

Rayat Shikshan Sanstha's
Karmaveer Bhaurao Patil College, Vashi, Navi Mumbai
Autonomous College
[University of Mumbai]
Syllabus for Approval

M.Sc.-II Analytical Chemistry

Sr. No.	Heading	Particulars
1	Title of Course	M.Sc.-II Analytical Chemistry
2	Eligibility for Admission	M.Sc.-I
3	Passing Marks	Minimum 'D' Grade or equivalent minimum marks for passing at the M.Sc.-I level.
4	Ordinances/Regulations (if any)	
5	No. of Years/Semesters	One year/Two semester
6	Level	P.G. Part-II
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic year	2019-20

AC – 02/03/2019

Item No. 2.9



Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
(AUTONOMOUS COLLEGE)

Sector-15- A, Vashi, Navi Mumbai - 400 703

Syllabus for M. Sc.-II Analytical Chemistry

Program: M.Sc.

Course: M.Sc. Analytical Chemistry

**(Choice Based Credit, Grading and Semester System
with effect from the academic year 2019-2020)**

Title of Specific Program:
M.Sc. Analytical Chemistry

Program Specific Outcomes:

1. To demonstrate knowledge and understanding in their main field of Analytical

Chemistry, including both broad knowledge in the field and substantially deeper knowledge of certain parts of the Analytical Chemistry, together with deeper insight into current research and development work.

2. To demonstrate deeper methodological knowledge in Analytical Chemistry.
3. To be able to independently pose and analyse questions of chemical relevance and, through experiments, computer calculations, and information retrieval, collect sufficient information to suggest an answer, even if full information is lacking.
4. Off assessments in their main field of study, taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical aspects of research and development in Analytical Chemistry.
5. To demonstrate insight into the potential and limitations of organic chemistry, its role in society and people's responsibility for how it is used.
6. To identify their need of further knowledge and to take responsibility for developing their Analytical Chemistry knowledge.

Attainment of program outcome.

The scheme developed for the M. Sc. in Inorganic Chemistry programme and the curriculum laid down for every subject is designed in a way to achieve academic excellence and meet the requirements of stakeholders and all-in-all move towards the attainment of department as well as Institutional Mission

Administrative system helps in ensuring the Achievement of PSOs

1. Lectures are delivered primarily through chalk and talk as well as ICT methods such as ppt presentations, google classrooms, and other web based interactive platforms.
2. Tutorial supplements the lecture by providing exercises and example problems to enhance the understanding.
3. Written assignments, class tests, asking questions in between the lectures, participation in classroom, discussions, research projects, Industrial visits, Industrial internships creates better learning environment for the students.
4. The POs, PSOs and COs Objectives are determined and evaluated through a regular examination process, Class Tests, Seminars and consultation that involve Students, Parents and Faculty.
5. Regular departmental meetings are held which is presided by respective HOD and all agenda of improvement of academics are discussed to achieve the PSOs. Concerned faculty keeps a check on the students not only in academic matters but also in their personal and emotional affairs through mentor- mentee meeting which are held periodically.
6. The faculty along with other stakeholders keeps a vigilant eye on course structure and suggests the changes to the department as and when required.
7. Student input is obtained through student's online feedback, interaction with mentor-mentee record and individual faculty-student interaction.
8. Alumni, parents input is obtained through regular meetings with alumni representatives, and interaction with graduating students.
9. Faculty input is obtained through departmental committees, regular faculty meetings, and departmental retreats.
10. Faculties from other institutes and BOS members also submit online feedback on the curriculum which is obtained periodically.

Attainment of each of the PSOs and COs can be judged from the following:

1. Increase in pass percentage of students.
2. Percentage of students joining various chemistry related jobs, qualifying NET/SET and other competitive exams.
3. Rise in the number of students going for research institutions for further research.
4. Increase in number of placement per student and in better industries after the completion of the degree programme.
5. Percentage of failures in different courses is reducing every year.

Course Code	Title of Course	Unit	Course Outcome
			After successful completion of each course in Chemistry a learner should be able to;
Semester-III			
PGCHA301	Quality In Analytical Chemistry - I	Unit I: Quality In Analytical Chemistry I	<ol style="list-style-type: none"> 1. Students should understand and the concept of sampling. ^[2] 2. They can get knowledge of Pre-treatment of sampling. ^[2] 3. To understand for incorrect analytical results. performance criteria for methods used, ^[2] 4. To Know incorrect analytical results, method validation, ^[2] 5. To Study quality by design process analytical technology (PAT). ^[2]
		Unit II : Quality In Analytical Chemistry II	<ol style="list-style-type: none"> 1. To Measurement of uncertainty. ^[4] 2. To find Signal to noise. ^[2] 3. To Understand Pharmaceutical Legislation. ^[2] 4. To Understand Concept of GLP And GMP. ^[2] 5. their regulations for analytical labs, roles and responsibilities of personnel, ^[2] 6. To understand appropriate design and placement of laboratory equipment, requirements for maintenance and calibration ^[2]
		Unit III: Chromatographic Techniques I	<ol style="list-style-type: none"> 1. To understand Ion exchange Chromatography. ^[2] 2. To understand principle of Ion Chromatography. ^[2] 3. To understand principle of Exclusion chromatography. ^[2] 4. To Study: Theory, instrumentation and applications of gel permeation chromatography, ^[1] 5. retention behavior, ^[1] 6. To know inorganic molecular sieves determination of molecular weight of polymers ^[1]
		Unit IV:Chromatographic Techniques II	<ol style="list-style-type: none"> 1. To find applications of Supercritical fluid Chromatography. ^[4] 2. To understand principle of Affinity Chromatography. ^[2] 3. To understand principle of Optimum pressure liquid

			<p>chromatography. ^[2]</p> <ol style="list-style-type: none"> To Study types of supercritical fluids, instrumentation, applications to environmental, ^[2] To know the food, pharmaceuticals and polymeric analysis. ^[2]
PGCHA302	Advance Instrumental Techniques	Unit I: Spectral Method – I	<ol style="list-style-type: none"> To Understand Principle instrumentation and applications of the following- ^[2] To Apply Secondary Ion mass spectroscopy. ^[3] To study Particle-Induced X-Ray Emission. ^[2] To apply Electron Spin Resonance Spectroscopy (ESR) ^[3]
		Unit: II Microscopic Methods	<ol style="list-style-type: none"> They should understand the Principle instrumentation and applications of the following Microscopic Techniques- ^[2] To Apply Atomic Force Microscope (AFM) ^[3] To study Fluorescence Microscopy. ^[2] To Know Digital Holographic Microscopy (DHM) ^[2] To Apply Infrared Microscopy Laser Microscopy ^[3]
		Unit: III: Electroanalytical Methods.	<ol style="list-style-type: none"> Students should understand the different types of Advanced Electro -analytical Methods. ^[2] TAST Polarography. ^[2] To Know Linear Sweep and Cyclic Voltammetry, ^[2] To Study Chronoamperometry, Controlled Potential Chronoamperometry, ^[2] To study and Apply Stripping Voltametry ^[2] To understand Chemically and electrolytically modified electrodes ^[2]
		Unit: IV: Miscellaneous Techniques.	<ol style="list-style-type: none"> They should remembering Principle, Instrumentation and Applications of Chemi luminescence techniques Chiro optical Methods : ORD, CD ^[1] Magnetic measurement and magnetic properties of earth materials. Magnetic measurement and magnetic properties of earth materials ^[2] To study Magnetic properties, cause of the magnetism, dimagnetism, paramagnetism,

			<p>quenching of orbital angular momentum by ligand fields, ^[2]</p> <ol style="list-style-type: none"> To know spin orbit coupling, ferromagnetism and ant ferromagnetism, ^[2] To study instrumentation and applications of magnetic susceptibility measurements ^[2]
PGCHA303	Bio- analytical Chemistry and Food Analysis	Unit I: Bioanalytical Chemistry	<ol style="list-style-type: none"> They understand Bio analytical Chemistry of-Body Fluids ^[2] Composition of Body Fluids ^[2] Physiological and nutritional significance of vitamins and minerals. ^[2] To study Analytic Analytical techniques (including microbiological techniques) for vitamins ^[2] To know analysis of different products. ^[2]
		Unit II: Immunological Methods	<ol style="list-style-type: none"> Students should analysing Composition of bodyfluids, Glucose, creatinine, uric acid in blood, ^[3] Students should analysing protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases. ^[3] It clear the concept of General processes of immune Immunological methods and determination of Serumi) Calcium, ii) Serum/Plasma iii) Bicarbonate (Titrimetry)iv) Serum sodium and potassium (Flame photometry) ^[1] Students understand determination of- (i) Cholesterol .(ii) Total Protein (iii) BloodUrea in Serum (iv) Amylase (v) Aspartate (By Spectrophotometry) ^[2] Students Evaluating determination of- (1) Thyroxin and (2) Thyroid-Stimulating Hormone (TSH) ^[5]
		Unit III: Food Analysis I	<ol style="list-style-type: none"> They get knowledge about Food Processing and Preservation. ^[2] They should evaluating food contaminants & Food packaging ^[5] To know Food Contaminants– Trace metals and pesticide residues, ^[2] To Study contaminants from

			<p>industrial wastes (polychlorinated polyphenols, dioxins),^[2]</p> <p>5. To know toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine^[2]</p> <p>6. To Study contaminants^[2]</p>
		Unit IV: Food Analysis II	<p>1. Students understand testing of following in food samples^[2]</p> <p>2. Carbohydrates^[2]</p> <p>3. Proteins^[2]</p> <p>4. Analysis of Lipids^[2]</p> <p>5. To know Estimation of oil in oilseeds, Estimation of free fatty acids,^[2]</p> <p>6. To Study Saponification value of oils, iodine value,^[2]</p> <p>7. To know Determination of acid value of oil, determination of peroxide value of oil,^[2]</p> <p>8. Identification and quantification of fatty acids.^[3]</p>
PGCHA EC-II 304	Pharmaceutical and Organic Analysis	Unit I: Pharmaceutical Analysis.	<p>1. Students can clear the concept and applications of analytical chemistry.^[2]</p> <p>2. General idea regarding the Pharmaceutical Industry.^[2]</p> <p>3. Role of FDA in pharmaceutical industries^[2]</p> <p>4. Sources of impurities in pharmaceutical products and raw materials.^[2]</p> <p>5. Standardization of finished products and their characteristics^[2]</p> <p>6. To study Sources of impurities in pharmaceutical products and raw materials.^[2]</p> <p>7. to know the Standardization of finished products and their characteristics, official methods of quality control^[2]</p>
		Unit II: Drugs Analysis	<p>1. They should understand instrumental methods for drug analysis.^[2]</p> <p>2. They can remember different types of test for drug analysis.^[2]</p> <p>3. Students should understand the Applications of limit tests in novel drug delivery system^[2]</p> <p>4. To study Limit tests, solubility tests, disintegration tests, stability</p>

			<p>studies, ^[2]</p> <p>5. To study impurity profile of drugs, bioequivalence and bioavailability studies. ^[2]</p> <p>6. To study Polymers in pharmaceuticals and novel drug delivery systems ^[2]</p>
		Unit III:Forensic Science.	<p>1. They should Know the applications of analytical chemistry- ^[2]</p> <p>2. Role of Analytical Chemistry in Forensic Science. ^[2]</p> <p>3. Role of Analytical Chemistry in Cosmetic Analysis. ^[2]</p> <p>4. Students should know the identification and determination of toxic material analysis Narcotics, Heroin, Morphine and Cocaine ^[2]</p>
		Unit IV: Cosmetic Analysis	<p>1. They should understand analysis of- Cosmetic, Deodorants and antiperspirants, ^[2]</p> <p>2. To Study Face powder, Hair Tonic, Creams and Lotions ^[2]</p> <p>3. To Know Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers) ^[2]</p> <p>4. To study Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) ^[2]</p>
PSCHA3P1 Group–A	Bio- analytical Chemistry and Food Analysis Practical		<p>1. Students can learn use of Instruments for qualitative and quantitative analysis. ^[2]</p> <p>2. Determination of the pK value of an indicator. ^[2]</p> <p>3. Determination of copper and bismuth in mixture by photometric titration. ^[2]</p> <p>4. Estimation of strong acid, weak acid and salt in the given mixture conductometrically, ^[4]</p> <p>5. Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pH metry. ^[4]</p> <p>6. Determination of copper by extractive photometry using diethyldithiocarbamate. ^[4]</p>

PSCHA3P2 Group–B	Pharmaceutical and Organic Analysis Practical		<p>Students can clear the concept and applications of analytical chemistry</p> <ol style="list-style-type: none"> 1. Estimation of drugs by non-aqueous titration: Pyridoxine hydrochloride, Sulphamethoxazole. ^[2] 2. Determination of percentage purity of methylene blue indicator. ^[4] 3. Estimation of cholesterol and Uric acid in the given sample of blood serum ^[2] 4. Estimation of fluoride in a tooth paste. ^[4] 5. Determination of silica by molybdenum blue method. ^[2]
PSCHA3P3 Group–C	Bio- analytical Chemistry and Food Analysis Practical		<p>Students can learn quantitative analysis of food analysis:-</p> <ol style="list-style-type: none"> 1. Total reducing sugars before and after inversion in honey using: <ol style="list-style-type: none"> (a) Cole's Ferricyanide (b) Lane - Eynon method. ^[2] 2. Analysis of lactose in milk ^[4] 3. Estimation of Caffeine in tea ^[4] 4. Estimation of Vitamin C in lemon Juice/ squash by Dichlorophenol-indophenol method ^[4] 5. Iodine value of oil / fat ^[2] 6. Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation. ^[4]
PSCHA3P4 Group–D	Pharmaceutical and Organic Analysis Practical		<p>Students can learn quantitative analysis ore and Physical properties of water samples:-</p> <ol style="list-style-type: none"> 1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry. ^[4] 2. To analyze Magnesium for Mg by complexometry. ^[4] 3. Analysis of Bauxite for Ti by Colorimetry / Al by gravimetry / Fe (volumetry) ^[2] 4. Analysis of water sample: Total hardness and salinity. ^[4] 5. Analysis of water sample: Acidity and sulphate (Benzidine method). ^[4]

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analysing, [5]: Evaluating, [6]: Creating**

Scheme of Examination for Each Semester:

Continuous Internal Evaluation: 40 Marks (Common Written Test-20 Marks & 20 Marks For- Seminar, Assignment, Projects, Group discussion, Open book test, online test, Industrial visits etc.)

Semester End Examination: 60 Marks will be as follows -

I.	Theory:	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q – I	From Unit – I (having internal options.) 15 M
	Q – II	From Unit – II (having internal options.) 15 M
	Q – III	From Unit – III (having internal options.) 15 M
	Q – IV	Questions from all the THREE Units with equal weightage of marks allotted to each Unit. 15 M
II.	Practical	The External examination per practical course will be conducted as per the following scheme.
Sr. No.	Particulars of External Practical Examination	Marks%
1	Laboratory Work	80
2	Journal	10
3	Viva	10
	TOTAL	100

**Choice Based Credit, Grading and Semester System with effect from the
academic year 2019-2020**

M.Sc.-II Analytical Chemistry

Semester - III

Course Code	Unit	Topics	Credits	L/Week
PGCHA301	I	Quality In Analytical Chemistry – I	4	1
	II	Quality In Analytical Chemistry – II		1
	III	Chromatographic Techniques -I		1
	IV	Chromatographic Techniques -II		1
PGCHA302	I	Spectral Methods I	4	1
	II	Spectral Methods – II		1
	III	Electroanalytical Methods		1
	IV	Miscellaneous Techniques		1
PGCHA303	I	Food Analysis – II	4	1
	II	Immunological Methods		1
	III	Food Analysis – I		1
	IV	Bioanalytical chemistry		1
PGCHAEC-II 304	I	Pharmaceutical Analysis	4	1
	II	Drugs		1
	III	Forensic Science		1
	IV	Cosmetic Analysis		1
PGCHAP301 PGCHAP302 PGCHAP303 PGCHAP304	-	Practical Course	8	16
<p>Note: 1. Blue Highlighted Topic / Course has focus on employability/ entrepreneurship/skill development 2. Green Highlighted Topic / Course is related to local/national/regional & global development needs.</p>				

M.Sc. ANALYTICAL CHEMISTRY
SEMESTER – III PGCHA301
QUALITY IN ANALYTICAL CHEMISTRY

UNIT I	Quality In Analytical Chemistry	15
	1.1 Sampling: Definition, types of sample, sampling plan, quality of sample, subsampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of Samples. Pre-treatment of samples: soil, food and cosmetics. (8L) 1.2 Selection of the Method: sources of methods, factors to consider when selecting a method, performance criteria for methods used, reasons for incorrect analytical results, method validation, and quality by design process analytical technology (PAT). (7L)	
UNIT II	Quality In Analytical Chemistry - II	15
	2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (5L) 2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis, signal to noise enhancement. (3L) 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. (7L)	
UNIT III	Chromatographic Techniques -I	15
	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)	
UNIT IV	Chromatographic Techniques -II	15
	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)	

List of books and references:

1. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y 1997.
2. Quality assurance in analytical Chemistry, W Funk, V Dammann, G. Donnevert VCH Weinheim1995.
3. Amit S. Patil *et. al.*, Quality by Design (QbD) : A new concept for development of Quality pharmaceuticals, International Journal of Pharmaceutical Quality Assurance; 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 Wiley and sons 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, Van Nostrand Reinhold, 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 nd
11. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2 ed 1963
12. Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976
13. Chromatographic and electrophoresis techniques I Smith MenemannInterscience 1960

SEMESTER-IIIPGCHA302**ADVANCE INSTRUMENTAL TECHNIQUES**

UNIT I	Spectral Method - I	15
	1.1 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy. (3L) b. Particle-Induced X-Ray Emission (4L) c. Electron Spin Resonance Spectroscopy (ESR) (4L) d. Mossbauer's Spectroscopy (4L)	
UNIT II	Microscopic Methods	15
	2.1 Timeline of microscope technology Principle, instrumentation and applications of the following: Atomic Force Microscope (AFM) Fluorescence Microscopy Digital Holographic Microscopy (DHM) Infrared Microscopy Laser Microscopy	
UNIT III	Electroanalytical Methods	15
	Advanced Electroanalytical 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- Chronoamperometry (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-microelectrodes in voltammetry (3L)	
UNIT IV	Miscellaneous Techniques	15
	Principle, Instrumentation and Applications of: 4.1 Chemiluminescence techniques (3L) 4.2 Chiroptical Methods : ORD, CD (5L) 4.3 Magnetic measurement and magnetic properties of earth materials Introduction, Magnetic properties, cause of the magnetism, diamagnetism, paramagnetism, quenching of orbital angular momentum by ligand fields, spin orbit coupling, ferromagnetism and antiferromagnetism, instrumentation and applications of magnetic susceptibility measurements.	

List of books and 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,
5th Edition (1998)

4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6th Ed 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. Electroanalytical 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. Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
11. Techniques and mechanism of electrochemistry, 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. Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience 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
17. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester.
18. Instrumental methods of chemical analysis by H.Kaur.,Pragati Prakashan, Meerut.

SEMESTER-IIIPGCHA303

BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS

UNIT I	Bioanalytical chemistry	15
	<p>1.1 Body Fluids</p> <p>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)</p> <p>1.1.2 Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals. (5L)</p> <p>1.1.3 Analytical techniques (including microbiological techniques) for vitamins. (5L)</p>	
UNIT II	Immunological Methods	15
	<p>2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.(6L)</p> <p>Determination of</p> <p>(1) Serum Calcium (2) Serum/Plasma Bicarbonate (Titrimetry).</p> <p>(3) Serum sodium and potassium (Flamephotometry).</p> <p>Determination of SerumChloride (Coulometry) - Determination of (1) Cholesterol (2) Total Protein (3) Blood Urea inSerum (4) Amylase (5) Aspartate Amino Transferase (AST) and Alanine Amino Transferase (ALT) (by Spectrophotometry).</p> <p>Determination of (1) Thyroxin and (2) Thyroid-Stimulating Hormone (TSH)(by RIA Method)</p>	
UNIT III	Food Analysis – I	15
	<p>1 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. (8L)</p> <p>3.2 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. (5L)</p> <p>3.3 Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L)</p>	
UNIT IV	Food Analysis II	
	<p>a. Carbohydrates: Definition, classification, and functions, Analysis of carbohydrates from food sample by different method i) volumetric determination by Fehling's solution, ii) Colorimetric analysis of carbohydrates by Folin Wu method, Nelson Somyogi method, iii) total carbohydrates by Anthrone method, iv) Determination of amylase, v) Estimation of crudefibbers.</p>	

	<p>b. Proteins: Definitions and functions, Analysis of proteins by Kjeldahl's method, analysis of protein by Lowry method, Estimation of amino acids by colorimetric method, Estimation of food grain for methionine content, Protein digestibility invitro, Protein efficiency and net protein ratio, Determination of net protein utilization, digestibility and biological value, Polyacrylamide gel electrophoresis of proteins.</p> <p>c. Analysis of Lipids: Estimation of oil in oilseeds, Estimation of free fatty acids, Saponification value of oils, iodine value, Determination of acid value of oil, determination of peroxide value of oil, Identification and quantification of fatty acids.</p>	15
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List of books and References:

1. General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.
 2. Advance dairy chemistry, vol 3, P. F. Fox, P. L. H. McSweeney Springer.
 3. Physiological fluid dynamics vol 3, Nanjanagud Venkatanarayanasastry 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, Macgra Wreycyco.
 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, Accademic press 1978

SEMESTER – III
PGCHAEC-II 304

Pharmaceutical and Organic Analysis

UNIT I	Pharmaceutical Analysis	15
	<p>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)</p> <p>1.2 Sources of impurities in pharmaceutical products and raw materials. (4L)</p> <p>1.3 Standardization of finished products and their characteristics, official methods of quality control. (4L)</p>	
UNIT II	Drugs Analysis	15
	<p>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)</p> <p>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)</p>	
UNIT III	Forensic Science	15
	<p>3.1 Analytical Chemistry in Forensic Science: General idea.(2L)</p> <p>3.2 Forensic Analysis: Blood, Alcohol in body fluids, systematic drug identification.(5L)</p> <p>3.3 Analytical Toxicology: Isolation, identification and determination of:</p> <p>3.3.1 Narcotics: Heroin, morphine and cocaine.</p> <p>3.3.2 Stimulants: Amphetamines and caffeine.</p> <p>3.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax.</p> <p>3.3.4 Metabolites of drugs in blood and urine of addicts.</p> <p>3.3.5Viscera, stomach wash, vomit and postmortem blood for poisons like - Cyanide, arsenic, mercury, insecticides and pesticides. (8L)</p>	
UNIT IV	Cosmetic Analysis	15
	<p>4.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis.(3L)</p> <p>4.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.(3L)</p> <p>4.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total).(3L)</p> <p>4.4 Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers)(3L)</p> <p>4.5 Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (3L)</p>	

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 Charalambous, 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, M L Mehra, University Book Agency, Ahmedabad, 1997.
- 11) Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
- 12) Text book 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, R M Pandey and S K 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, DrGayatriPrakash, S Chand and Company Ltd, New Delhi.
- 21) Manual of Medical Laboratory Techniques, S Ramakrishnan and K N Sulochana, Jaypee Brothers Medical Publishers (P) Ltd, 2012.
- 22) Indian Pharmacopeia, Volume I and II.
- 23) Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
- 24) Forensic Chemistry, David E Newton, Infobase Publishing, 2007.
- 25) Encyclopedia of Analytical Chemistry, Volume 3, Academic Press, 1995.
- 26) AOAC Volume I and II.

SEMESTER-III PRACTICALS

PSCHA3P1 Group-A:

1. Determination of the pK 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.

PSCHA3P2 Group–B:

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
4. Estimation of fluoride in a tooth paste.
5. Determination of silica by molybdenum blue method.

PSCHA3P3 Group–C:

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.

PSCHA3P4 Group–D:

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

NOTE:

1. The candidate is expected to submit a journal certified by the Head of the Department / institution at the time of the practical examination.
2. A candidate will not be allowed to appear for the practical examination unless he / she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate. Use of non-programmable calculator is allowed both at the theory and the practical examination.

Course Code	Title of Course	Unit	Course Outcome
			After successful completion of each course in Chemistry a learner should be able to;
Semester – IV			
PGCHA401	Quality in Analytical Chemistry	Unit I: Separation Science	<ol style="list-style-type: none"> 1. Student should be able to understand the theory of separation techniques. ^[2] 2. They should clear Principle of solvent Extraction. ^[2] 3. Student should get knowledge of applications of solvent extraction. ^[2] 4. To Study roles of solvent extraction in analytical chemistry, ^[2] 5. To Know solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical determination. ^[2]
		Unit II: Separation, Analysis and Standardization of Herbal based products	<p>Students can understand:-</p> <ol style="list-style-type: none"> 1. Separation, Analysis and Standardization of Herbal based products. ^[2] 2. Extraction of herbal materials. ^[2] 3. Standardization of herbal formulation and Herbal extracts. ^[2] 4. To Know Standardization of herbal formulation and herbal extracts: ^[2] 5. To study Standardization of herbal extract as per WHO, GMP guidelines, ^[2] 6. To know Physical, Chemical, Spectral and toxicological standardization, qualitative and quantitative estimations ^[2]
		Unit III: Green Chemistry	<p>Students get knowledge of –</p> <ol style="list-style-type: none"> 1. Principle and concepts of green chemistry. ^[2] 2. They can understand use of green chemistry in industrial case studies ^[2] 3. They should understand emerging green techniques. ^[2] 4. To explain Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. ^[2] 5. To study Chemistry using microwaves, sonochemistry and electrochemical synthesis. ^[2] 6. To Know Industrial case studies: A brighter shade of green- greening of

			acetic acid, Vitamin C ^[2] 7. To Study synthesis-enzyme routes. Polythene manufacture-metallocene catalysis. ^[2]
		Unit IV:Advanced Techniques	They can learn Advance Techniques:- 1. Electrophoresis ^[2] 2.Techniques of Electrophoresis ^[2] 3.Analytical techniques in nanotechnology ^[2] 4. To Study Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, ^[2] 5. To Know electronic structure, optical properties) one dimensional nanomaterials (nanofilms, nanolayers), ^[2] 6. To study two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials. ^[2]
PGCHA402	Advanced Instrumental Techniques	Unit I: Separation Science	Students can understand the theory, Instrumentation and application of NMR Spectroscopy. 1. Raman spectroscopy. ^[2] 2.Auger electron spectroscopy ^[2] 3.Ultaviolet photoelectron spectroscopy ^[2] 4.Comparison between ESCA &Auger Spectroscopy ^[2]
		Unit II: Spectral Methods	Students can understand the theory, Instrumentation and application of – 1.Mass Spectroscopy ^[2] 2.Raman Spectroscopy ^[2]
		Unit III: Radiochemical & Thermal Methods	Students can understand the theory, Instrumentation and application of – 1.Neutron Activation Analysis ^[2] 2.Simultaneous Thermal Analysis ^[2] 3.Evolved gas analysis ^[2]
		Unit IV: Hyphenated Techniques	Students can understand the theory, Instrumentation and application of – Hyphenated Techniques:- 1.GC – MS, ^[2] 2. ICP -MS, ^[2] 3. GC - IR, ^[2] 4.Tandem Mass Spectrometry ^[2] 5. LC – MS: ^[2] 6.HPLC-MS, ^[2] 7.CE-MS ^[2]

PGCHA403	Selected Topics in Analytical Chemistry	Unit I: Effluent Treatment	<ol style="list-style-type: none"> 1. Students can learn Effluent treatment of waste water, disposal of Sewage. ^[2] 2. Use of Recycle and reuse of process and treated (Effluent) water. ^[3] 3. They should Permissible limits for metal in the Effluent. ^[2] 4. Students should get knowledge of removal of Heavy metals from waste water. ^[2]
		Unit II: Solid Waste Management	<p>Students can understand –</p> <ol style="list-style-type: none"> 1. Solid waste management ^[2] 2. Methods of solid waste disposal ^[2] 3. Treatment and disposal of sludge/dry cake ^[2] 4. Managing non-decomposable solid wastes ^[2] 5. Bio-medical waste ^[2]
		Unit III: Plastic and Polymers	<p>Students can understand-</p> <ol style="list-style-type: none"> 1. Plastics and Polymers analysis. ^[2] 2. Metallic impurities in plastic and their Determination. ^[2] 3. Impact of plastic on environment as Pollutant. ^[2] 4. They should know the analysis of Paints & Pigments ^[2] 5. Role of organo silicones in paints and their impact on environment. ^[2]
		Unit IV: Geochemical & alloy Analysis	<p>Students get Knowledge of analysis of</p> <p>Geochemical materials such as-</p> <ol style="list-style-type: none"> 1. Dolomite ^[2] 2. Ilmenite ^[2] 3. Monazite ^[2] 4. Hematite ^[2] 5. Pyrolusite ^[2] <p>Students get Knowledge of analysis of</p> <p>Alloys such as-</p> <ol style="list-style-type: none"> 1. Stainless ^[2] 2. Bronze and Gun metal ^[2] 3. Solder alloy ^[2]
PGCHIE-I 404	Research methodology	Unit: I	<ol style="list-style-type: none"> 1. To understand various terminologies like Journal abbreviations, abstracts, current titles, reviews etc. ^[2] 2. To recite various terms like Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. ^[2] 3. To deduce information related given subject from digital sources available online. ^[2]

		Unit II: Data analysis	<ol style="list-style-type: none"> 1. To apply scientific methods and design experiments. ^[3] 2. To analyse and present data of studied material using various calculative methods, tools and software. ^[4]
		Unit III: methods of scientific research and writing scientific papers	<ol style="list-style-type: none"> 1. To analyse and write literature surveys and reviews, organize a poster display and give an oral presentation. ^[4] 2. To publish scientific work done by using ethics and avoiding plagiarism. ^[6]
		Unit IV: chemical safety & ethical handling of chemicals	<ol style="list-style-type: none"> 1. To describe Safe working procedure in laboratories safe storage and use of hazardous chemicals. ^[2] 2. To work safely with substances that pose hazards, flammable or explosive hazards. ^[2] 3. To demonstrate disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals ^[2] 4. To identify, verify and segregate laboratory waste and perform proper disposal of chemicals. ^[4]
PGCHAP401 Group – A	Quality in Analytical Chemistry Practical		<p>Students can learn :-</p> <ol style="list-style-type: none"> 1. Determination of pK value of H₃PO₄ potentiometrically ^[3] 2. Estimation of Na⁺ in dairy whitener by flame photometry ^[3] 3. Spectrophotometric determination of pH of buffer solution. ^[3] 4. Simultaneous determination of Ti³⁺ and V⁵⁺ spectrophotometrically by H₂O₂ method. ^[4] 5. To analyze Bronze for Zn by complexometric method. ^[4]
PGCHAP402 Group – B	Advanced Instrumental Techniques Practical		<p>Students can learn:-</p> <ol style="list-style-type: none"> 1. Analysis of drugs by non-aqueous titration: Glycine, Sodium Benzoate ^[4] 2. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity ^[4] 3. Determination of the purity of crystal Violet. ^[3] 4. Estimation of Calcium lactate tablets. ^[4] 5. Estimation of waste water sample for heavy metals (any two elements) by AAS. ^[4]
PGCHAP403 Group – C	Selected Topics in Analytical		<p>Students can learn:-</p> <ol style="list-style-type: none"> 1. Analysis of Calcium, Iron and

	Chemistry practical		Phosphorous in milk. ^[4] 2. Determination of SAP value of oil. ^[4] 3. Estimation of Aldehyde in lemon grass oil / Cinnamon oil ^[4] 4. Estimation of Glucose by Folin-Wu method ^[2] 5. Analysis of water sample: Mn ²⁺ by colorimetric method ^[4]
PGCHAP404 Group – D	Project Evaluation		1. Students can Develop research attitude in their mind. ^[6] 2. To inspire their mind towards Applied Research. ^[6] 3. Literature Survey. ^[2] 4. Presentation Skill. ^[2]

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analysing, [5]: Evaluating, [6]: Creating**

**Choice Based Credit, Grading and Semester System with effect from the
academic year 2019-2020**

M.Sc.-II Analytical Chemistry

Semester - IV

Course Code	Unit	Topics	Credits	L/Week
PGCHA401	I	SEPARATION SCIENCE	4	1
	II	SEPARATION, ANALYSIS AND STANDARDIZATION OF HERBAL BASED PRODUCTS.		1
	III	GREEN CHEMISTRY		1
	IV	ADVANCED TECHNIQUES		1
PGCHA402	I	SPECTRAL METHODS III	4	1
	II	SPECTRAL METHODS IV		1
	III	RADIOCHEMICAL AND THERMAL METHODS		1
	IV	HYPHENATED TECHNIQUES		1
PGCHA403	I	EFFLUENT TREATMENT	4	1
	II	SOLID WASTE MANAGEMENT		1
	III	PLASTICS AND POLYMERS		1
	IV	GEOCHEMICAL & ALLOY ANALYSIS		1
PGCHAOC-I 404	I	PRINT, JOURNALS, DIGITAL, INFORMATION TECHNOLOGY AND LIBRARY RESOURCES	4	1
	II	DATA ANALYSIS		1
	III	METHODS OF SCIENTIFIC RESEARCH AND WRITING		1
	IV	SCIENTIFIC PAPERS		1
PGCHAOC-II 404	I	Introduction to Nanotechnology	4	1
	II	Carbon Nanostructures		1
	III	Biomedical applications of Nanotechnology		1
	IV	Environmental impacts of nanotechnology		1
PGCHAP401 PGCHAP402 PGCHAP403 PGCHAP404	-	Practical Course	8	16

- Note:** 1. Blue Highlighted Topic / Course has focus on employability/ entrepreneurship/skill development
 2. Yellow Highlighted Topic / Course is related to professional ethics, gender, human values, Environment & sustainability
 3. Green Highlighted Topic / Course is related to local/national/regional & global development needs.

**SEMSTER-IV
PGCHA401**

Quality in Analytical Chemistry

UNIT I	Separation Science	15
	<p>1.1 Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis. (8L)</p> <p>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)</p>	
UNIT II	Separation, Analysis and Standardization of Herbal based products.	15
	<p>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)</p> <p>2.2 Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.(3L)</p> <p>2.3 Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO, GMP guidelines, Physical, Chemical, Spectral and toxicological standardization, qualitative and quantitative estimations.(6L)</p>	
UNIT III	Green Chemistry	15
	3.1 Principle and concepts of green chemistry: sustainable development	

	<p>and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity (4L)</p> <p>3.2 Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents (4L)</p> <p>3.3 Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. (4L)</p> <p>3.4 Industrial case studies: A brighter shade of green- greening of acetic acid, Vitamin C synthesis-enzyme routes. Polythene manufacture-metallocene catalysis.</p>	
UNIT IV	Advanced Techniques	15
	<p>4.1 Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) (2L)</p> <p>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)</p> <p>4.3 Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, electronic structure, optical properties) one dimensional nanomaterials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots). (5L)</p>	

List of Books and 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 electrophoresis 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.

PGCHA402

Advanced Instrumental Techniques

UNIT I	Separation Science	15
	NMR Spectroscopy 1.1 Theory, Instrumentation and application of FTNMR, 2D NMR Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR) (9L) 1.2 Auger electron spectroscopy Introduction, Principle, (06) Instrumentation and applications. 1.3 Ultraviolet photoelectron spectroscopy (UPS) Introduction, Principle, Instrumentation and applications. 1.4 Comparison between ESCA, Auger and UPS.	
UNIT 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)	
UNIT III	Radiochemical And Thermal Methods	
	Activation analysis- NAA ,radiometric titrations and radio-release methods(7L) 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)	
UNIT 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)	

List of Books and 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 6thEdition (1998)th
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann 5 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, 3rdEdition W. W. Wendlandt, John Wiley, N.Y. (1986)
7. Principles and Practices of X-ray spectrometric Analysis, 2 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
- 16 Principles and Applications of Thermal Analysis Edited by Paul Gabbott

SEMESTER – IV

PGCHA403

Selected Topics in Analytical Chemistry

UNIT I	Effluent Treatment	15
	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)	
UNIT 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	
UNIT III	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, Flash point (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)	
UNIT IV	Geochemical & alloy Analysis	
	Analysis of Geological materials: (7 L) i) Dolomite (For silicate, Mg and Ca content), ii) Ilmenite (for silicate, Ti and Fe content), iii) Monazite (for rare earth metals), iv) Hematite and Magnetite (silicate and Fe content), v) Pyrolusite (for silicate and Mn content) and bauxite (for Al and Silicate content). Analysis of Alloys: (6 L) i) Stainless Steel (for Fe, Cr, Ni, Co, Pb and Zr) ii) Bronze and Gun metal (Cu, Sn), ,	

	ii) Brass (Cu, Zn, Sn, Pb), iv) Solder (Pb and Sn),	
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List of Books and References:

1. Environmental Pollution Analysis, S. M. khopkar, New Age International publication (2011).
2. Water and water pollution (hand book) Ed., Seonard' lCiacere, Vol I to IV, Marcel Dekker inc. N.Y.(1972)
3. Water pollution, Arvindkumar, APH publishing (2004)
4. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
5. Solid waste management, K Sasikumar and SanoopGopi Krishna PHI publication (2009)
6. Solid waste management, SurendrakumarNorthen Book Center (2009)
7. Handbook of chemical technology and pollution control 3rdEdn Martin Hocking AP Publication (2005).
- 8 Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005
9. Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
10. 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.
11. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
12. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology & Engineering(1960).

Course Code: PGCHAOC-I 404

PAPER – IV: RESEARCH METHODOLOGY

Unit 1:

Print:

Primary, Secondary and Tertiary sources.

Journals:

Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital:

Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources:

The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.

Unit II: DATA ANALYSIS

The Investigative Approach:

Making and recording Measurements, SI units and their use, Scientific methods and design of experiments.

Analysis and Presentation of Data:

Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.

Unit III: METHODS OF SCIENTIFIC RESEARCH AND WRITING SCIENTIFIC PAPERS

Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.

Writing Scientific Papers:

Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.

Unit IV: CHEMICAL SAFETY & ETHICAL HANDLING OF CHEMICALS

Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

REFERENCES:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), *Practical skills in Chemistry*, 2nd Ed., Prentice Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data Analysis for Chemistry* Oxford University Press.
3. Topping, J., (1984) *Errors of Observation and their Treatment* 4th Ed., Chapman Hill, London.
4. Harris, D. C. (2007) *Quantitative Chemical Analysis* 6th Ed., Freeman Chapters 3-5
5. Levie, R. De. (2001) *How to use Excel in Analytical Chemistry and in general scientific data analysis* Cambridge University Press.
6. Chemical Safety matters – IUPAC-IPCS, (1992) Cambridge University Press.
7. OSU Safety manual 1.01

PAPER – IV: PGCHEC-II 404

Applied Nanotechnology

UNIT-I	Introduction to Nanotechnology	15
	Introduction – Quantum wire, quantum well, quantum dot, nanotubes, Properties of nanomaterials Synthesis techniques – Chemical precipitation and Co-precipitation, Sol-gel, CVD, Microwave heating, Sonochemical, Electrochemical, Photochemical methods. Nanomaterial characterization techniques – Diffraction methods, FTIR, UV-Visible, TGA, DTA, DSC.	
UNIT-II	Carbon Nanostructures	15
	1.1 Introduction, carbon molecules, allotropes of carbon, Graphite, Diamonds, Fullerenes, Carbon anions, carbon clusters, carbon nanotubes, 1.2 Synthetic methods of different allotropes of carbon. 1.3 Applications of carbon materials on nanotechnology.	
UNIT-III	Biomedical applications of Nanotechnology	15
	Introduction, biological sciences, photodynamic therapy in targeted drugs, advances in manufacturing, biomedical sensor and biosensors, quantum dot technology in cancer treatment, nanoparticles as a drug carrier	
UNIT-IV	Environmental impacts of nanotechnology	15
	Introduction, engineered nonmaterial's in the body, routes of entry, toxic mechanisms, environmental implications of nanoparticles, toxicological health effects, relevant parameters in nanoparticle toxicology, integrated concept of risk assessment of nanoparticles	

It is a top ranked subject related to academic and research. Emerging area that engages almost every technical discipline from chemistry to computer sciences.

It has diverging impact on many aspects of our daily lives and the opportunities in carrier.

REFERENCES:

1. Introduction to nanoscience and nano technology by, T. Pradeep.
2. Fundamentals of nano technology by, Gabor L., J. Dutta., J. Moore.
3. Text book of nanoscience and nano technology, James Murday.
4. Basics of Nanotechnology, H. G. Rubhan.

Practical course

PGCHAP401

Group – A:

1. Determination of pK value of H_3PO_4 potentiometrically
2. Estimation of Na^+ in dairy whitener by flame photometry
3. Spectrophotometric determination of pH of buffer solution.
4. Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method
5. To analyze Bronze for Zn by complexometric method

PGCHAP402

Group – B:

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
4. Estimation of Calcium-pentathionate/calcium lactate tablets
5. Estimation of waste water sample for heavy metals (any two elements) by AAS

PGCHAP403

Group – C:

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
5. Analysis of water sample : Mn^{2+} by colorimetric method

PGCHAP404

Group – D: Project Evaluation

NOTE:

3. The candidate is expected to submit a journal certified by the Head of the Department / institution at the time of the practical examination.
4. A candidate will not be allowed to appear for the practical examination unless he / she produces a certified journal or a certificate from the Head of the institution/department

stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate.

Use of non-programmable calculator is allowed both at the theory and the practical examination.