University of Mumbai, Mumbai

R.P. Gogate College of Arts & Science
and
R.V. Jogalekar College of Commerce,
(Autonomous)
Ratnagiri

Syllabus for M.Sc.
II
(Analytical Chemistry)
Semester III & IV
Under Choice Based Credit System (CBCS)
With effect from Academic Year-
2024-2025

R. P. Gogate College of Arts & Science and
R. V. Jogalekar College of Commerce (Autonomous), Ratnagiri

Board of Studies in Chemistry

Academic Year 2024-25

PG Courses:

S. N.	Type of the course	No. of Cr.	Course Code	Nomenclature	S. N.	Type of the course	No. of Cr.	Course code	Nomenclature
Semester I					**Semester II**				
1	Major Mandatory	04	24_PSCH 101	Inorganic Chemistry-I	1	Major Mandatory	04	24_PSCH 201	Inorganic Chemistry-II
2	Major Mandatory	04	24_PSCH 102	Organic Chemistry-I	2	Major Mandatory	04	24_PSCH 202	Organic Chemistry-II
3	Major Mandatory	04	24_PSCH 103	Analytical Chemistry-I	3	Major Mandatory	04	24_PSCH 203	Analytical Chemistry-II
4	Major Mandatory	02	24_PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	4	Major Mandatory	02	24_PSCH 204	Chemistry Practical- (Organic Chemistry and Analytical Chemistry)
5	Major Electives	02	24_PSCH 105	Physical Chemistry I	5	Major Electives	02	24_PSCH 205	Physical Chemistry III
6	Major Electives	02	24_PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	6	Major Electives	02	24_PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)
7	Major Electives	02	24_PSCH 107	Physical Chemistry II	7	Major Electives	02	24_PSCH 207	Physical Chemistry IV
8	Major Electives	02	24_PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	8	Major Electives	02	24_PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)
9	Major Mandatory	04	24_PSCH 109	Research Methodology	9	Major Mandatory	04	24_PSCH 209	On Job Training/Internship Field Project/Extended Experiment
	Major Mandatory	04	24_PSACH309	Research Project (RP)					

S. N.	Type of the course	No. of Cr.	Course Code	Nomenclature	S. N.	Type of the course	No. of Cr.	Course code	Nomenclature
Semester III					**Semester IV**				
1	Major Mandatory-I	4	24_PSACH301	Quality in Analytical Chemistry I	1	Major Mandatory-I	4	24_PSACH401	Quality in Analytical Chemistry -II
2	Major Mandatory- II	4	24_PSACH302	Advanced Instrumental Techniques –I	2	Major Mandatory- II	4	24_PSACH402	Advanced Instrumental Techniques –II
3	Major Mandatory-III	4	24_PSACH303	Bio analytical Chemistry and Food Analysis	3	Major Mandatory-III	4	24_PSACH403	Analytical Chemistry Practical Group (A+B+C)
4	Major Mandatory- IV	2	24_PSACH304	Analytical Chemistry Practical Group (A + B)					
5	Major Electives-I	02	24_PSACH305	Environmental Chemistry	5	Major Electives-I	4	24_PSACH404	Selected Topics in Analytical Chemistry
6	Major Electives-I	02	24_PSACH306	Analytical Chemistry Practical Group (C + D)	6	Major Electives-II	4	24_PSACH405	Pharmaceutical and Organic Analysis
7	Major Electives-II	02	24_PSCHA307	Industrially Important Materials	**7**	Major Mandatory	06	24_PSACH406	Research Project (RP)
8	Major Electives-II	02	24_PSACH308	Analytical Chemistry Practical Group (C + D)					
9	Major Mandatory	04	24_PSACH309	Research Project (RP)					

Master of Science (M.Sc) Programme

under Choice Based Credit System Course Structure

M.Sc. II Analytical Chemistry

(To be implemented from Academic Year 2024-25)

No. of Courses	Semester III	Credits		No. of Courses	Semester IV	Credits	
	Major Mandatory				Major Mandatory		
24_PSACH301	Quality in Analytical Chemistry-I	04		24_PSACH401	Quality in Analytical Chemistry-II	04	
24_PSACH302	Advanced Instrumental Techniques –I	04		24_PSACH402	Advanced Instrumental Techniques -II	04	
24_PSACH303	Bio Analytical Chemistry and Food Analysis	04		24_PSACH403	Analytical Chemistry Practical Group (A+B+C)	04	
24_PSACH304	Analytical Chemistry Practical Group (A + B)	02					
	Major Electives (Any One)				Major Electives (Any One)		
24_PSACH305	Environmental Chemistry	02	04	24_PSACH404	Selected Topics In Analytical Chemistry	04	04
24_PSACH306	Analytical Chemistry Practical Group (C + D)	02					
	OR				OR		
24_PSACH307	Industrially Important Materials	02	04	24_PSACH405	Pharmaceutical and Organic Analysis	04	04
24_PSACH308	Analytical Chemistry Practical Group (C + D)	02					
24_PSACH309	Research Project (RP)	04		24_PSACH406	Research Project (RP)	06	
Total Credits		22		Total Credits		22	

Syllabus for Master of Science in Analytical Chemistry for the year 2024-25

Name of Programme	Master of Science
Level	PG
No of Semesters	04
Year of Implementation	2024-25
Programme Specific Outcomes (PSO)	At the end of the programme, learner will be able to 1. Apply the skills to do specialized research in the core and applied areas of chemical sciences. 2. Handle the advance analytical instruments. 3. Understand good laboratory practices and safety. 4. Explain why analytical chemistry plays an integral role in addressing social, economic and environmental problems. 5. Design and optimize separation methods for various compounds and analytes, considering actors like selectivity, resolution and efficiency. 6. Understand the fundamental principles of separation sciences, including chromatography, electrophoresis, and extraction techniques. 7. Demonstrate the developed skills such as problem- solving approach, critical thinking, analytical reasoning, team work and effective communication for solving the applied research problems related to their field. 8. Generate awareness of the benefits and impacts of chemistry related to the environment, society, and other disciplines outside the scientific community .

Relevance of PSOs to the local, regional, national, and global developmental needs	Analytical chemistry is a powerful discipline with a far- reaching impact, addressing issues and challenges at all levels, from local environmental concerns to global health and trade standards. Its applications are critical for the well-being of communities and nations and the advancement of science and technology. Analytical techniques are used to confirm product safety and authenticity. It is used for national security in areas like forensics and defense, providing tools for crime scene investigations, explosives detection, and border control. Analytical chemistry ensures the safety of food, pharmaceuticals, and consumer products. National regulatory agencies use analytical methods to enforce quality and safety standards. Apply the skill stood specialized research in the core and applied areas of chemical sciences. Become professionally skilled for higher studies in research institutions and to work in industries. Students will be able to integrate chemical concepts and ideas learned in lecture courses with skills learned in laboratories to formulate hypotheses, propose and perform experiments, collect data, compile and interpret results and draw reasonable and logical conclusions. Be proficient in the use of both classical and modern tools (e.g., instrumentation, techniques, software) for analysis of chemical systems.

Syllabus for Master of Science in Analytical Chemistry for the year 2024-25

Nomenclature of the Course	Quality in Analytical Chemistry
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH301
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

At the end of the Course, the learner will be able to:

CO1: Define a sample and develop effective sampling plans to ensure representative sample quality across raw materials, intermediates, and finished products. Apply appropriate dissolution techniques for various sample types to facilitate accurate analysis. Explain proper storage conditions to maintain sample integrity. Understand the purpose of method validation and the role of performance criteria in ensuring the reliability of analytical data.

CO2: Evaluate measurement uncertainty to interpret analytical results and improve data quality. Analyze and optimize signal-to-noise ratios in instrumental analysis by identifying noise sources and implementing appropriate hardware and software noise reduction techniques. Understand pharmaceutical legislation, including drug acts, drug rules (schedules), GLP, GMP and apply this knowledge to ensure compliance in analytical laboratory operations, encompassing personnel roles, equipment design, maintenance, and calibration.

CO3: Explain the principles and applications of ion exchange chromatography, ion chromatography and size exclusion chromatography (gel filtration and gel permeation). Evaluate the advantages and limitations of each chromatographic technique. Apply ion exchange equilibrium equations to understand and predict ion exchange process. Evaluate the selectivity and efficiency of ion exchangers in analytical applications.

CO4: Elaborate on the principles and instrumentation of Optimum Pressure Liquid Chromatography (OPLC) and Supercritical Fluid Chromatography (SFC), and explain their applications in various fields such as pharmaceuticals, biotechnology, and environmental sciences. Additionally, explain the mechanisms of Affinity Chromatography and its applications in biomolecular separations.

Syllabus for Master of Science in Analytical Chemistry for the year 2024-25

Curriculum:			
Unit No.	**Unit Title**	**Sub titles (Learning Points)**	**No. of Hours**
I	Quality In Analytical Chemistry–I	1.1 Sampling: Definition, types of samples, sampling plan, quality of sample, Sub sampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of Sample. Pre-treatment of samples: soil, food and cosmetics. (8L) 1.1 Selection of the Method: sources of methods, factors to consider when selecting method, performance criteria for methods used, reasons for incorrect analytical results, method Validation. (7L)	15
II	Quality In Analytical Chemistry-II	2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L) 2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, and software methods for noise reduction. (6L) 2.3 Pharmaceutical Legislation: introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for Maintenance and Calibration. (5L)	15
III	Chromatographic Techniques –I	3.1 Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins and their applications for separation of inorganic and organic compounds. (8L) 3.2 Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L) 3.3 Exclusion chromatography: Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers. (5L)	15

IV	Chromatographic Techniques –II	4.1 Supercritical fluid Chromatography: Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis. (8L) 4.2 Affinity Chromatography: principle, instrumentation and applications. (4L) 4.3 Optimum pressure liquid chromatography (OPLC). (3L)	15

References:

1. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y1997.
2. Quality assurance in analytical Chemistry, W Funk, V Dammann, G. Donnevert VCH Weinheim 1995.
3. Amit S. Patil*et. al*. Quality by Design (QbD) : A new concept for development of Qualitypharmaceuticals,InternationalJournalofPharmaceuticalQualityAssurance; 4(2); 13-19.
4. Lalit Singh and Vijay Sharma, Quality by Design (QbD) Approach in Pharmaceuticals: Status, Challenges and Next Steps, Drug Delivery Letters, 2015, 5,2-8. Quality in the analytical chemistry laboratory, E Prichard, John Wile yandsons N. Y. 1997.
5. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication.
6. Chemical methods of separation, J. A. Dean, VanNostrandReinhold,1969
7. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
8. Analytical Chemistry, G. D. Christain, Wiley.
9. Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978.
10. Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996.
11. Ion exchange separation in analytical chemistry O Samuel son John Wiley2^{n}ded 1963
12. Ion exchange chromatography Ed H. F Walton Howden, HutchensonandRossing1976.
13. Chromatographic and electrophoresis techniques I Smith Menemann Interscience 1960.

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in Hrs.)**
I	Quality In Analytical Chemistry - I	Lecture, PPT	15
II	Quality In Analytical Chemistry - II	Lecture, PPT	15
III	Chromatographic Techniques-I	Lecture, PPT	15
IV	Chromatographic Techniques-I	Lecture, PPT	15

Evaluation Pattern:

A. Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B. Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	Short note / objective, etc.	12

Nomenclature of the Course	Advanced instrumental techniques-I
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH302
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

At the end of the Course, the Learner will be able to:

CO1: Demonstrate the spectral surface analytical techniques by explaining the principles, instrumentation, and applications of Secondary Ion Mass Spectroscopy (SIMS), Particle-Induced X-ray Emission (PIXE) Spectroscopy, Low Energy Ion Scattering (LEIS), and Rutherford Backscattering Spectrometry (RBS) for material characterization.

CO2: Explain principle and applications of Electron Spin Resonance (ESR) spectroscopy, Mossbauer spectroscopy, and Atomic Emission Spectroscopy (AES) in chemical analysis.

CO3: Apply fundamental principles to analyze chemical substances using methods such as potentiometry, voltammetry, and conductometry, while evaluating their applications, advantages, and limitations in analytical chemistry.

CO4: Describe miscellaneous analyti 10 hniques, including chemiluminescence, chirooptical methods, photoacoustic spectroscopy, and spectroelectrochemistry, by applying their principles, instrumentation, and analytical applications in chemical analysis.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Spectral Methods I	1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L) 1.2 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy (4L) b. Particle-Induced X-Ray Emission (5L) c. Low-Energy Ion Scattering and Rutherford Back scattering (5L)	15
II	Spectral Methods– II	Principle, Instrumentation, and Applications : 2.1 Electron Spin Resonance Spectroscopy (ESR) (5L) 2.2 Mossbauer's Spectroscopy (5L) 2.3 Atomic Emission Spectroscopy- based on plasma and electrical discharge sources (5L)	15

III	Electro analytical Methods	Advanced Electro analytical Techniques: 3.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L) 3.2 Potential Sweep methods- Linear sweep Voltammetry and Cyclic voltammetry (3L) 3.3 Potential Step method-Chronoamperomertry (2L) 3.4 Controlled potential technique-Chronopotentiometry (2L) 3.5 Stripping Voltammetry- anodic, cathodic, and adsorption (2L) 3.6 Chemically and electrolytically modified electrodes and ultra-micro electrodes in voltammetry (3L)	15
IV	Miscellaneous Techniques	Principle, Instrumentation and Applications of: 4.1 Chemiluminescence techniques (3L) 4.2 Chirooptical Methods : ORD, CD (5L) 4.3 Photoacoustic spectroscopy (3L) Spectroelectrochemistry (4L)	15

References:

1. Analytical Chemistry, G. D. Christian,4th Ed. John Wiley, New York (1986)
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J. Holler Holt- Saunders 6th Edition (1992)
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann,5thEdition (1998)
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. SettleJr6thEd CBS (1986)
5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F.A. Settle Jr 7th Ed CBS (1986)
6. Introduction to Instrumental Analysis, R.D. Braun, Mc Graw Hill (1987)
7. Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
8. Electro analytical Chemistry, J. J. Lingane,2nd Ed Interscience, New York (1958)
9. Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980.
10. Electro analytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
11. Techniques and mechanism of electro chemistry, P. A. Christian and A. Hamnett, Blachie Academic and Professional (1994)
12. Wilson and Wilson's Comprehensive Analytical Chemistry, Ed. G. Svehla. (A series of Volumes)
13. Treatiseon Analytical Chemistry, Eds. I. M. Kolth off and Others, Inter science Pub. (A series of volumes).

14. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, (A series of volumes)
15. Polarographic Methods in Analytical Chemistry, M. G. Arora, Anmol Publications Pvt Ltd
16. Surface Analysis–The Principal Techniques, 2 Edition Edited by John C. Vickerman and Ian S. Gilmore 2009 John Wiley & Sons, Ltd. ISBN: 978-0-470-01763-0

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
1	Spectra Methods I	Lecture, PPT	15
2	Spectral Methods– II	Lecture, PPT	15
3	Electro analytical Methods	Lecture, PPT	15
4	Miscellaneous Techniques	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner , mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	Short note / objective, etc.	12

Nomenclature of the Course	Bio analytical Chemistry and Food Analysis
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH303
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

At the end of the Course, the learner will be able to:

CO1: Explain the composition of body fluids and apply biochemical techniques to detect abnormal levels of biomolecules in blood and urine, interpret their significance in disease diagnosis, and evaluate the physiological and nutritional roles of vitamins and minerals using analytical and microbiological methods.

CO2: Demonstrate the immune response mechanisms, antigen-antibody interactions, and immunoassay techniques, while also evaluating human nutrition through the estimation of biological values, enzymes, macronutrients, and essential amino acids.

CO3: Analyze the fuel value and nutritional significance of food, evaluate the role of food additives in processing and preservation, and assess the presence of contaminants and toxicants in food products through analytical techniques.

CO4: Demonstrate knowledge of food packaging materials and industrial requirements, assess the processing and quality parameters of various food products and apply analytical techniques for evaluating the composition and safety of milk, oils, fats, and spices.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Bio analytical chemistry	1.1 Body Fluids 1.1.1 Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases. (5L) 1.1.2 Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals. (5L) 1.1.3 Analytical techniques (including microbiological techniques) for vitamins (5L)	15

II	Immunological Methods	2.1 General processes of immune response, antigen- antibody reactions, precipitation reactions, radio, enzyme and Fluoro-immuno assays. (8L) 2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, Essential amino acids and lipids. (7L)	15
III	Food Analysis-I	3.1 Fuel value of food and importance of food nutrients. (2L) 3.2 Food Additives - General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour. (5L) 3.3 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. (8L)	15
IV	Food Analysis –II	4.1.1 Food packaging – Introduction, types of packing materials, properties and industrial requirements. (2L) 4.1.2 Processing and Quality requirements of Milk and milk products (cheese, butter and ice cream), vegetables and fruits, meat and meat products. (6L) 4.2 Analysis of Milk–Fat content, proteins, acidity, bacteriological quality and milk adulterants. (2L) 4.3 Analysis of Oils and Fats – acid value, sap value, iodine value. Determination of rancidity and antioxidants. (2L) 4.4 Analysis of spices (cloves, cinnamon, pepper, mustard) Determination of volatile oils and fixed oils. (3L)	15

References:

1. General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.

2. Advanced dairy chemistry, vol. 3, P. F. Fox, P. L. H. McSweeney, Springer.

3. Physiological fluid dynamics vol. 3, Nanjanagud Venkatanarayana Sastry Chandrasekhara Swamy, Narosa Pub. House, 1992.

4. Molecular Biological and Immunological Techniques and Applications for food, edited by Bert Popping, Carmen Diaz-Amigo, Katrin Hoenicke, John Wiley & sons.

5. Food Analysis: Theory and practice, Yeshajahu Pomeranz, Clifton E. Meloan, Springer.

6. Principles of package development, Gribbin et al.

7. Modern packaging Encyclopedia and planning guide, MacgraWreyco.

8. Food Analysis, Edited by S. Suzanne Nielsen, Springer.

9. Analytical Biochemistry, D. J. Homes and H. Peck, Longman (1983).

10. Bioanalytical Chemistry, S. R. Mikkelesen and E. Corton, John Wiley and sons 2004. Analysis of food and beverages, George Charalanbous, Academic press 1978.

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
1	Bio analytical chemistry	Lecture, PPT	15
2	Immunological Methods	Lecture, PPT	15
3	Food Analysis-I	Lecture, PPT	15
4	Food Analysis –II	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner , mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	Short note / objective, etc.	12

Nomenclature of the Course	Analytical Chemistry Practical Group A + Group B
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH304
No. of Credits	02
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

At the end of the Course, the Learner will be able to

CO1 : Determine the pK_{In} value of an indicator spectrophotometrically.

CO2 : Estimate the amount of copper and Bismuth in a mixture of sample by photometric titration.

CO3 : Determine the amount of strong acid, weak acid and salt in the given mixture conductometrically.

CO4 : Estimate amount of carbonate and bicarbonate in the given sample mixture Using pH metry.

CO5 : Determine % of copper by extractive photometry using diethyldithiocarbamate.

CO6 : Estimate the % purity of given drugs by non-aqueous titration.

CO7 : Determine the percentage purity of methylene blue indicator.

CO8 : Estimate the amount of cholesterol and uric acid in the given sample of blood serum.

CO9 : Estimate the amount of fluoride in a toothpaste.

CO10: Estimate the amount of silica by molybdenum blue method.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I & II	**Group A (30hrs)** **Instrumental**	1. Determination of the pK_{In} value of an indicator. 2. Determination of copper and bismuth in mixture by photometric titration. 3. Estimation of strong acid, weak acid and salt in the given mixture conductometrically. 4. Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pH metry. 5. Determination of copper by extractive photometry using diethyldithiocarbamate.	60

	Group B **(30hrs)** **Non-Instrumental** **Instrumental**	1. Estimation of drugs by non-aqueous titration: Pyridoxine hydrochloride, Sulphamethoxazole. 2. Determination of percentage purity of methylene blue indicator. 3. Estimation of cholesterol and Uric acid in the given sample of blood serum 1. Estimation of fluoride in a tooth paste. 2. Determination of silica by molybdenum blue method	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by; A.I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis; F.J. Welcher, 1975.
4. Standard methods of chemical analysis: Instrumental methods of Analysis; F.J. Welcher, vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W.W. Scott, Vol. I, Van Nostrand Company, Inc., 1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B. Sandell and H. Onishi, Part II, 4th Ed., A Wiley Interscience Publication, New York.1978

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Group A	Lecture, Demo, experiment	**60**
II	Group B	Lecture, Demo, experiment	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks:20

Method	**Marks**
Assessment during practical (Interaction / Performance) skill, Accuracy, precision of measurement, Record of observation, calculations, result and conclusion.	10
Timely submission of journal	05
Overall performance (attendance, punctuality, interaction during practical session throughout semester)	05

Semester End Examination: Maximum Marks: 60

Sr. No.	**Name of course**	**Method**	**Duration**	**Marks**
1.	Group A	Experiment performance as per the practical slip	Three and half hours	25
2.	Group B	Experiment performance as per the practical slip	Three and half hours	25
3	Journal+ Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Nomenclature of the Course	Environmental Chemistry
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH305
No. of Credits	02
Nature	Theory
Type	Major Electives

Course Outcomes:

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

CO1 Explain the sources, classification, and permissible limits of air pollutants; apply appropriate sampling and analysis methods for industrial emissions and automobile exhaust; evaluate the impact of air pollution on global issues, greenhouse gases, and carbon credits; and analyze environmental legislation and regulatory measures for pollution control

CO2 Discuss the various aspects of water pollution, its sources, and the mechanisms to ensure water quality, especially for potable water. It includes the analysis of water pollutants and their impact on natural sources, such as rivers and bore wells, and the processes involved in making water safe for consumption.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Air Pollution	1.1 Sources, classification, pollutants and permissible limits. (2L) 1.2 Sampling methods for air, flew gas, Industrial Exhaust, stag samples etc. (2L) 1.3 Importance of automobile exhaust control and its limits. (2L) 1.4 Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors. (3L) 1.5 Carbon credit and global issues related to air pollution. (3L) 1.6 Greenhouse gases and their substitutes. (1L) 1.7 Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC. (2L)	15

II	Water Quality Standard	2.1 Water pollution and sources (1L) 2.2 Water Pollutants for potable water reservoirs, quality of potable water from Natural sources (2L). 2.3 Water: quality and requirements of potable water, direct and indirect (6L) 2.4 Bore well water quality and analytical parameters. Quality of bottled mineral water. Process of purification of bore well water to bottled mineral water. (2L) 2.5 Regulatory requirements for packaged drinking water (4L).	15

References:

1. Environmental Chemistry, A.K. De, 2nd ED. Wiley (1989).
2. Environmental Pollution Analysis, S. M. Khopkar, John Wiely (1993).
3. Air Pollution Sampling and Analysis, Sharad Gokhale, IIT Guwahati, May 2009.
4. Environmental Pollution Analysis, S.M. Khopkar, New Age International publication (2011).
5. Water and Water Pollution (handbook) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N. York (1972).
6. Water Pollution, Arvind Kumar, and APH publishing (2004).
7. Introduction to Potable Water Treatment Processes, Simon Parsons, Bruce Jefferson, Paperback publication.
8. Guidelines for drinking-water quality, Third edition, (incorporating first and second addenda).WHO report.

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
1	Air Pollution	Lecture, PPT	15
2	Water Pollution	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 20

Method	**Marks**
One Periodical Class Test/Written objectives/Assignments/Short answer Questions/Seminar to be conducted in the given semester	15
Active participation in routine class, instructional deliveries and overall conduct as a responsible learner , mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05

B) Semester End Examination: Maximum Marks: 30

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q. 1	Unit I	Descriptive, short note	10
Q. 2	Unit II	Descriptive, short note	10
Q. 3	All units	Short note , objective, etc.	10

Nomenclature of the Course	Analytical Chemistry Practical Group C + Group D
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH306
No. of Credits	02
Nature	Practical
Type	Major: Elective

Course Outcomes:

CO1: Estimate total reducing sugars before and after inversion in honey by redox titration.

CO2: Determine the % of lactose in milk sample.

CO3: Determine the % of caffeine in tea sample.

CO4: Estimate the amount of Vitamin C in lemon Juice/squash.

CO5: Study of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation.

CO6: Determine the metal ions in given Pyrolusite ore.

CO7: Determine the metal ions in given Magnesium alloy.

CO8: Determine the composition of Bauxite ore.

CO9: Determine the chemical properties of water sample such as total hardness and salinity.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I & II	**Group C (30hrs) Non–Instrumental**	1. Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method. 2. Analysis of lactose in milk. 3. Estimation of Caffeinein tea. 3. Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method. 4. Iodine value of oil / fat 5. Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation	60

		1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry. 2. To analyze Magnelium for Mg by complexometry. 3. Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry) 1. Analysis of water sample: Total hardness and salinity. 2. Analysis of water sample: Acidity and sulphate (Benzidine method)	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by; A.I. Vogels, 3rd Ed. ELBS (1964).
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis; F.J. Welcher, 1975.
4. Standard methods of chemical analysis: Instrumental methods of Analysis; F.J. Welcher, vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W.W. Scott, Vol. I, Van Nostrand Company, Inc., 1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B. Sandell and H. Onishi, Part II, 4th Ed., A Wiley Inter Science Publication, New York, 1978.

Teaching plan :			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs.)**
I	Group C	Lecture, Demo, experiment	60
II	Group D	Lecture, Demo, experiment	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 20

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	15
Active participation in routine class instructional deliveries and overall conduct as a responsible learner , mannerism and articulation and exhibit of leadership Qualities in organizing related academic activities.	05

B) Semester End Examination: Maximum Marks: 60

Sr. No.	**Name of course**	**Method**	**Duration**	**Marks**
1.	Group C	Experiment performance as per the practical slip	Three and half hours	25
2.	Group D	Experiment performance as per the practical slip	Three and half hours	25
	Journal+ Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30Marks.

CIE	Semester End	Total Marks
20	30	50

Nomenclature of the Course	Industrially Important Materials
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH307
No. of Credits	02
Nature	Theory
Type	Major Electives

Course Outcomes:

At the end of the course, the learner will be able to:

CO1 Systematically classify the composition of plastics, polymers, paints, and pigments. Understand the determination of additives, metallic impurities, and molecular weight distribution; evaluate the environmental impact of plastics and organo-silicones; and apply appropriate analytical techniques for their characterization.

CO2 Elaborate the important industrial materials, including pesticides, soaps, detergents, and petrochemical products; analyze their composition and classify them. Apply appropriate qualitative and quantitative methods for their evaluation and environmental impact assessment.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Plastics and Polymers	3.1 Classification of plastic, determination of additives, molecular weight. distribution, analysis of plastic and polymers based on styrene, vinyl chloride, Ethylene, acrylic and cellulosic plastics. (5L) 3.2 Metallic impurities in plastic and their determination, (2L) 3.3 Impact of plastic on environment as pollutant. (2L) 3.4 Paints and pigments: Types of paints pigments, determination of volatile and non - volatile components, (significance and method of determination), separation and analysis of pigments, binders and thinners. (3L) 3.5 Role of Organo silicones in paints and their impact on environment. (3L)	15

II	Industrial Materials	4.1 Pesticides: definition, classification of insecticides pesticides. Biodegradation of insecticides and pesticides (5L). 4.2 Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents (5L) 4.3 Petrochemical products: crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, Corrosion test, carbon residue and impact on Environment. (5L)	15

References:

1. Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005
2. Environmental law in India, Mohammad Naseem, Wolters Kluwer.
3. Environmental Protection, Law and Policy in India Kailash Thakur google books (1997).
4. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002)
5. Pesticide Analysis Ed K. G. Das, Dekker (1981)
6. Analytical, Agricultural Chemistry S. L Chpra J.S Kanwar Kalyani publication
7. Soil and plant Analysis C.S Piper, Hans Publication

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
1	Plastics and Polymers	Lecture, PPT	15
2	Industrial Materials	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 20

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	15
Active participation in routine class instructional deliveries and overall conduct as a responsible learner , mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05

B) Semester End Examination: Maximum Marks: 30

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q. 1	Unit I	Descriptive, short note	10
Q. 2	Unit II	Descriptive, short note	10
Q. 3	All units	Short note , objective, etc.	10

Nomenclature of the Course	Analytical Chemistry Practical Group C + Group D
Class	M.Sc.-II
Semester	III
Course Code	24_PSACH308
No. of Credits	02
Nature	Practical
Type	Major: Elective

Course Outcomes:

CO1: Estimate total reducing sugars before and after inversion in honey by redox titration.
CO2: Determine the % of lactose in milk sample.
CO3: Determine the % of Caffeine in tea sample.
CO4: Estimate the amount of Vitamin C in lemon Juice/squash.
CO5: Study of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation.
CO6: Determine the metal ions in given Pyrolusite ore.
CO7: Determine the metal ions in given Magnesium alloy.
CO8: Determine the composition of Bauxite ore.
CO9: Determine the chemical properties of water sample such as total hardness and salinity.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I & II	**Group C (30hrs) Non–Instrumental**	1. Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method. 2. Analysis of lactose in milk. 3. Estimation of Caffeine in tea. 4. Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method. 5. Iodine value of oil / fat. 6. Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation.	**60**

	Group D (30hrs) Instrumental	1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry. 2. To analyze Magnelium for Mg by complexometry. 3. Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry).	
	Non–Instrumental	1. Analysis of water sample: Total hardness and salinity. 2. Analysis of water sample: Acidity and sulphate (Benzidine method).	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by; A.I. Vogels,3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis; F. J. Welcher, 1975.
4. Standard methods of chemical analysis: Instrumental methods of Analysis; F.J. Welcher, vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol.I, Van Nostr and Company, Inc., 1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B. Sandell and H. Onishi, Part II, 4th Ed., A Wiley Inter Science Publication, New York,1978.

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Group C	Lecture, Demo, experiment	60
II	Group D	Lecture, Demo, experiment	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 20

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	15
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: Maximum Marks: 60

Sr. No.	**Name of course**	**Method**	**Duration**	**Marks**
1.	Group C	Experiment performance as per the practical slip	Three and half hours	25
2.	Group D	Experiment performance as per the practical slip	Three and half hours	25
	Journal+ Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Nomenclature of the Course	Research Project (RP)
Class	M.Sc. II
Semester	III
Course Code	24_PSACH309
No. of Credits	04
Nature	Research Project
Type	Major: Mandatory

Course Outcomes:

On successful completion of this course, learners will be able to:

On successful completion of this course, learners will be able to:

CO1: Identify a suitable research problem in chemistry or applied chemistry through comprehensive literature review and define clear research objectives.

CO2: Develop and demonstrate core laboratory competencies in chemical synthesis, sample preparation, and analytical method development relevant to various branches of chemistry and applied chemistry.

CO3: Utilize standard instruments such as UV-Vis, IR, NMR, GC, HPLC, or AAS for the characterization and analysis of chemical compounds.

CO4: Analyze experimental data critically to draw meaningful conclusions using appropriate chemical principles and instrumental responses.

CO5: Prepare a concise scientific report presenting the methodology, data, and Interpretations in alignment with research protocols.

Curriculum:

Unit No.	Unit Title	Subtitles (Learning Points)
I	**Project-I (120hrs)**	Identifying problem for project work, literature survey, deciding methodology, practical implementation of the project, data analysis and conclusions, preparing project Report (a dissertation).

References:

1. Research Papers
2. Internet
3. Books and journals

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures**
I	Identifying problem for project work, literature survey	Discussion, literature review.	120
	Deciding methodology and practical implementation of the project (if any).	Discussion, Experimental work.	
	Data analysis (if any) and conclusions, preparing project report (a dissertation).	Presentation and discussion.	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	Marks
Identifying problem for project work, literature review	15
Regularity, lab work and progress	10

B) Semester End Examination: Maximum Marks: 60

Sr. No	Criteria	Marks
1	Significance of the study /Society application and Inclusion of recent references	10
2	Experimental Work & data presentation	10
3	Final report	20
4	Viva voce / presentation	20

Project guidelines:

1. Every learner is required to complete a research project during the academic year as a part of their curriculum.
2. Learners may opt for either: One long-term project spanning both Semester III and Semester IV, or two short-term projects, one in each semester.
3. For learners undertaking a long-term project:

   A separate project report/dissertation must be submitted in each semester.

   The Semester III report (4 credits) should include: Problem definition, Literature review and current status, Objectives of the study, Methodology, Preliminary experimental work

   The Semester IV report (6 credits) must cover: Detailed experimental work, Results and analysis Interpretation and conclusions
4. The research project may include one or more of the following:

   Experimental work related to an advanced topic in Chemistry

   Interdisciplinary research

Industrial research project

Training undertaken at a research institute

Training undertaken at a research institute

Training in the handling and operation of sophisticated scientific instruments

(only for 4 credit)

5. A maximum of **three learners** may jointly work on a project. However, each student must submit an **individual report**.
6. If a learner undertakes training in a research institute or in handling sophisticated instruments, the report should clearly state:

   Nature and scope of the training received, Details of the instruments handled Principles and working mechanisms of the instruments
7. Each project will be 100 marks with 40% by continuous evaluation and 60% by semester end evaluation.
8. The final report must be submitted as a bound hard copy.
9. Number of copies of report to be submitted: 02 (Department copy and candidate copy)

Format of Project Report:

a) **Title Page:**
   Mentioning the title of the report, name of the learner, program, institution, and the project.

b) **Declaration:**
   A statement by the learner declaring that the report is the original work and acknowledging any assistance or references used.

c) **Acknowledgments:**
   Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

d) **Table of Contents:**
   Providing a clear outline of the report's sections and page numbers.

e) **Abstract:**
   A bird's eye view of learner's entire presentation has to be precisely offered under this category. A brief overview of the project, its objectives and key findings should be mentioned.

f) **Introduction:**
   Background information about the project and its significance. Objectives and scope of the project.

g) **Literature Review:**
   Overview of relevant literature and studies related to the chosen field and development issues.

h) **Methodology:**
   Description of: Planning of experimental procedure as per the need of the project.

Designing and implementation of the project as per the objectives through theoretical, experimental or computational methods.

i) **References** & **Appendices:**
List of all sources cited in the project report. Additional supporting materials.

The project report shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman.
- Font size: 13-For content, 14-for Title.
- Line Space: 1.5-for content and 1-for in table work, justified format.
- Page Size: A4.
- Margin: in Left-1.5, Up-Down-Right-1.
- The Project Report should be hard bound

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

To

R. P. Gogate College of Arts & Science and
R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

of

Master in Science

Under the Faculty of Science

By

Name of Student

Under the Guidance of
Name of the Guiding Teacher

R**. P. Gogate college of Arts & Science and**
R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri
Advocate N.V. Joshi Road,
Near Ratnagiri District Court, Ratnagiri

Month and Year

On separate page

Index

On separate page

Declaration by learner

I the undersigned Miss/Mr. _____
[Name of the learner] here by, declare that work embodied in this Research project work titled _____ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher] _____ is a result of my own research work and has not been previously submitted to any other University or College for any other Degree/ Diploma.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by

Name and signature of the Guiding Teacher

On separate page

Acknowledgment

(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this Research project.

I thank the **R. P. Gogate college of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri** for giving me opportunity to do this project.

I would like to thank my **Principal, Prof. Dr M. R. Sakhalkar Sir**, for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our Coordinator_____, for his moral support and guidance. I would also like to express my sincere gratitude towards my project guide _____ whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project

_____

R. P. Gogate College of Arts & Science and R. V. Jogalekar College of Commerce (Autonomous), Ratnagiri

Nomenclature of the Course	Quality in Analytical Chemistry - II
Class	M.Sc.-II
Semester	IV
Course Code	24_PSACH401
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

At the end of the course, the learner will be able to

CO1 Demonstrate the operating principles and applications of membrane separation processes, including microfiltration, ultrafiltration, reverse osmosis, dialysis, and electrodialysis. Apply solvent extraction techniques effectively for sample preparation and pretreatment to isolate analytes from complex matrices.

CO2 Define herbs, herbal medicine, and herbal medicinal products, and understand the processes involved in the selection, identification, authentication, drying, and processing of herbal raw materials. Explain principles behind each method, ensuring the efficient extraction of active compounds from herbal material. Explain importance of quality control and standardization in herbal medicine, covering both theoretical principles and practical applications to ensure the safety, efficacy, and consistency of herbal medicinal products.

CO3 Discuss on green chemistry, including sustainable development, atom economy, and strategies for reducing toxicity. Apply these principles to evaluate and design environmentally benign processes, such as solvent-free systems and the use of supercritical fluids. Explore emerging green technologies, including photochemical reactions, microwave-assisted chemistry, sonochemistry, and electrochemical synthesis, assessing their advantages and challenges. Apply principles of inherently safer design and process intensification, integrated with in-process monitoring, to improve the sustainability and safety of chemical processes.

CO4 Explain the principles of electrophoresis, and factors that influence migration rates and compare the properties and applications of various supporting media used in electrophoresis. Develop practical knowledge of electrophoretic techniques, including low and high voltage electrophoresis, SDS-PAGE, capillary electrophoresis, and isoelectric focusing, along with their instrumentation, detection methods, and applications. Explain the field of nanotechnology, including the implications of the nanoscale, the properties of nanomaterials, and the analytical techniques used to characterize them. Differentiate the properties of 1D, 2D, and 3D nanomaterials, and characterize their morphology, electronic structure, and optical properties.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Separation Science	1.1 Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis. (8L) 1.2 Applications of Solvent extraction in Analytical Chemistry. Recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical Determination. (7L)	15
II	Separation, Analysis and Standardization of Herbal based products.	2.1 Herbs as a raw material: Definition of herb, herbal medicine, herbal Medicinal products, herbal drug preparation. Sources of herbs. Selection, identification and authentication of herbal materials, drying and processing of herbal raw materials, drying and processing of herbal raw material. (6L) 2.2 Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principle involved in extraction. (3L) 2.3 Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical, Spectral and toxilogical standardization, qualitative and quantitative estimations. (6L)	15
III	Green Chemistry	3.1 Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity (4L) 3.2 Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents (4L) 3.3 Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. (4L) 3.4 Designing Greener Processes: Inherently Safer Designs (ISD), Process Intensification (PI) in-process monitoring. (3L)	15

IV	Advanced Techniques	4.1 Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers). (2L) 4.2 Techniques of Electrophoresis: low and high voltage, sds- page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis and miceller electro kinetic capillary chromatography, instrumentation, detection and applications. (8L) 4.3 Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanaoparticles morphology, electronic structure, optical properties) one dimensional nano material (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanaoparticles And quantum dots). (5L)	15

References:

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

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Separation Science	Lecture, PPT	15
II	Separation, Analysis and Standardization of Herbal based Products.	Lecture, PPT	15
III	Green Chemistry	Lecture, PPT	15
IV	Advanced Techniques	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	short note / objective, etc.	12

Nomenclature of the Course	Advanced instrumental techniques
Class	M.Sc.-II
Semester	IV
Course Code	24_PSACH402
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

At the end of the course, the learner will be able to:

CO1 Demonstrate a comprehensive understanding of NMR spectroscopy, including Fourier Transform (FT) NMR, 2D NMR techniques (COSY, TOCSY, and HETCOR), Free Induction Decay (FID) signal processing, and Magnetic Resonance Imaging (MRI), to analyze molecular structures and interactions.

CO2 Apply mass spectrometry and Raman spectroscopy techniques to comprehensively analyze and characterize the molecular composition, structure, and properties of various samples, integrating data from both methods for enhanced chemical analysis and interpretation.

CO3 Discuss on radiochemical techniques and thermal analysis methods to investigate the properties, stability, and behavior of materials, integrating both approaches to provide a comprehensive understanding of material composition and degradation processes.

CO4 Explain and apply hyphenated analytical techniques (such as GC-MS, HPLC-UV, or FTIR-MS) to perform comprehensive chemical analysis, combining the strengths of multiple methods for enhanced sensitivity, accuracy, and data interpretation.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Spectral Methods III	NMR Spectroscopy 1.1 Theory and Instrumentation- recapitulation, FT NMR, 2D NMR, - FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy(COSY), Total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR). (9L) 1.2 Radio waves in imaging- principle, instrumentation and applications of MRI (3L) 1.3Application of NMR to other nuclei C^{13}, P^{31} and F^{19} spectroscopy (3L)	15
II	Spectral Methods IV	2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure-interpretation of mass spectra-molecular identification, metastable peaks, Fragmentation Reactions (9L) 2.2 Raman spectroscopy: Principle, Theory, Instrumentation, techniques (SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)	15
III	Radiochemical And Thermal Methods	3.1 Activation analysis- NAA, radiometric titrations and radio-release methods (7L) 3.2 Thermal analysis- Principle, Interfacing, instrumentation and Applications of a)Simultaneous Thermal Analysis- TG- DTA and TG- DSC Evolved gas analysis- TG-MS and TG-FTIR (8L)	15
IV	Hyphenated Techniques	4.1 Concept of hyphenation, need for hyphenation, possible hyphenations. (2L) 4.2 Interfacing devices and applications of GC – MS, ICP - MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)	15

References:

1. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986).
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J. Holler Holt- Saunders 6 th Edition (1998).
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J. A. Niemann 5th Ed.
4. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A.

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

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Spectral Methods III	Lecture, PPT	15
II	Spectral Methods IV	Lecture, PPT	15
III	Radiochemical and Thermal Methods	Lecture, PPT	15
IV	Hyphenated Techniques	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	short note / objective, etc.	12

Nomenclature of the Course	Analytical Chemistry Practical's (Group A+ Group B+ Group C)
Class	M.Sc.-II
Semester	IV
Course Code	24_PSACH403
No. of Credits	04
Nature	Practical
Type	Major: Mandatory

Course Outcomes:

At the end of the course, the learner will be able to: CO1:
Determine pK value of H_3PO_4 potentiometrically.
CO2: Estimate the amount of Na^+ in dairy whitener by flame photometry
CO3: Find the pH of buffer solution by Spectrophotometrically.
CO2: Estimate the amount of Ti^{3+} and V^{5+} by Spectrophotometrically.
CO3: Estimate the amount Glucose by Spectrophotometrically.
CO4: Estimate the % purity of given drugs by non-aqueous titration
CO5: Determine the percentage purity of crystal Violet indicator.
CO6: Estimation of Calcium in Calcium in drug and food samples.
CO7: Determine the of SAP value of oil.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	**Group A Instrumental**	1. Determination of pK value of H_3PO_4 potentiometrically. 2. Estimation of the amount of Na^+ in dairy whitener by flame photometry. 3. Determination of the pH of buffer solution by Spectrophotometry 4. Determination of the amount of Ti^{3+} and V^{5+}in a given sample spectrophotometrically by H_2O_2 method.	120

II	**Group–B** **Non-Instrumental**	1. Analysis of drugs by non- aqueous titration: Glycine, Sodium Benzoate. 2. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity. 3. Determination of the purity of crystal Violet indicator. 4. Canned food: Limits test for tin/zinc 5. Estimation of Calcium in Calcium pentathonate/calcium lactate Tablet	
	Group–C **Non-Instrumental** **Instrumental**	1. Analysis of Calcium, Iron and phosphorous in milk 2. Determination of SAP value of oil 3. Estimation of Aldehyde in lemon grass oil / Cinnamon oil 4. Estimation of Glucose by Folin-Wu method 1. Analysis of water sample : Mn^{2+} by colorimetric method	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by; A. I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis; F. J. Welcher, 1975.
4. Standard methods of chemical analysis: Instrumental methods of Analysis; F. J. Welcher, vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc., 1939.
6. "Spectrophotometric Determination of Traces of Metals"; E. B. S and ell and H. Onishi, Part II,4th Ed, A Wiley Inter Science Publication, New York,1978

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Group A	Lecture, Demo, experiment	120 hrs
II	Group B	Lecture, Demo, experiment	
III	Group C	Lecture, Demo, experiment	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	Marks
Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	30
Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	10

B) Semester End Examination: Maximum Marks: 120

Sr. No.	Name of course	Method	Duration	Marks
1.	Group A	Experiment performance as per the practical slip	Three and half hours	35
2.	Group B	Experiment performance as per the practical slip	Three and half hours	35
3.	Group C	Experiment performance as per the practical slip	Three and half hours	35
	Journal+ Viva			5+5+5
Total				**120**

Practical examination will be of 120 marks at the end of semester which will be converted to 60 Marks.

CIE	Semester End	Total Marks
40	60	100

Nomenclature of the Course	Selected Topics in Analytical Chemistry
Class	M.Sc.-II
Semester	IV
Course Code	24_PSCHA403
No. of Credits	04
Nature	Theory
Type	Major Electives

Course Outcomes:

At the end of the course, the learner will be able to

CO1 Apply fundamental concepts of effluent treatment, sewage disposal, and metallurgical effluent management, including permissible limits of metal traces, modern metal recovery methods, and strategies for water recycling and reuse.

CO2 Discuss on solid waste management principles, including recycling, reuse, recovery, disposal methods, sludge treatment, and the management of non-decomposable and biomedical wastes.

CO3 Elaborate various environmental pollutants, including soil, noise, thermal, and radioactive pollution, along with their sources, effects, and control measures, while understanding soil analysis techniques and the significance of environmental audits

CO4 Explain ore dressing, metallurgical pollution, chemical analysis of ores and alloys, and advanced purification techniques for high-purity materials

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)	No. of Hours
I	Effluent Treatment	1.1 Effluent treatment plant general construction and process flow charts (3L) 1.2 Treatment and disposal of Sewage. (3L) 1.3. Effluent parameters for metallurgical industry. (2L) 1.4 Permissible limits for metal (example Cr, As, Pb, Cd etc.) traces in the effluent. (2L) 1.5 Recovery of metals from effluent, modern methods –Electrodialysis, Electrodeposition and Ion Exchange etc.(3L) 1.6 Recycle and reuse of process and treated (effluent) water. (2L)	15

II	Solid Waste Management	2.1 Solid waste management: objectives, concept of recycle, reuse and recovery. (3L) 2.2 Methods of solid waste disposal. (2L) 2.3 Treatment and disposal of sludge / dry cake. (3L) 2.4 Managing non-decomposable solid wastes. (2L) 2.5 Bio- medical waste: Introduction, Classification and methods of disposal. (5L)	15
III	Other Types Of Pollution	3.1 Soil pollution and Soil Analysis: sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long-term effect on soil quality. (6L) 3.2 Noise Pollution: sources, effects, methods of measurements and control measures. (2L) 3.3 Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy. (3L) 3.4 Radioactive pollutants: source, exposure hazards, precautions in handling and safety, long term effects. (2L) 3.5 Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification. (2L)	15
IV	Metallurgy	4.1 Ores and minerals: Dressing of ores, pollution due to metallurgical processes (ore dressing, calcination, smelting) (3L) 4.2 Chemical analysis of ores for principal constituents: Galena, Pyrolusite, Bauxite, Hematite, Monazite. (4L) 4.3 Alloys: definition, analysis of Cupronickel, Magnelium, Steel and Stainless Steel, Bronze, Gun metal. (4L) 4.4 Techniques of purification: Zone refining, analysis of high purity Materials like silicon, vacuum fusion and extraction techniques. (4L)	15

References:

1. Environmental Pollution Analysis, S. M. khopkar, New Age International publication (2011).
2. Water and water pollution (hand book) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N.Y. (1972)
3. Water pollution, Arvind kumar, APH publishing (2004)
4. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
5. Solid waste management, K Sasikumar and Sanoop Gopi Krishna PHI publication (2009)
6. Solid waste management, Surendrakumar Northen Book Center (2009)
7. Soil pollution, S.G. Misra and Dinesh Mani, APH Publishing Corporation, (2009).
8. Soil Pollution: origin, monitoring and remediation, Abrahim Mirsal, Springer (2010).
9. Noise Pollution, Donald F Anthrop, Lexington Books, (1973)
10. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise (1981) Available at NCL laboratories e- Library.
11. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).
12. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication, (2003).
13. Handbook of chemical technology and pollution control 3 rd Edn Martin Hocking AP Publication (2005).
14. Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi, Alpha Science, 2005
15. Chemical analysis of metals; Sampling and analysis of metal bearing ores: America Society for Testing and Materials 1980 - Technology & Engineering
16. Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel & Mines, Indian Bureau of Mines, 1979.
17. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
18. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology & Engineering (1960).

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures**
I	Effluent Treatment	Lecture, PPT	15
II	Solid Waste Management	Lecture, PPT	15
III	Other types of pollution	Lecture, PPT	15
IV	Metallurgy	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	**Marks**
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: Maximum Marks: 60

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	**Unit and sub unit (with number and title)**	**Type of Question (Essay / short note / Objective / Diagram, etc.)**	**Marks**
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	short note / objective, etc.	12

Nomenclature of the Course	Pharmaceutical and organic analysis
Class	M.Sc.-II
Semester	IV
Course Code	24_PSACH405
No. of Credits	04
Nature	Theory
Type	Major Electives

Course Outcomes:

At the end of the course, the learner will be able to:

CO1 Discuss the idea regarding pharmaceutical industry, drug classification, formulation, dosage forms, and quality control methods. It also covers the regulatory role of bodies like the FDA, sources of impurities in pharmaceutical products, and standardization processes to ensure the safety, efficacy, and quality of pharmaceutical products.

CO2 Analyze functional groups in drug molecules and understand their relevance in determining the drug's chemical and pharmacological properties. Evaluate drug stability, impurity profiles, bioequivalence, and bioavailability, and understand the role of polymers in pharmaceuticals and novel drug delivery systems.

CO3 Elaborate analytical chemistry in forensic science. Explain the processes involved in forensic investigations, from crime scene analysis to laboratory analysis. Classify and report on various drug categories (narcotics, stimulants, depressants, hallucinogens) and their physiological effects, based on the toxicological analysis.

CO4 Explain the properties of various ingredients used in cosmetic formulations (e.g., emulsifiers, preservatives, colorants, fragrances, surfactants). Analyze the safety, stability, and efficacy of ingredients and raw materials commonly used in deodorants, antiperspirants, and face powders.

Curriculum:			
Unit No.	**Unit Title**	**Sub titles (Learning Points)**	**No. of Hours**
I	Pharmaceutical Analysis	1.1 General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations, Classification of dosage forms. Role of FDA in pharmaceutical industries. (7L) 1.2 Sources of impurities in pharmaceutical products and raw materials. (4L) 1.3 Standardization of finished products and their characteristics, official methods of quality control. (4L)	15
II	Drugs	2.1 Analysis of compounds based on functional groups, instrumental methods for analysis of drugs, assays involving chromatographic separations, proximate assays, assays of enzyme containing substances, Biological and microbiological assays and tests. (8L) 2.2 Limit tests, solubility tests, disintegration tests, stability studies, Impurity profile of drugs, bioequivalence and bioavailability studies. Polymers in pharmaceuticals and novel drug delivery systems. (7L) 2.3 Polymers in pharmaceuticals and novel drug delivery systems. (7L)	15
III	Forensic Science	3.1 Analytical Chemistry in Forensic Science: General idea. (2L) 3.2 Forensic Analysis: Blood, DNA profiling, Hair analysis, Alcohol in body fluids, systematic drug identification. (5L) 3.3 Analytical Toxicology: Isolation, identification and determination of: 3.3.1 Narcotics: Heroin, morphine and cocaine. 3.3.2 Stimulants: Amphetamines and caffeine. 3.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax. 3.3.4 Hallucinogens: LSD and Cannabis. 3.3.5 Metabolites of drugs in blood and urine of addicts. 3.3.6 Viscera, stomach wash, vomit and postmortem blood for poisons like – Cyanide, arsenic, mercury, insecticides and pesticides. (8L)	15

IV	Cosmetic Analysis	4.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw Materials and additives. Formulation, standards and methods of analysis. (3L) 4.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea. (3L) 4.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L) 4.4 Hair tonic: 2,5 di amino toluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, di thio glycollic acid (in permanent wavers) .(3L) 4.5 Creams and lotions: Types of emulsions, chloroform soluble material, glycerol, Ph, emulsion, nonvolatile matter (IR spectroscopy). (3L)	15

References:

1. Analytical Biochemistry, David J Holmes and Hazel Peck, Longman, 1983.
2. Bioanalytical Chemistry, Susan R Mikkelesen and Eduardo Cotton, John Wiley and Sons, 2004.
3. Analysis of food and beverages, George Charalanbous, Academic Press, 1978.
4. Harry's Cosmetology, 7th Ed, Longman Scientific Co.
5. Formulation and Function of Cosmetics, Joseph Stefan Jellinek, Wiley Interscience, 1971.
6. Cosmetic Technology, Edward Sagarin, Interscience Publishers, 1957.
7. Modern Cosmetics, Edgar George Thommsen, Francis Chilson, Drug and Cosmetic Industry, 1947.
8. Encyclopedia of Industrial Chemical Analysis, Foster Dee Snell et al, Interscience Publishers, 1967.
9. Government of India Publications of Food, Drug and Cosmetic Act and Rules.
10. The Handbook of Drug Laws, ML Mehra, University Book Agency, Ahmedabad, 1997.
11. Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
12. Textbook of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
13. Food Processing and Preservation, B Sivasankar, Prentice-Hall of India Private Limited, 2007.
14. Food Additives, RMP Pandey and SK Upadhyay, INTECH, Open Science/Open Minds.
15. Food Science, B Srilakshmi, New Age International (P) Ltd. Publishers, 2003.
16. Food Contaminants: Sources and Surveillance, Edited by C Creaser, R Purchase, Elsevier, 1991.
17. The Chemical Analysis of Food and Food Products, Morris B Jacobs
18. FSSAI (Food Safety and Standards Authority of India) Manuals of Methods of Analysis of Foods (Oils and Fats, Milk and Milk Products, Food Additives), Ministry of Health and Family Welfare, Government of India.
19. Fundamentals of Urine and Body Fluid Analysis, Nancy A Brunzel, Elsevier Health Sciences, 2013.
20. Lab Manual on Blood Analysis and Medical Diagnostics, Dr Gayatri Prakash, S Chand and

Company Ltd, New Delhi.
21. Manual of Medical Laboratory Techniques, S Rama Krishnan and K N Sulochana, Jaypee Brothers Medical Publishers (P) Ltd, 2012. 22) Indian Pharmacopeia, Volume I and II.
22. Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
23. Forensic Chemistry, David E Newton, Infobase Publishing, 2007.
24. Encyclopedia of Analytical Chemistry, Volume 3, Academic Press, 1995.
25. AOAC Volume I and II.

Teaching Plan:			
Unit No.	**Unit Title**	**Teaching Methods**	**No. of Lectures (in hrs)**
I	Pharmaceutical Analysis	Lecture, PPT	15
II	Drugs	Lecture, PPT	15
III	Forensic Science	Lecture, PPT	15
IV	Cosmetic Analysis	Lecture, PPT	15

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 40

Method	Marks
One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) S**emester End Examination: Maximum Marks: 60**

Question No. and Sub questions (If any) (E.g. Q. 1 a) …	Unit and sub unit (with number and title)	Type of Question (Essay / short note / Objective / Diagram, etc.)	Marks
Q.1	Unit I	Descriptive. short note etc.	12
Q.2	Unit II	Descriptive. short note etc.	12
Q.3	Unit III	Descriptive. short note etc.	12
Q.4	Unit IV	Descriptive. short note etc.	12
Q.5	All Units	short note / objective, etc.	12

Nomenclature of the Course	Research Project
Class	M.Sc.-II
Semester	IV
Course Code	24_PSACH406
No. of Credits	06
Nature	Project
Type	Mandatory

Course Outcomes:

On the successful completion of this course learners will be able to:

CO1: Design and execute independent experimental work in the chosen area of chemistry, adhering to proper research methodology and lab safety practices.

CO2: Apply appropriate laboratory techniques and instrumental methods for the synthesis, separation, purification, or analysis of chemical substances.

CO3: Perform systematic characterization of compounds or materials using suitable analytical techniques such as UV-Vis, IR, NMR, Mass Spectrometry, GC, HPLC, etc.

CO4: Analyze experimental data critically and interpret results with logical reasoning supported by scientific principles and literature.

CO5: Discuss the significance of the results obtained in the context of existing knowledge and draw meaningful conclusions.

CO6: Compile and present the research findings in the form of a well-structured dissertation and deliver an effective oral/poster presentation.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
I	**Research Project (180hrs)**	After identifying problem for project work, actual experimental work which involve Analysis (qualitative and quantitative), separations, purification, characterization, etc and preparing project report (a dissertation).

References:

1. Previous Project Literature.
2. Internet.
3. Research Publications.
4. Project related references

Teaching Plan:			
Unit	**Unit Title**	**Teaching Methods**	**No. of Lectures**
II	Deciding methodology and practical implementation of the Project	Discussion, Experimental work	180 hrs
	Data analysis (if any) and conclusions, preparing project report (a dissertation).	Presentation and discussion	

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 60

Sr. No	Method	Marks
1	Experimental work	25
2	Presentation	15
3	Lab work and regularity	10
4	Viva voce	10

B) Semester End Examination: Maximum Marks: 90

Sr. No	Criteria	Marks
1	Dissertation/report quality	30
2	Experimental design, execution & results	30
3	Presentation	15
3	Final viva voce and defense of work	15

Project guidelines:

1. Every learner is required to complete a research project during the academic year as a part of their curriculum.
2. Learners may opt for either: One long-term project spanning both Semester III and Semester IV, or two short-term projects, one in each semester.
3. For learners undertaking a long-term project:

   A separate project report/dissertation must be submitted in each semester.

   The Semester III report (4 credits) should include: Problem definition, Literature review and current status, Objectives of the study, Methodology, Preliminary experimental work

   The Semester IV report (6 credits) must cover: Detailed experimental work, Results and analysis Interpretation and conclusions
4. The research project may include one or more of the following:

   Experimental work related to an advanced topic in Chemistry or applied chemistry

   Interdisciplinary research

   Industrial research project
5. A maximum of **three learners** may jointly work on a project. However, each student must submit an **individual report**.
6. Each project will be 100 marks with 40% by continuous evaluation and 60% by semester end evaluation.
7. The final report must be submitted as a bound hard copy.
8. Number of copies of report to be submitted: 02 (Department copy and candidate copy)

Format of Project Report:

a. Title Page:

Mentioning the title of the report, name of the learner, program, institution, and the project.

b. Certificate of Completion:

A certificate issued by guide confirming the successful completion of the project.

c. Declaration:

A statement by the learner declaring that the report is the original work and acknowledging any assistance or references used.

d. Acknowledgments:

Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e. Table of Contents:

Providing a clear outline of the report's sections and page numbers.

f. Abstract:

A bird's eye view of learner's entire presentation has to be precisely offered under this category. A brief overview of the project, its objectives and key findings should be mentioned.

g. Introduction:

Background information about the project and its significance. Objectives and scope of the project.

h. Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

i. Methodology:

Description of: Planning of experimental procedure as per the need of the project. Designing and implementation of the project as per the objectives through theoretical, experimental or computational methods.

j. Observations and data analysis:

Details of Testing, debugging, troubleshooting as per the need. Data collection and analysis.

k. Conclusion:

Summary of the key findings and outcomes of the project.

l. References & **Appendices:**

List of all sources cited in the project report. Additional supporting materials.

The project report shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman,
- Font size: 13-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work, Justified format
- Page Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report should be hard-bound.

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

To

R. P. Gogate College of Arts & Science and
R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri

of

Master in Science

Under the Faculty of Science

By

Name of Student

Under the Guidance of
Name of the Guiding Teacher

R**. P. Gogate college of Arts & Science and**
R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri
Advocate N.V. Joshi Road,
Near Ratnagiri District Court, Ratnagiri

Month and Year

On separate page

Index

On separate page

Declaration by learner

I the undersigned Miss/Mr. _____
[Name of the learner] here by, declare that work embodied in this Research project work titled _____ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher] _____ is a result of my own research work and has not been previously submitted to any other University or College for any other Degree/ Diploma.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by

Name and signature of the Guiding Teacher

On separate page

Acknowledgment

(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this Research project.

I thank the **R. P. Gogate college of Arts & Science and R.V. Jogalekar College of Commerce (Autonomous), Ratnagiri** for giving me opportunity to do this project.

I would like to thank my **Principal, Prof. Dr M. R. Sakhalkar Sir**, for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our Coordinator_____, for his moral support and guidance.
I would also like to express my sincere gratitude towards my project guide _____ whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project

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Date: 30/11/2024

Place: Ratnagiri

Signature

Dr. M. G. Gore

Chairperson & HOD, Chemistry

Ratnagiri Education Society's
R. P. Gogate College of Arts and Science and R. V. Jogalekar College of Commerce
(Autonomous), Ratnagiri

Meeting of BoS in Chemistry

Date	30th November 2024
Time	11.30 AM
Venue	Library Hall
Mode	Hybrid

Attendance

Sr. No.	Name and type of the Member	Present mode Online / Offline	Signature
1	Name: Dr. Milind Ganesh Gore Head of the Department (Chairman)	offline	
2	Name: Dr. Ghanashyam B. Sathe (VC nominee)	Online	–
3	Name: Prof. Savita Ladage Dean. HBCSE, TIFR Mumbai	Online	–
4	Name: Dr. Ganpat K. Naik HOD Chemistry, Parvatibai Chougule College Madgaon, Goa	Online	–
5	Name: Mr. Sandeep Suresh Gongale GM (HR) Finolex Industries Pvt Ltd, Ranpar	leave	–
6	Name: Dr. Vikas Kulkarni, GM, Lupin Pharmaceuticals, Mumbai Alumnus	Online	–
7	Name: Dr. Mrs. Aparna M. Kulkarni Department faculty member (1)	offline	
8	Name: Mr. Maruti B. Kamble Department faculty member (2)	offline	
9	Name: Dr. Swaminath L Bhattar Department faculty member (3)	offline	
10	Name: Dr. Umesh B. Sankpal Department faculty member (4)	offline	
11	Name: Dr. Meghana E. Mhadye Department faculty member (5)	offline	
12	Name: Mrs. Pratikha Barsakar Department faculty member (6)	offline	
13	Name: Mr. Ankit A Surve Department faculty member (7)	offline	
14	Name: Trupti Gajanan Joshi Department faculty member (8)	offline	
15	Name: Miss Rina B. Shinde Department faculty member (9)	offline	
16	Name: Mr. Shirin S Limaye Department Faculty member (10)	offline	
17	Name: Mr. Ganesh M. Rathod Department faculty member (11)	offline	