysis**	15
	2.1. Introduction to drugs, their classification, 2.2. Sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. 2.3. Limit tests: Limit test for impurities for Pb, As, Fe, Se, etc. 2.4. Estimation of moisture (K-F method), halide (Schnoiger's oxygen flask method), sulfate, boron, etc. 2.5. Analysis of commonly used drugs such as antihistamines, sulfa drugs, barbiturates, etc. 2.6. using non-aqueous titrations, sodium nitrite titrations, differential UV methods, colorimetric and fluorimetric methods of analysis.	

III	**Analysis of Paints**	**15**
	3.1. Introduction, Classification of paint, preliminary inspection of sample, 3.2. Test on the total coating, 3.3. Separation and estimation of pigments, 3.4. Binder and thinner of latex paints; modification of binder, Flashpoint of paints. 3.5. Practical applications and example.	
IV	**Analysis of Oils, Fats and Soaps & Detergents**	**15**
	4.1. Analysis of oils and fats: softening point, 4.2. Congent point, Titre point, cloud point, 4.3. Iodine, saponification, acid, hydroxyl, R-M and Polenske value, Elaiden test. 4.4. Introduction to soaps, analysis of soap (saponifiable, unsaponifiable) and for un- saponified matter in soaps, 4.5. Estimation of free alkali and phenol in soap. 4.6. Classification of detergents (in Brief): Analysis of active ingredients from detergents (methylene blue and Hyamine-1622 method); 4.7. Estimation of Critical Micelle Concentration (CMC), Chlorides, total phosphates etc.	
	Course outcomes: After completion of the course students will be able to… 1. explain 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. describe 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)	

Discipline Specific Elective (DSE)*(Elective)*

Credits 2	MACT 534 E-I: Electro Analytical Techniques in Chemical Analysis-I	Hours30

Course Objectives: Student will be able to: -

1. learn ion selective electrodes & electrochemical sensors.
2. study particle size analysis.

Unit No	Title and Syllabus	Hours allotted
I	**Ion selective electrodes & Electrochemical sensors**	15
	1.1. Introduction, Principle of Ion Selective Electrode 1.2. types and construction of electrodes, glass electrode, solid state and precipitate electrodes, liquid – liquid membrane electrodes enzyme and gas electrodes, 1.3. Chemically modified electrode, Introduction, Basic Principle of Enzyme based electrode, catalytic electrodes, ultra micro electrodes and applications.	
II	**Particle Size Analysis**	15
	2.1. Introduction, Low angle LASER light scattering: Instrumentation, theoretical models, Mie-theory, Fraunhofer diffraction theory, particle size distribution analysis, Applications. 2.2. Dynamic Light Scattering: Introduction, Instrumentation, photo detector sample cell and sample handling, Applications, 2.3. Photo sedimentation: Setting velocity and particle size, Stokes equation, Instrumentation, sedimentation modes, Particle size distribution analysis, photometric measurements and applications. 2.4. Comparison with particle size measurements using XRD, SEM and TEM. 2.5. Practical applications in analytical chemistry.	

Course outcomes: Student should be able to

1. Explain types and construction of electrodes and electrochemical sensors.
2. Demonstrate instrumentation, applications XRD, SEM, TEM.

References

1.Jirm Koryta Karel Stulik, Ion selective electrodes, Cambridge university press (1983)

2. Douglas. A. Skoog, E.James Holler, Stanley R.Crouch Principles of Instrumental analysis engage Learning (2006)

3.Willard, Meritt, Dean and Settle, Instrumental methods of Analysis. CBS Publisher (2004)

4.S. M. Khopkar Basic Concepts of Analytical Chemistry. New age international publishers (2008)

Credits 2	MACT 534 E-II: Electro Analytical Techniques in Chemical Analysis-II	Hours 30

Course objectives: Students should be able to...

1. discuss various types of voltammetry techniques.
2. learn of techniques in electrophoresis.

Unit No	Title and Syllabus	Hours allotted
I	**Voltammetry Techniques**	15
	3.1. Introduction, Principle, excitation signals in voltammetry, 3.2. basic instrumentation based on operational amplifiers, voltammetric electrodes 3.3. Cyclic Voltammetry: instrumentation, Determination of analyses using cyclic voltammetry, Applications. 3.4. Pulse voltammetry: Introduction, Normal Pulse Voltammetry, 3.5. Reverse pulse voltammetry, 3.6. Differential pulse voltammetry, 3.7. Stripping voltammetry: Cathodic and Anodic stripping voltammetry, Practical applications in analytical chemistry.	
II	**Electrophoresis**	15
	4.1. Introduction, 4.2. Paper electrophoresis Principle, Factors governing migration of ions, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, thin layers), 4.3. Techniques of electrophoresis: Low and high voltage, iso electric focusing, continuous electrophoresis, capillary electrophoresis, Zone, gel, 4.4. Applications and numerical.	

Course outcomes: Student should be able to

1. analyses the samples using cyclic voltammetry, pulse voltammetry, Stripping voltammetry,
2. understand the techniques of electrophoresis and its applications.

References

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

MACT 535- Research Project (6 Credits)

Student will undertake research in specific area of his major/core with ana advisory supported by teacher/faculty member. Students are required to take 6 credits to research project for semester III under the guidance of faculty members.

Credits 2	MACP 536: Chemistry Practical-III(LAB-III)	Hours 60

Course objectives: Students should be able to...

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

Section	Title and Syllabus	Hours allotted
	1. Analysis of Bronze 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. 8. Analysis of Dolomite ore. 9. To determine the dissociation constant of ortho-phosphoric acid by titrating with it standard NaOH solution. 10. Estimation of Sulphur from supplied fungicide sample. (Any other suitable experiment may be added when required.) 11. Analysis of calcium content from plaster of Paris 12. Determination of Barium ions by Turbidimetry. 13. To determine relative strength of acetic acid by cloro-acetic acid measuring ka value. 14. Identification of organic compounds by their IR spectra 15. Determination of chloride content from saline water by potentiometry. 16. Estimation of lactose in given milk sample. 17. Determination of pKa of given dibasic acid pH-metrically. 18. To determine relative strength of acetic acid by cloro-acetic acid measuring pKa value. 19. Identification of organic compounds by their IR spectra 20. Determination of chloride content from saline water by potentiometry. (Any other suitable experiment may be added when required.)	

	Course Outcome: Student should be able to 1. explain analysis of alloys. 2. calculate the estimations of pharmaceutical tablets, food samples. 3. explain and calculate the analysis of copper fungicide, vitamin-C in juices and squashes. analyze 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)	

M.Sc. Part–II, Semester IV
Discipline Specific Course (DSC)*(Mandatory)*

Credits 4	MACT 541: Techniques in Forensic Science and Microbiological Analysis.	Hours 60

Course objectives: Student will be able to

1) Understand of body fluid and clinical analysis body fluid analysis.
2) Discuss analysis of biomolecules like carbohydrates, proteins, vitamins, lipids.
3) learn classification and analysis of pesticides.
4) distinguish special features of forensic analysis and classification of poisons.

UnitNo	Title and Syllabus	Hours allotted
I	**Analysis of Body Fluid and Clinical Analysis**	15
	A) Body fluid analysis. 1.A.1. Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases, 1.A.2. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum), 1A..3. Blood-Estimation of glucose, cholesterol, urea, hemoglobin and bilirubin Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride, 1.A.4. Fluid, Blood, Composition of Blood, 1.A.5. Estimation of serum calcium, Blood Chloride, Blood Urea, Uric Acid in Serum, Serum Cholesterol and Potassium, **B) Clinical Analysis** 1.B.1. Biological significance, 1.B.2. Analysis of assay of enzymes (pepsin, monoamine, oxidase, tyrosinase), 1.B.4. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum), 1.B.5. Blood- Estimation of glucose, chlolesterol, urea, hemoglobin and bilirubin, Urine- urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.	
II	**Analysis of Biomolecules.**	15
	A) Carbohydrates, 2.A.1Recapitulation of Carbohydrates 2.A.2. Analysis of total carbohydrates by Anthrone method, 2.A.3. Analysis starch using Anthrone reagent, 2.A.4. Analysis pectin by gravimetric method, and crude fibres. **B) Proteins** 2.B.1. Recapitulation of Proteins, 2.B.2. Analysis protein by Kjeldhal method and Lowry method, 2.B.3. Analysis total free amino acids, **C) Vitamins**	

	2.C.1. Recapitulation of Vitamins, 2.C.2. Analysis of Retinol, Vitamin D3, Vitamin E, Vitamin B1, Vitamin B2, Vitamin B6, Nicotinic acid, Vitamin C. **D)Lipids** D.2.1. Recapitulation of Lipids, Analysis of free fatty acids, saponification value, iodine value, peroxide value.	
III	**Analysis of Agrochemicals - I**	**15**
	3.1. Introduction, 3.2. Classification of pesticides, 3.3. Sampling, sample pretreatment and processing, 3.4. Analysis of Parathion, gammexane, endosulphan, zinab, ziram, malathion, thiram, thiometon, simazine, chloridane. 3.5. Applications of colorimetric and chromatographic techniques (GC-MS, HPLC-MS) in analysis of pesticide residue. 3.6. Analysis Introduction to EPA regulatory body. 3.7. Analysis Practical applications and examples in analytical chemistry and research.	
IV	**Forensic Analysis**	**15**
	4.1. Special features of forensic analysis, 4.2. Sampling, Sample storage, sample dissolution, 4.3. Classification of poisons, 4.4. Lethal dose, Significance of LD-50 and LC-50. 4.5. General discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom. 4.6. Estimation of poisonous materials such as lead, mercury and arsenic in biological samples. 4.7. Practical applications and examples in analytical chemistry.	

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. Perform 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)

4.Intellectual Property Rights in India, Shodhganga, (UNIT IV).

5.WIPO Intellectual Property Handbook 2nd Edition, (2004) (Unit I and II)

Credits 4	MACT 542: Environmental chemical analysis and control	Hours 60

Course objectives: Student will be able to

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

Unit No	Title and Syllabus	Hours allotted
I	**Air and Water Pollutant Analysis**	15
	1.1. Source of Air pollutants, 1.2. Methods of analysis of air pollutants; CO, CO_2, NOX, NH_3, H_2S, SO_2 etc. 1.3. Monitoring Instruments, 1.4. Potable and Industrial water, Major and minor components, 1.5. Dissolved oxygen (DO) and their measurements 1.6. Chemical oxygen demand (COD) and their measurements 1.7. Biochemical oxygen demand (BOD) and their measurements. 1.8. Analysis of Pd, Cd, Hg, Cr, As and their physiological manifestations. 1.9. Quality of industrial waste water analysis for organic and inorganic constituents.	
II	**Other Types of Pollution**	15
	A) Soil pollution and soil analysis: 2.A.1. Source of soil pollution and their control, 2.A.2. Sampling of soil, 2.A.3. Determination of water holding capacity, total nitrogen, ammonia and nitrates, 2.A.4. Fertility of soil and effect of pollution on it, 2.A.5. Synthetic fertilizers and their long-term effect on soil quality. **B) Noise Pollution:** 2.B.1. Sources of noise Pollution, 2.B.2. Effects of noise Pollution, 2.B.3. Methods of measurements and control measures. **C) Thermal pollution:** C.2.1. Definition, Sources of thermal pollution, C.2.2. Harmful effects of thermal pollution,	

	C.2.3. Control measures of thermal pollution.	
III	**Organic Pollutants and Their Analysis**	**15**
	3.1. Sources, Disposal, 3.2. Treatment and analysis of phenolic residues, 3.3. methods of recovery of phenols from liquid effluents, 3.4. Organomercurials and its analysis, 3.5. Analysis of organochlorine pesticides, 3.6. Volatile organic pollutants and their analysis.	
IV	**Environmental protection Policy**	**15**
	4.1. Introduction, 4.2. Environmental Legislation: Status in India, 4.3. Environmental Law-The water (Prevention and control of pollution) Act 1974, 4.4. The Air (Prevention and control of pollution) Act 1981, 4.5. The Environmental (Protection) Act 1986, 4.6. 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)*

Credits 4	MACT 543: Applied Industrial Analysis	Hours 60

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) learn Composition and analysis of petroleum products and biofuels.
4) Acquire analysis of cement and glass ceramics.

Unit No	Title and Syllabus	Hours allotted
I	**Analysis of Agrochemicals -II**	**15**
	1.1. Introduction, Classification, 1.2. Analysis of insecticides: DDT, BHC, Aldrin, Endosulfon, Malathion, Parathion. 1.4. Analysis of Herbicides: 2, 4- dichloro phenoxy acetic acid, dalapon, paraquat, Banalin, Butacarb . 1.5. Analysis of Fungicides; Boardeaux mixture, Copper oxychloride, Zineb, Benomyl (Benlte) 1.6. Analysis of pesticide residue and toxicological effects.	
II	**Analysis of cosmetics**	**15**
	A) Analysis of creams and lotions 2.A.1. Composition of creams and lotions: 2.A.2. Determination of water, propylene glycol non-volatile matter, ash content, borates, carbonates, sulphate, phosphate, chloride, titanium, Zinc oxide. **B) Analysis of face powder:** 2.B.1. Introduction, Composition of face Powder 2.B.2. Estimation of boric acid, Mg, Ca, Zn, Fe, Al and Ba.	
III	**Analysis of Petroleum products**	**15**
	A) Analysis of petroleum products 3.A.1. Introduction and constituents 3.A.2. Petroleum fractionation, 3.A.3. Quality control; - specific gravity, viscosity, Cloud point, pour point, flash point, vapor pressure, Doctor test, sulphuric acid absorption, aniline point, and cloud point, pour point. A.3.4. Determination of water, neutralization value (acid and base numbers), ash content, sulphur and mercaptan sulphur. A.3.5. Determination of lead in petroleum; **B) Analysis of coal and coke:** 3.B.1. Introduction and constituents 3.B.2. Preparation of sample, 3.B.3. Proximate and ultimate analysis 3.B.4. Calorific value by Bomb Colorimetry.	

IV	**Analysis of cement and ceramics**	**15**
	A) Cement: 4.A.1. Estimation of Loss on ignition, insoluble residue, total silica, lime, magnesia, ferric oxide, sulphuric anhydride, 4.A.2. Air and dust pollution from cement plants, 4.A.3. Atmospheric dispersion of pollutants in cements industry. **B) Glass and Glass-Ceramics-** B .4.1. Introduction, Composition, B .4.2. Method of analysis-sampling and sample preparation, B .4.3. Analysis-preliminary testing, decomposition, chemical method for the individual constituents-Si,B, Pb, Al, Ca.	

Course Outcomes: Student should be able to

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

References: -

1. O.P.Shukla, Omkar and A.K. Kulshrestha Pesticides , Man amd 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)

Discipline Specific Elective (DSE)*(Elective)*

Credits 4	MACT 544 E-I: Quality Assurances and Quality control.	Hours 60
Course objectives: Course Objectives: Student will be able to 1) study the quality control and quality assurance. 2) learn documentation for quality assurance. 3) Understand management of raw data in quality assurance 4) Acquire Laboratory Accreditation, Quality Management and ISO.		
UnitNo	**Title and Syllabus**	**Hours allotted**
I	**Quality Assurance**	**15**
	1.1. Introduction to Quality Control and quality assurance: 1.2. Concepts and significance. 1.3. Quality control and statistical techniques: 1.4. Quality control charts, the X-quality control chart, 1.5. The R-quality control chart and its interpretation, 1.6. Spiked sample control charts, 1.7. Calibration and maintenance of Instruments / Equipment 1.8. Instrument calibration 1.9. Linear calibration curves, 1.10. Equipment calibration, 1.11. Frequency of calibration, 1.12. 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.,). 1.13. Maintenance of instruments and equipment.	
II	**Documentation for Quality Assurance: Introduction of Raw Data**	**15**
	2.1. Type of notebooks, 2.2. Control of notebook distribution and data entry. 2.3. General Reagents and volumetric reagents. 2.3. Sampling – sampling methods, sample labelling, and sample login/register. Sample analysis, reporting, recording and personal training. 2.4. Instrument calibration and maintenance. 2.5. Material Safety Data Shift (MSDS), 2.6. Good laboratory practices and personnel, 2.7. Quality Program, 2.8. Instrument and Organization calibration, 2.9. Customer Satisfaction.	

III	**Documentation for Quality Assurance: Management of Raw Data**	**15**
	3.1. Computers and quality assurance: 3.2. Sample handling. 3.3. Data Acquisition. 3.4. Quality control data and calculations, 3.5. Computer generated analytical reports. 3.6. Security considerations. 3.7. Hardware and software. 3.8. Establishing a Quality Assurance program: Management commitment. 3.9. Define the quality assurance program. 3.10. Writing standard operating procedures. 3.11. Topics for standard operating procedures. 3.12. Consolidating the program. 3.13. Monitoring the program – monitoring quality assurance data 3.14. Reporting quality assurance problems. 3.15. Writing the quality assurance manuals.	
IV	**Quality Accreditation**	**15**
	4.1. Laboratory Accreditation: 4.2. Need for laboratory accreditation, 4.3. International aspects of laboratory accreditation and in India. 4.4. Criteria for laboratory accreditation, 4.5. Benefits of laboratory accreditation, 4.6. Evolution and significance of Quality Management, 4.7. Background to ISO 9000, 4.8. Comparison between ISO-9001, ISO-9002 & ISO-9003., 4.9.ISO 9000-2000 series of standards on quality management system, 4.10. Evolution of series of standards, 4.11. Introduction to ISO organization, and Registration / certification- 4.12. Benefits of QMS certification, 4.13. Structure of ISO 9000-2000 family of standards. 4.14. Advantages of ISO 9000-2000, 4.15. Requirements of ISO 9001-2000 QMS and applications, 4.16. Steps for effective implementations, 4.17. Significance of ISO - 9001, 9002, 9003 & 9004.	

Course outcomes: After completion of the course students will be able to…

1. Apply basic concepts of quality assurance and calibration of instruments.
2. Imbibe distribution and data entry, sample labelling, and MSDS.
3. Demonstrate Documentation for Quality Assurance
4. Explain 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,AshishBudhrani,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)

Credits 4	MACT 544 E-II: INDUSTRIAL ANALYTICAL CHEMISTRY.	Hours 60

Course objectives: Students should be able to...

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

Unit No	Title and Syllabus	Hours allotted
I	**Analysis of metals and alloys**	15
	1.1Foundry materials, 1.2. Ferroalloys, 1.3. Special steels, 1.4. Slags, 1.5. Fluxes. 1.6. Analysis of alloys, 1.7. Analysis of bronze, 1.8. Analysis of brass, 1.9. Analysis of Alnico 1.10. Analysis of Nichrom.	
II	**Spectrochemical Methods of Analysis**	15
	2.1. Introduction to spectrochemical methods, 2.2. Electronic spectra and molecular structure, 2.3.NIR Spectrometry for nondestructive testing, 2.4. Solvents for spectrometry, 2.5. FTIR spectrometer, 2.6. Fluorometry, 2.7. Optical sensors, 2.8. Analysis of ores –bauxites, dolomites, monazites. 2.9. Analysis of Portland cement.	
III	**Analysis of Commercial materials**	15
	3.1. Analysis of explosive materials, TNT, RDX, lead azide, EDNA (ethylene dinitramine). 3.2. Analysis of conducting polymer, resins and rubber. 3.3. Analysis of luminescent paints, 3.4. Analysis of lubricants and adhesive.	
IV	**Analysis of soil and fertilizers**	15
	4.1. Method of soil analysis, 4.2. Soil fertility its determination, 4.3. Determination of inorganic constituents of 4.4. Plant materials, 4.5. Chemical analysis as measure of soil fertility,	

	4.6. 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. Explain 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)

Credits :4	**MACT 545: ON JOB TRAINING.**	**Hours : 120**

On job Training

OJT Will provide the opportunities for internship with local/regional industries, business organization, health and allied areas, local government, etc. So that undergo 4 Credit work-based learning/OJT/Internship.

Credits 2	MACP 546: Chemistry Practical IV(LAB-IV)	Hours 60

Course objectives: Students should be able to...

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

Section	Title and Syllabus	Hoursallotted
	1. Estimation of Calcium from Cement Sample. 2. Estimation of Copper from Supplied Fungicide Sample. 3. To estimate amount of Mn from Tea Powder. 4. Agricultural analysis of soil sample, animal feeds, soil micronutrients, milk powder for Ca, Fe and P content. 5. To determine the percentage of Calcium from given chalk sample. 6. Analysis of alloy. 7. Estimation of salicylic acid and zinc oxide from medicated powder. 8. Simultaneous spectrophotometric determination of Cr and Mn. 9. To estimate percentage of iron from the given iron tablet by calorimetrically. 10. Studies on the effect of substituent at ortho position of benzoic acid, salicylic acid and Sulphosalicylic acid on its equilibrium constant pH metrically. 11. Determination of pKa of dibasic acid, by potentiometry. 12. Estimation of Fe from soil sample. 13. Determination of chemical oxygen demand of water sample (dye solution). 14. Determination of amount of H_3BO_3 by Conductometrically. 15. Estimation of Zn in the given solution fluorometrically. 16. Estimation of acetyl salicylic acid in the given aspirin tablet by titrating against 0.1N alcoholic KOH potentiometrically. 17. To determine the dissociation constant of dibasic acid by using potentiometrically. 18.Analysis of Na and K from soil sample. 19.Determination of flash point of oil/fuel. 20.Determination of dissociation constant of weak acid pH- metrically. 21.Determination of critical micelle concentration of given surfactants conductometrically. 21. To determine the acid base dissociation constant and 22. isoelectric point of amino acid pH metrically. (Any other experiments may be added when/if required)	

Course outcomes: After completion of the course students will be able to…

1. explain analysis of ore.
2. analyze of milk, pesticides, insecticides, cements, soil etc.
3. explain 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)