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	PSCH 101	Inorganic Chemistry-I	1	Major Mandatory	04	PSCH 201	Inorganic Chemistry-II
2	Major Mandatory	04	PSCH 102	Organic Chemistry-I	2	Major Mandatory	04	PSCH 202	Organic Chemistry-II
3	Major Mandatory	04	PSCH 103	Analytical Chemistry-I	3	Major Mandatory	04	PSCH 203	Analytical Chemistry-II
4	Major Mandatory	02	PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	4	Major Mandatory	02	PSCH 204	Chemistry Practical- (Organic Chemistry and Analytical Chemistry)
5	Major Electives	02	PSCH 105	Physical Chemistry I	5	Major Electives	02	PSCH 205	Physical Chemistry III
6	Major Electives	02	PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	6	Major Electives	02	PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)
7	Major Electives	02	PSCH 107	Physical Chemistry II	7	Major Electives	02	PSCH 207	Physical Chemistry IV
8	Major Electives	02	PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	8	Major Electives	02	PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)
9	Major Mandatory	04	PSCH 109	Research Methodology	9	Major Mandatory	04	PSCH 209	On Job Training/Internship Field Project/Extended Experiment
	Major Mandatory	04	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	PSACH301	Quality in Analytical Chemistry I	1	Major Mandatory-I	4	PSACH401	Quality in Analytical Chemistry -II
2	Major Mandatory-II	4	PSACH302	Advanced Instrumental Techniques –I	2	Major Mandatory-II	4	PSACH402	Advanced Instrumental Techniques –II
3	Major Mandatory-III	4	PSACH303	Bio analytical Chemistry and Food Analysis	3	Major Mandatory-III	4	PSACH403	Analytical Chemistry Practical Group (A+B+C)
4	Major Mandatory-IV	2	PSACH304	Analytical Chemistry Practical Group (A + B)					
5	Major Electives-I	02	PSACH305	Environmental Chemistry	5	Major Electives-I	4	PSACH404	Selected Topics in Analytical Chemistry
6	Major Electives-I	02	PSACH306	Analytical Chemistry Practical Group (C + D)	6	Major Electives-II	4	PSACH405	Pharmaceutical and Organic Analysis
7	Major Electives-II	02	PSCHA 307	Industrially Important Materials	**7**	Major Mandatory	06	PSACH406	Research Project (RP)
8	Major Electives-II	02	PSACH308	Analytical Chemistry Practical Group (C + D)					
9	Major Mandatory	04	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		
PSACH301	Quality in Analytical Chemistry-I	04		PSACH401	Quality in Analytical Chemistry-II	04	
PSACH302	Advanced Instrumental Techniques –I	04		PSACH402	Advanced Instrumental Techniques -II	04	
PSACH303	Bio Analytical Chemistry and Food Analysis	04		PSACH403	Analytical Chemistry Practical Group (A+B+C)	04	
PSACH304	Analytical Chemistry Practical Group (A + B)	02					
	Major Electives				Major Electives		
PSACH305	Environmental Chemistry	02	04	PSACH404	Selected Topics In Analytical Chemistry	04	04
PSACH306	Analytical Chemistry Practical Group (C + D)	02					
	OR				OR		
PSACH307	Industrially Important Materials	02	04	PSACH405	Pharmaceutical and Organic Analysis	04	04
PSACH308	Analytical Chemistry Practical Group (C + D)	02					
PSACH309	Research Project (RP)	04		PSACH406	Research Project (RP)	06	
Total Credits		22		Total Credits		22	

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

Name of Programme	Masters 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. The students will become technically sound to handle the advance analytical instruments. 3. The students will understand good laboratory practices and safety. 4. The students make aware and handle the sophisticated instruments/equipment. 5. Explain why analytical chemistry plays an integral role in addressing social, economic and environmental problems. 6. Ability to design and optimize separation methods for various compounds and analytes, considering actors like selectivity, resolution and efficiency. 7. Understanding of the fundamental principles of separation sciences, including chromatography, electrophoresis, and extraction techniques. 8. Demonstrating 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. 9. Generate awareness of the benefits and impacts ofchemistry 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 regulatoryagencies use analytical methods to enforce quality and safety standards. Apply the skill stood specialized research in the coreand 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 drawreasonable 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 Masters of Science in Analytical Chemistry for the year 2024-25

Nomenclature of the Course	Quality in Analytical Chemistry
Class	M.Sc.
Semester	III
Course Code	PSACH301
No. of Credits	04
Nature	Theory
Type	Major: Mandatory-I

Course Outcomes:

CO1: Explain the concept of sampling and various methods used to prepare and store samples.
CO2: Choose the most effective out of all the methods available for the analysis of samples.
CO3: Describe the sources and different methods employed to improve the signal-to noise ratio.
CO4: Evaluate the uncertainty involved in a measurement.
CO5:Illustrate the principles behind different chromatographic techniques including ion chromatography, ion–exchange and size exclusion chromatography to carryout sample separation and analysis of sample.
CO6: Discuss the basic principles and instrumentation of ion chromatography, ion – exchange and size exclusion chromatography.
CO7:Explain the basic theory and principle, instrumentation and applications involved in Supercritical fluid Chromatography, Affinity Chromatography and Optimum pressure liquid chromatography (OPLC).
CO8: Learn about the Selection of stationary phases, organic modifiers and additives in Supercritical fluid Chromatography (SFC).

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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) 1.2 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, and quality by design (PAT). (7L)
II	Quality In	2.1 Measurement of uncertainty: Definition and evaluation of

	Analytical Chemistry-II	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)
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)
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)

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 inPharmaceuticals: Status, Challenges and Next Steps, Drug Delivery Letters, 2015, 5,2-8. Quality in the analytical chemistry laboratory, EPrichard, 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, JADean, 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, ElsevierPublications1978.
10. Supercritical Fluid Extraction, LarryTaylorWileypublishersN.Y.1996.
11. Ion exchange separation in analyticalchemistryOSamuelsonJohnWiley2nded1963
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	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: Make use of the surface analytical techniques (such as SIMS, PIXE) for Obtaining information about the surfaces while characterizing the samples.

CO2: Learn the basic principle, instrumentation and applications of Rutherford Backscattering.

CO3: Understand the Mossbauer spectroscopy by learning the principle and recording of spectrum including Doppler Effect, chemical shift etc. Understand the basic principles, Instrumentation and applications of ESR and AES.

CO4: Select a suitable method of voltammetry for the analysis of a particular sample.

CO5: Explain anodic, cathodic and adsorptive stripping methods in voltammetry.

CO6: Develop a working knowledge of various methods used in polarography.

CO7: Apply the principle underlying Spectro electrochemistry & the use of optically transparent electrodes to carry out the analysis of samples.

CO8: Make use of the phenomenon of chemiluminescence for varied applications.

CO9: Elaborate on the concept of Chiro-optical methods such as ORD & CD.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
II	Spectral Methods– II	Principle, Instrumentation, and Applications of 2.1 Electron Spin Resonance Spectroscopy (ESR)(5L) 2.2 Mossbauer's Spectroscopy. (5L) 2.3 Atomic Emission Spectroscopy- based on plasma and electrical discharge sources (5L)
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)
IV	Miscellaneous Techniques	Principle, Instrumentation and Applications of: 4.1 Chemiluminesescence techniques (3L) 4.2 Chirooptical Methods: ORD, CD (5L) 4.3 Photoacousticspectroscopy(3L) 4.4 Spectroelectrochemistry (4L)

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, 2nd 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	PSACH303
No. of Credits	04
Nature	Theory
Type	Major: Mandatory

Course Outcomes:

CO1: To study about detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine.

CO2: Enlist the physiological and nutritional significance of vitamins & biological macromolecules.

CO3: Apply the various analytical (microbiological techniques) learned for the analysis of these vitamins and biological macromolecules which in turn will help them in identification and diagnosis of diseases.

CO4: Explain the mechanism of operation of immune system and Immunological assays.

CO5: Enlist the Biological values of carbohydrates, proteins, essential amino acids and lipids.

CO6: Describe the various food preservation techniques that are widely practiced in food industries as quality control measure.

CO7: Design an experiment to confirm the presence and amount of various components present in Different types of food samples for further label claim studies.

CO8: To study about analyzing everyday items like milk, oil and fats as well as spices.

CO9: Describe the various food packaging and food processing methods.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
I	Bio analytical chemistry	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 bilirubinin 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)
II	Immunological	2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and

	Methods	Fluoro-immuno assays. (8L) 2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, Essential amino acids and lipids. (7L)
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)
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)

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.
Semester	III
Course Code	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: Find the amount of cholesterol and uric acid in the given sample of blood serum.

CO9: Estimate the amount of fluoride in a toothpaste.

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

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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 photometrictitration. 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

	Group B **(30hrs)** **Non-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
	Instrumental	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's (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

B) Semester End Examination: Maximum Marks: 30

Sr. No.	Name of course	Method	Duration	Marks
1.	Group A	Experiment performance as per the practical slip	Three hours and half hours	25
2.	Group B	Experiment performance as per the practical slip	Three hours 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	PSACH305
No. of Credits	02
Nature	Theory
Type	Major Electives

Course Outcomes:

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

CO1: To understand the classification of sources of pollution and their permissible limit.

CO2: Employ the sampling techniques to collect samples of these air pollutants.

CO3: Outline the role of pollution control boards in monitoring and controlling pollution.

CO4: Evaluate the quality of potable water based on the guidelines laid down by the regulatory bodies.

CO5: To understand methods to maintain the quality of water.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
II	Water Pollution	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).

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	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)
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

	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 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 andoverall 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

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	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 Make use of the methodologies learned to carry out the analysis of each and every component present in paints.

CO2: Outline the importance of additives in plastic.

CO3: Estimate the amount of metallic impurities in plastics.

CO4: Recommend methods for the biodegradation of insecticides and pesticides.

CO5: Judge the quality of the detergents by making use of the various methods which are used in industries for carrying out their analysis.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
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)

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 KanwarKalyani 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	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)
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 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
	Group D (30hrs) Instrumental **Non–Instrumental**	1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn byvolumetry. 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 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 qualitiesin organizing related academic activities.	05

B) Semester End Examination: Maximum Marks: 30

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 convertedto 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	PSACH309
No. of Credits	04
Nature	Research Project
Type	Major: Mandatory

Course Outcomes:

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

CO1: Understand the ethics and research methodology.

CO2: Identify the research problem and formulate objectives.

CO3: Understanding the current research on particular topic analyzing recent literature, identifying gaps or area for further study and finding new insights

CO4: Critically evaluate literature with respect to research problem / objectives and formulate it.

CO5: Demonstrate the ability to develop a comprehensive research proposal, including clear research questions, appropriate methodologies, and feasible timelines

CO6: Enhance their written and oral communication skills through the creation and presentation of a well-structured research proposal.

CO7: Gain practical experience in budget planning and resource allocation for research projects, including identifying potential funding sources and justifying expenses.

Curriculum:

Unit No.	Unit Title	Sub titles (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 survey	25
Presentation skill	15

B) Semester End Examination: Maximum Marks: 60

Sr. No	Criteria	Marks
1	Theoretical methodology/Working condition of project	15
2	Significance of the study/Society application and Inclusion of recent references	10
3	Depth of knowledge in the subject	10
4	Synopsis	10
5	Research Proposal Viva	15

Project guidelines:

1. Every learner will have to complete one project within academic year.
2. Learners can take one long project or two short projects.
3. However, for one long project learners have to submit two separate project reports / dissertation consisting of the problem definition, literature survey and current status, objectives, methodology and some preliminary experimental work in Semester III for 4 credits and actual experimental work, results and analysis in semester IV with six credits.
4. The experimental project, related to advanced topic in chemistry/ interdisciplinary topic. industrial project, training in a research institute, training of handling a sophisticated equipment etc.
5. Maximum three learners can do a joint project. Each one of them will submit a separate project report with details.

6. In case a learner takes training in a research institute/training of handling sophisticate equipment, he/she should mention in a report what training he/she has got, which instruments he/she handled and their principle and operation etc.
7. Each project will be of 100 marks with 40% by continuous evaluation and 60% by semester end evaluation.
8. The project report should be file bound/spiral bound/hard bound.

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: 12-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 shall be hard bounded

Title of the Project

A Synopsis Submitted

To

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce College (Autonomous), Ratnagiri

Under

University of Mumbai

For partial completion of the degree

Of

Master in Science

(Analytical Chemistry)

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce College (Autonomous) Ratnagiri

Month and Year

On separate page

Index

Sr No	Title	Page No.
01		
02		
03		
04		
05		

DECLARATION BY LEARNER

I the undersigned Miss/Mr. _____

[Name of the learner] here by, declare that work embodied in this 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 for any other

Degree/ Diploma to this or any other University.

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

(To be written by learner)

(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 project.

I thank the R. P. Gogate College of Arts and Science and R.V. JogalekarCollege of Commerce, Ratnagiri (Autonomous) and University of Mumbai for giving me opportunity to do this project.

I would like to thank my Principal,_____for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our HOD_____, for hismoral support andguidance

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 booksand 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.

Signature of Lerner

Nomenclature of the Course	Quality in Analytical Chemistry - II
Class	M.Sc.-II
Semester	IV
Course Code	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: To gain knowledge of solvent extraction and their applications.

CO2: Select an appropriate method for the processing, extraction using different techniques and standardization of the herbal materials as per WHO GMP guidelines.

CO3: To understand about the identification, processing and authentication of herbal materials.

CO4: Acquire awareness of the principles of green chemistry.

CO5: To acquire general awareness on green chemistry, green solvents and green principles of organic synthesis.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
II	Separation, Analysis and Standardizatio n 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)
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)
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)

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	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: Explain the basic theory of 1HNMR spectroscopy & Raman Spectroscopy.

CO2: Describe the working of the different components of NMR spectrophotometer.

CO3: Apply ^{1}H, ^{13}C, ^{31}P and ^{19}F NMR spectroscopy techniques in combination with other spectroscopic data to carry out structure determination.

CO4: Explain the mechanism of formation and fragmentation of ions in gas phase.

CO5: Interpret the information contained in the mass spectra.

CO6: Describe the working of Raman spectrometer and will be able to explain how the spectrum is recorded.

CO7: Elaborate on the essential principles underlying the applications of thermal methods and radiochemical methods.

CO8: Enlist the advantages of development of hyphenated techniques and will be able to explain the different types of interfaces that are used to achieve this hyphenation.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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) 1.3 Application of NMR to other nuclei C^{13}, P^{31} and F^{19} spectroscopy (3L)
II	Spectral Methods IV	2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from

		mass spectra- molecular identification, metastable peaks, Fragmentation Reactions (9L) 2.2 Raman spectroscopy: Principle Theory Instrumentation, techniques (SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)
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 (b) Evolved gas analysis- TG-MS and TG-FTIR (8L)
IV	Hyphenated Techniques	4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2 L) 4.2 Interfacing devices and applications of GC – MS, ICP - MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)

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	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)
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 Spectrophotometrically. 4. Determination of the amount of Ti^{3+} and V^{5+}in a given sample spectrophotometrically by H_2O_2 method.
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	60
II	Group B	Lecture, problem solving	60
III	Group C	Lecture, Demo, experiment	60

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: 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.	Group C	Experiment performance as per the practical slip	Three and half hours	25
	Journal+ Viva			5+5+5
Total				**90**

Practical examination will be of 90 marks at the end of semester which will be converted to 60Marks.

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	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: Elaborate on the various physical, chemical and biological processes which are used to remove the contaminants from wastewater

CO2: Discuss the different methods of recovery of metals from effluent treatment such as Electrodialysis, Electrodeposition and Ion Exchange etc.

CO3: Discuss the significance of recycling and reuse of solid wastes.

CO4: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

CO5: To understand a method for analyzing different elements present in ores and alloys.

CO6**:** Develop an understanding of zone refining and vacuum fusion and extraction techniques.

CO7**:** Enlist properties of an ideal fuel. Determine the calorific value of fuels using the methodologies learned.

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
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)
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) 3.5Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification (2L)
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)

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, AbrahimMirsal, 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 Bureauof 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	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: Categorize the different types of drugs and dosage forms.
CO2: Outline the role of FDA in pharmaceutical industry.
CO3: Make use of the different methods learned to estimate the amount of drug present in sample.
CO4: Apply the concept of impurity profiling, stability studies, limit test, bioavailability and bioequivalence while insuring the uniformity in the standard of quality, efficacy and safety of pharmaceutical products.
CO5: Elaborate the role of analytical chemistry in forensic science.
CO6: Identify and Estimate amount of toxins found at crime scene.
CO7: Evaluate the quality of cosmetic product by carrying out the analysis using the methods learned

Curriculum:

Unit No.	Unit Title	Sub titles (Learning Points)
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)
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)
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)
IV	Cosmetic Analysis	4.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw Materials and additives. Formulation, standards and methods ofanalysis. (2L) 4.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea. (3L) 4.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L)

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) 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	Research Project
Class	M.Sc.-II
Semester	IV
Course Code	PSACH406
No. of Credits	06
Nature	Project
Type	Mandatory

Course Outcomes:

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

CO1: Identify the research problem and formulate objectives.

CO2: Understanding the current research on particular topic analyzing recent literature, identifying gaps or area for further study and finding new insights.

CO3: Choose appropriate methodology with proper tools and techniques.

CO4: Analyze and interpret the data collected from the performed experiments.

CO5: Make decision or find out conclusions on the basis of data analysis

CO6: Recall and list key research paradigms and methodologies in the subject.

CO7: Explain the principles of statistical analysis and their application in subject of research.

CO8: To develop skills such as problem solving approach, critical thinking, analytical reasoning, encourage team work, improve communication skills.

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
	Deciding methodology and practical implementation of the Project	Discussion, Experimental work	

II	Data analysis (if any) and conclusions, preparing project report (a dissertation).	Presentation and discussion	180 hrs

Evaluation Pattern:

A) Continuous Internal Evaluation: Maximum Marks: 60

Sr. No	Method	Marks
1	Lab performance	40
2	Presentation	20

B) Semester End Examination: Maximum Marks: 90

Sr. No	Criteria	Marks
1	Experimental/Theoretical methodology/Working condition of project	25
2	Significance of the study/Societal application and inclusion of recent References	15
3	Depth of knowledge in the subject / Results and discussions	15
4	Project Report	15
5	Presentation	20

Project guidelines:

1. Every learner will have to complete one project within academic year.
2. Learners can take one long project or two short projects.
3. However, for one long project learners have to submit two separate project reports / dissertation consisting of the problem definition, literature survey and current status, objectives, methodology and some preliminary experimental work in Semester III for 4 credits and actual experimental work, results and analysis in semester IV with six credits.
4. The experimental project, related to advanced topic in chemistry/ interdisciplinary topic. industrial project, training in a research institute, training of handling a sophisticated equipment etc.
5. Maximum three learners can do a joint project. Each one of them will submit a separate project report with details.
6. In case a learner takes training in a research institute/training of handling sophisticate equipment, he/she should mention in a report what training he/she has got, which instruments he/she handled and their principle and operation etc.
7. Each project will be of 100 marks with 40% by continuous evaluation and 60% by semester end evaluation.
8. The project report should be file bound/spiral bound/hard bound.

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: 12-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 shall be hard bounded.

Title of the Project

A Project Submitted

To

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce College (Autonomous), Ratnagiri

Under

University of Mumbai

For partial completion of the degree

Of

Master in Science

(Analytical Chemistry)

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce College (Autonomous) Ratnagiri

Month and Year

On separate page

Index

Sr No	Title	Page No.
01		
02		
03		
04		
05		

DECLARATION BY LEARNER

I the undersigned Miss/Mr. _____ [Name of the learner] here by, declare that work embodied in this 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 for any other Degree/ Diploma to this or any other University.

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

(To be written by learner)

(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 project.

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

I would like to thank my Principal,_____for providing thenecessary facilities required for completion of this project.

I take this opportunity to thank our HOD_____, for his moral support and guidance

I would also like to express my sincere gratitude towards my project guide _____ for valuable guidance .

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.

Signature of Guide

Signature of Learner

Date: 30/04/2024
Place: Ratnagiri

Chairperson BOS
HOD

R. P. Gogate College of Arts & Science and

R. V. Jogalekar College of Commerce, (Autonomous) Ratnagiri 61 |