



Janardan Bhagat Shikshan Prasarak Sanstha's
CHANGU KANA THAKUR
ARTS, COMMERCE & SCIENCE COLLEGE,
NEW PANVEL (AUTONOMOUS)
Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Programme: M.Sc.
Course: M.Sc.-II
Analytical Chemistry
Choice Based Credit, Grading and Semester System (60:40)
w.e.f. Academic Year 2020-2021

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of Course	M.Sc.-I Chemistry
2	Eligibility for Admission	Passed from M.Sc. I
3	Passing marks	Minimum D Grade or equivalent minimum marks for passing at the Graduation level.
4	Ordinances/Regulations (if any)	
5	No. of Semesters	One year/Two semester
6	Level	P.G. part-II
7	Pattern	Semester (60:40)
8	Status	Revised
9	To be implemented from Academic year	2020-2021

Name of BOS Chairman: Dr. S. K. Patil

Signature of BOS Chairman:

Preamble of the Syllabus:

Master of Science (M.Sc.) in analytical chemistry is a post-graduate course of department of chemistry, Changu Kana Thakur Arts, Commerce & Science college, New Panvel (Autonomous).

The programme is envisioned to provide a focused, outcome-based syllabus at the postgraduate level with student-centric structure of the teaching-learning experiences. It engages students in the curriculum of their choice and prepare students for both academia and employability.

The new curriculum of MSc II (Analytical Chemistry) offer courses in the various areas of analytical chemistry. All the courses are having defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas.

The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offers ample skills to pursue research as career in the field of chemistry and allied areas.

Department of Chemistry of Changu Kana Thakur Arts, Commerce and Science College hope the programme will create best analytical minds to meet the needs of society.

Objectives of the Course:

1. To develop laboratory competence related instrumental and non-instrumental analysis
2. To demonstrate the ability of critical thinking and data analysis.
3. To provide the students with sound preparation for requirement of modern industry and provide competency in basic academic research as well as a cohesive, clearly structured overview of Chemistry

Course Outcomes

M. Sc. Part II Analytical Chemistry

Semester III

Paper 1: Theory

- CSO1.** Students will understand theoretical aspects of sampling, pre-treatment and method validation.
- CSO2.** Student will get knowledge of how to measure uncertainty in measurements, dealing with signal to noise ratio and legislator aspects of pharmaceutical industries.
- CSO3.** Students will learn the principle of different separation techniques and their applications in various fields.
- CSO4.** Students will get detailed insights of modern chromatographic techniques for separation of mixture on the basis of charge, size, and affinity of composition.

Paper 1: Practical

CSO1. Students will learn the instrument based analysis of various types of samples.

CSO2. Students will learn graphical representation of the data.

Paper 2: Theory

CSO1. Student will help to understand the theoretical concepts of surface analytical techniques.

CSO2. Student will understand advanced spectroscopic techniques used for characterization of matter.

CSO3. Students will get detailed insights of advanced electroanalytical techniques.

CSO4. Student will find applications of chemiluminescence, ORD-CD, Photoacoustic spectroscopy in analytical chemistry.

Paper 2: Practical

CSO1. Students will learn the various analytical techniques for pharmaceutical analysis.

CSO2. Students will get acquainted with the analysis of biological samples.

Paper 3: Theory

CSO1. Student will learn bioanalytical techniques of analysis.

CSO2. Student will understand the immunological methods and the theoretical basic of each method.

CSO3. Student will get general idea about food processing, food preservation and determination of food contaminant etc.

CSO4: Student will understand technique use in food packaging and food analysis.

Paper 3: Practical

CSO1. Students will perform practical's based upon food analysis

CSO2: Students will understand data acquisition and analysis.

Paper 4 E1: Theory

CSO1. Student will learn different aspects of analysis of air pollutants.

CSO2. Student will understand the quality and requirement of potable water of bore well and bottle mineral water.

CSO3. Student will study the details of sources and hazardous of soil pollutant, noise pollutant, thermal pollutant, radioactive pollutant etc.

CSO4. Student will do the detail study of insecticides, pesticides, soaps, detergents and petrochemical products and their effects on environment.

Paper 4 E2: Theory

CSO1: Student will get general idea regarding the pharmaceutical analysis and quality control methods of pharmaceutical industry.

CSO2: Student will know the details of drug analysis on the basis of functional groups and other factors.

CSO3: Student will understand the applications of analytical chemistry in forensic science.

CSO4: Student will learn the various aspects of cosmetic industry and analysis of different type cosmetics.

Paper 4: Practical

CSO1: Students will perform the metallurgical analysis.

CSO2. Students will deal with the experiments related with environmental pollution.

Semester IV

Paper 1: Theory

CSO1: Student will learn details of various separation processes.

CSO2. Student will study the separation, analysis and standardization of herbal based products.

CSO3. Student will get conversant with the principle, advantages and challenges of green chemistry.

CSO4. Student will understand the concept of electrophoresis in analysis and basics of nanotechnology.

Paper 1: Practical

CSO1: Student will understand the use of instrumental methods for the analysis of metallurgical samples as well as other samples.

Paper 2: Theory

CSO1: Student will do the detail study of principle, instrumentation and applications of NMR spectroscopy.

- CSO2:** Student will understand the detail concept of mass spectroscopy and Raman spectroscopy.
- CSO3:** Student will learn principle and interfacing of radio analytical techniques and hyphenated thermal methods
- CSO4:** Student will know the detail concept of hyphenated techniques including GC-MS, GC-IR, LC-MS, HPLC-MS etc.

Paper 2: Practical

- CSO1:** Student will learn the quantitative estimation of pharmaceutical products.
- CSO2:** Students will get knowledge of quality control methods and understand the importance of accuracy.

Paper 3: Theory

- CSO1:** Student will learn the different aspects of effluent treatment.
- CSO2:** Student will understand steps involved in solid waste management.
- CSO3:** Student will get an idea about classifications and applications of plastics, polymer, paints and pigments and their environmental impact.
- CSO4:** Student will study metallurgical analysis.

Paper 3: Practical

- CSO1:** Students will learn quantitative estimation of various types of food samples.

Paper 4E1: Theory

- CSO1:** Student will learn about details intellectual property.
- CSO2:** Student will get knowledge of intellectual property rights (IPR).
- CSO3:** Student will understand concepts in cheminformatics.
- CSO4:** Student will learn the drug designing and traits in it.

Paper 4E2: Theory

- CSO1:** Student will learn every aspect of publication of research paper such as terms associated with journals, referencing and library resources.
- CSO2:** Student will get conversant with the methods of data analysis and various softwares employed for it.
- CSO3:** Student will get knowledge of actual writing scientific papers.
- CSO4:** Student will get information of the safety and ethical handling of chemicals.

Paper 4: Practical

- CSO1:** Student will actually get involved in research work.
- CSO2:** Student will understand the analysis of data generated by their research work.
- CSO3:** Student will learn how to present research work.

M. Sc. Analytical Chemistry

For the subject of analytical chemistry there shall be four papers for 60 lectures each comprising of four units of 15 L each.

Semester-III

1. Paper-I / Quality in Analytical Chemistry
2. Paper-II / Advanced Analytical Techniques
3. Paper- III / Bio-analytical Chemistry and Food Analysis
4. Paper- IV (Elective course-1)/ Environmental and Certain Industrially Important
Materials
(Elective course-2)/ Pharmaceutical and Organic Analysis

Semester-II

1. Paper-I / Quality in Analytical Chemistry
2. Paper-II / Advanced Analytical Techniques
3. Paper- III/ Selected Topics in Analytical Chemistry
4. Paper- IV (Optional course-1)/ Intellectual Property Rights & Cheminformatics
(Optional course-2)/ Research Methodology

Scheme of Examination

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks in the first part and by conducting the Semester End Examinations with 60% marks in the second part. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	One case study /review / project with presentation based on curriculum to be assessed by the teacher concerned	15 Marks
	Presentation	10 Marks
	Written Document	05 Marks
03	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 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Post Graduate Programmes)

Maximum Marks: 20

Duration: 40 Minutes

Questions to be set: 02

All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % 60 Marks

- Duration: The examination shall be of $2\frac{1}{2}$ hours duration.
- There shall be five questions each of 12 marks.

Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.

Question Paper Pattern for Semester End Examination

I	Theory: The Semester End Examination for theory course work will be conducted as per the following scheme.	
	Each theory paper shall be of two and half hour duration.	
	1. There shall be five questions each of 12 marks. All questions are compulsory and will have internal options. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depends on the weightage of the unit.	
	Q-1	From Unit – I (having internal options.) 12 M
	Q-2	From Unit – II (having internal options.) 12M
	Q-3	From Unit – III (having internal options.) 12M
	Q-4	From Unit – IV(having internal options.) 12M
Q-5	Questions from all the FOUR Units with equal weightage of marks allotted to each Unit. 12 M	
II	Practical	The Semester End Examination for Practical course work 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

❖ Passing Standard

The learners shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of grade D in each project wherever applicable to pass a particular semester.

❖ Guidelines and Evaluation pattern for project work (100 Marks)

Introduction

Inclusion of project work in the course curriculum of the M.Sc. programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of project work is to inculcate the element of research work challenging the potential of learner as regards to his/ her eager to enquire and ability to interpret particular aspect of the study in his/ her own words. It is expected that the guiding teacher should undertake the counselling sessions and make the awareness among

the learners about the methodology of formulation, preparation and evaluation pattern of the project work.

- There are two modes of preparation of project work
 1. Project work based on research methodology in the study area
 2. Project work based on internship in the study area

Choice Based Credit ,Grading and Semester System (CBCGS)

To be implemented from the Academic year 2020-2021

M.Sc.-II Analytical Chemistry

Semester- III

Course Code	Unit	Topics	Credits	L / Week
PSC3QAC	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
PSC3AIT	I	Spectral Methods -I	4	1
	II	Spectral Methods -II		1
	III	Electroanalytical Methods		1
	IV	Miscellaneous Techniques		1
PSC3BCF	I	Bio-analytical Chemistry	4	1
	II	Immunological Methods		1
	III	Food analysis-I		1
	IV	Food analysis-II		1
PSC3ENC	I	Air Pollution	4	1
	II	Water Quality Standards		1
	III	Other Types of Pollution		1
	IV	Industrial Materials		1
PSC3POA	I	Pharmaceutical Analysis	4	1
	II	Drugs		1
	III	Forensic Analysis		1
	IV	Cosmetics Analysis		1
PSC3QAP PSC3AIP PSC3BCP PSC3ENP/ PSC3POP	-	Practical Course	8	16

**Choice Based Credit ,Grading and Semester System (CBCGS)
To be implemented from the Academic year 2020-2021
M.Sc.-II Analytical Chemistry
Semester- IV**

Course Code	Unit	Topics	Credits	L / Week
PSC4QAC	I	Separation Science	4	1
	II	Separation, Analysis and Standardization of Herbal based products		1
	III	Green Chemistry		1
	IV	Advanced Techniques		1
PSC4AIT	I	Spectral Methods -III	4	1
	II	Spectral Methods -IV		1
	III	Radiochemical and Thermal Methods		1
	IV	Hyphenated Techniques		1
PSC4STA	I	Effluent Treatment	4	1
	II	Solid Waste Management		1
	III	Plastics and Polymers		1
	IV	Metallurgy		1
PSC4IPR	I	Introduction to Intellectual Property Rights-I	4	1
	II	Introduction to Intellectual Property Rights-II		1
	III	Introduction to Chemoinformatics		1
	IV	Application of Chemoinformatics		1
PSC4REM	I	Resources	4	1
	II	Data Analysis		1
	III	Methods of Scientific Research and Writing		1
	IV	Chemical Safety and Ethical Handling of Chemicals		1
PSC4QAP PSC4AIP PSC4STP	-	Practical Course	8	16
PSC4IPP/ PSC3REP		Project Evaluation / Industrial Internship		

Choice Based Credit, Grading and Semester System (CBCGS)
(To be implemented from the Academic year 2020-2021)

M.Sc. ANALYTICAL CHEMISTRY SEMESTER – III PSC3QAC Quality in Analytical Chemistry		
UNIT 1	Quality In Analytical Chemistry - I	
	<p>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)</p> <p>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 (PAT).(7L)</p>	
UNIT II	Quality In Analytical Chemistry - II	15
	<p>2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L)</p> <p>2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction. (6L)</p> <p>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)</p>	
UNIT III	Chromatographic Techniques -I	15
	<p>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)</p> <p>3.2 Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L)</p> <p>3.3 Exclusion chromatography : Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers, (5L)</p>	
UNIT IV	Chromatographic Techniques -II	15
	<p>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.</p>	

(8L)

4.2 Affinity Chromatography: principle, instrumentation and applications (4L)
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 Weinheim 1995.
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, Saunders, 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
11. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2nd ed 1963
12. Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976
- 13 Chromatographic and electrophoresis techniques I Smith Menemann Interscience 1960

SEMESTER-III
PSC3AIT
Advance Instrumental Techniques

UNIT I	Spectral Methods I	15
	<p>1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis. (1L) Principle, instrumentation and applications of Transmission Electron Microscopy (3L)</p> <p>1.2 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy. (4L) b. Low-Energy Ion Scattering and Rutherford Backscattering (5L) c. Atomic Emission Spectroscopy- electrical discharge sources (2L)</p>	
UNIT II	Spectral Methods – II	15
	<p>Principle, Instrumentation, and Applications of</p> <p>2.1 Electron Spin Resonance Spectroscopy (ESR) (5L) 2.2 Mossbauer's Spectroscopy (5L) 2.3 Particle-Induced X-Ray Emission (5L)</p>	
UNIT III	Electroanalytical Methods	15
	<p>Advanced Electroanalytical Techniques:-</p> <p>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)</p>	
UNIT IV	Miscellaneous Techniques	15
	<p>Principle, Instrumentation and Applications of:</p> <p>4.1 Chemiluminescence techniques (3L) 4.2 Chiroptical Methods : ORD, CD (5L) 4.3 Photoacoustic spectroscopy (3L) 4.4 Spectroelectrochemistry (4L)</p>	

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) Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. Settle Jr 6th Ed CBS (1986)
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr 7th Ed CBS (1986)
5. Introduction to Instrumental Analysis, R. D. Braun, Mc Graw Hill (1987)
6. Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
7. Electroanalytical Chemistry, J.J . Lingane, 2nd Ed Interscience, New York (1958)
8. Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980.
9. Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
10. Techniques and mechanism of electrochemistry, P. A. Christian and A. Hamnett, Blachie Academic and Professional (1994)
11. Wilson and Wilson's Comprehensive Analytical Chemistry, Ed. G. Svehla. (A series of Volumes)
12. Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience Pub. (A series of volumes).
13. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, (A series of volumes)
14. Polarographic Methods in Analytical Chemistry, M. G. Arora, Anmol Publications Pvt Ltd
15. 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
16. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester

SEMESTER – III
PSCH3BCF
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
	2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.(8L)	
	2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.(7L)	
UNIT III	Food Analysis - I	15
	3.1 Fuel value of food and importance of food nutrients (2L)	
	<p>3.2</p> <p>3.2.1 General idea about Food processing and preservation;</p> <p>3.2.2 Food Additives: Legislation, Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes.</p> <p>3.2.3 Analysis of food for additives: Determination of SO₂, nitrate and nitrites; determination of ascorbic acid; identification and determination of saccharine and identification of colors in food, natural colours (5L)</p>	
	3.3 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated biphenyls, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants. (8L)	
UNIT IV	Food Analysis - II	15
	<p>4.1</p> <p>4.1.1 Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L)</p> <p>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)</p>	
	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)	

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 Venkatanarayanasastri 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 Wreyco.
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.
11. Analysis of food and beverages, George Charalanbous, Accademic press 1978.

SEMESTER-III**PSC3ENC****Environmental and Certain Industrially Important Matrials**

UNIT I	Air Pollution	15
	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)	
UNIT II	Water Quality Standards	15
	2.1 Water: quality and requirements of potable water, direct and indirect pollutants for potable water reservoirs, quality of potable water from natural sources. (6L) 2.2 Bore well water quality and analytical parameters. Quality of bottled mineral water (3L) 2.3 Process of purification of bore well water to bottled mineral water. (2L) 2.4 Regulatory requirements for packaged drinking water (4L)	
UNIT III	Other Types Of Pollution	15
	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)	

	<p>3.3 Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy. (3L)</p> <p>3.4 Radioactive pollutants: source, exposure hazards, precautions in handling and safety, Long term effects. (2L)</p> <p>3.5 Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification (2L)</p>	
UNIT IV	Industrial Materials	15
	<p>4.1 Insecticides, Pesticides: definition, classification of insecticides pesticides. Biodegradation of insecticides and pesticides (5L).</p> <p>4.2 Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents (5L)</p> <p>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)</p>	

List of Books and 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 (hand book) Ed., Seonard'l Ciacere, Vol I to IV, Marcel Dekker inc. N.York(1972)
6. Water pollution, Arvind kumar, 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.
9. Soil pollution, S.G. Misra and Dinesh Mani, APH Publishing Corporation, (2009).
10. Soil Pollution: origin, monitoring and remediation, Abraham Mirsal, Springer (2010).
11. Noise Pollution, Donald F Anthrop, Lexington Books, (1973)
12. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise (1981) Available at NCL laboratories e- Library.

13. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).
14. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication , (2003).
15. Environmental law in India, Mohammad Naseem, Wolters Kluwer.
16. Environmental Protection, Law And Policy In *India* Kailash Thakur google books (1997).
17. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002)
18. Pesticide Analysis Ed K. G. Das, Dekker (1981)
19. Analytical, Agricultural Chemistry S. L Chpra J.S Kanwar Kalyani publication
20. Soil and plant Analysis C.S Piper , Hans Publication

SEMESTER – III

PSC3POA

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 and novel drug delivery system, classification of dosage forms. Role of FDA in pharmaceutical industries.(7L)</p> <p>Standardization and quality control of raw material and finished product Assay as per IP i) adrenaline, ii) Cephalexin, iii) ferrous fumarate, iv) paracetamol. (8L)</p>	
UNIT II	Drugs	15
	<p>2.1 Analysis of compounds based on functional groups, instrumental methods for analysis of drugs, proximate assays, assays of enzyme containing substances, biological and microbiological assays and tests. (8L)</p> <p>2.2 Limit tests, Sources of impurities and impurity profiling solubility tests, disintegration tests, stability studies, bioequivalence and bioavailability studies.(7L)</p>	
UNIT III	Forensic Science	15
	<p>3.1 Analytical Chemistry in Forensic Science: General idea.(2L)</p> <p>3.2 Forensic Analysis: 3.2.1 Blood: Blood preservation blood stain analysis.) 3.2.2 DNA profiling DNA typing procedures-RFLP, PCR, MVRPCR, Dot-blot, AMP-FLP, STR, other methods, paternity testing, 3.2.3 Hair analysis: Structure and composition of hair, morphological examination, Chemical analysis of hair components and components remaining on or in hair.) 3.2.4 Alcohol in body fluids: Sampling and sample preservation, analysis - GC, IR, enzymatic and other methods (5L)</p> <p>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. 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)</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.(2L)</p> <p>4.2 Deodorants and antiperspirants: Al, Boric acid, chlorides, sulphates, and methanamine. (3L)</p>	
	<p>4.3 Face powder: Ti, Fe, oxides of Ti, Fe and Al (total).(2L)</p>	

	4.4 Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers)(4L)	
	4.5 Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (3L)	
	4.6 Lipsticks: General analysis, lakes and fillers, trichloroethylene-acetone soluble contents.(1L)	

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, 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, Dr Gayatri Prakash, 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.
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SEMESTER-III PRACTICALS
PSC3QAP

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 pHmetry.
5. Determination of copper by extractive photometry using diethyldithiocarbamate.

PSC3AIP

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.

PSC3BCP

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. Estimation of micronutrient from food by AAS (any two elements such as Fe, Cu, Zn, Mo, B, Mn)

PSC3ENP/ PSC3POP

1. To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry.
2. Analysis of Nicrome alloy for Ni (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.
3. The list of the experiments performed by the candidate should be attached with such certificate.
4. Use of non-programmable calculator is allowed both at the theory and the practical examination.

SEMSTER-IV**PSC4QAC****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: Defination 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>2.2Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.(3L)</p> <p>2.3Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical,Spectral and toxillogical standardization,qualitative and quantitative esimations.(6L)</p>	

UNIT III	Green Chemistry	15
	<p>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)</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 Designing Greener Processes: Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring. (3L)</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: One dimensional nano materials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots); consequences of the nanoscale, (morphology, electronic structure, optical properties), Applications of UV-Vis, IR and Raman, X-ray diffraction, SEM, TEM and XPS, probe analysis (AFM) in characterization of nanomaterials. (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.

SEMESTER-IV**PSC4AIT****Advanced Instrumental Techniques**

UNIT I	Spectral Methods III	15
	<p>NMR Spectroscopy</p> <p>1.1 Theory and Instrumentation- recapitulation, FTNMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR) (9L)</p> <p>1.2 Radio waves in imaging- principle instrumentation and applications of MRI (3L)</p> <p>1.3 Application of NMR to other nuclei C¹³, P³¹ and F¹⁹ spectroscopy (3L)</p>	
UNIT-II	Spectral Methods IV	15
	<p>2.1 Mass spectrometry: 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)</p> <p>2.2 Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)</p>	
UNIT III	Radiochemical And Thermal Methods	15
	<p>3.1 Activation analysis- NAA ,radiometric titrations and radio-release methods(7L)</p> <p>3.2 Thermal analysis- Principle, Interfacing , instrumentation and Applications of</p> <p>(a) Simultaneous Thermal Analysis- TG-DTA and TG-DSC</p> <p>(b) Evolved gas analysis- TG-MS and TG-FTIR (8L)</p>	
UNIT IV	Hyphenated Techniques	15
	<p>4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2 L)</p> <p>4.2 Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)</p>	

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 (1998)
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, 3rd Edition W. W. Wendlandt, John Wiley, N.Y. (1986)
7. Principles and Practices of X-ray spectrometric Analysis, 2 NY, (1975)
8. Ed E. P. Bertain, Plenum Press, 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
PSC3STA
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	15
	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)	
UNIT – III	Plastics and Polymers	15
	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:	Metallurgy	15
	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, Magnesium, 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)	

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'1 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)
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7. Handbook of chemical technology and pollution control 3 Edn Martin Hocking AP Publication (2005).
8. 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).

SEMESTER – IV**PSC4IPR****Intellectual Property Rights & Cheminformatics**

UNIT I	Introduction to Intellectual Property-I	15
	<p>1.1 : Historical Perspective, Different types of IP, Importance of protecting IP.(2L)</p> <p>1.2: Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India (5L)</p> <p>1.3: Industrial Designs: Definition, How to obtain, features, International design registration.(2L)</p> <p>1.4: Industrial Designs: Definition, How to obtain, features, International design registration.(2L)</p> <p>1.5: Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. (2L)</p> <p>1.6: Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India. (2L)</p>	
UNIT – II	Introduction to Intellectual Property-II	15
	<p>2.1 Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.[2L]</p> <p>2.2 IP Infringement issue and enforcement: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. [2L]</p> <p>2.3 Economic Value of Intellectual Property: Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. [5L]</p> <p>2.4 Different International agreements: (a) World Trade Organization (WTO): [5L] (i) General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS); Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty (b) Paris Convention [6L] WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity</p>	
UNIT – III	Introduction to Chemoinformatics	15
	<p>3.1 History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation.[5L]</p> <p>3.2 Representation of molecules and chemical reactions: Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. [5L]</p> <p>3.3 Searching Chemical Structures: Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods,</p>	

	basics of computation of physical and chemical data and structure descriptors, data visualization. [5L]	
UNIT – IV	Applications of Chemoinformatics	15
	Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target, Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand based and Structure based Drug design, Application of Cheminformatics in Drug Design.	

SEMESTER – IV
PSC4REM
Research Methodology

UNIT I	Resources	15
	<p>1.1 Print: Primary, Secondary and Tertiary sources.</p> <p>1.2 Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents,</p> <p>1.3 Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.[5L].</p> <p>1.4 Digital: Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books,</p> <p>Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. [5L]</p> <p>Information Technology and Library Resources: Internet and World wide web, Internet resources for Chemistry, finding and citing published information. [5L]</p>	
UNIT – II	Data Analysis	15
	<p>2.1 The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments.</p> <p>2.2 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.</p>	
UNIT – III	Methods of Scientific Research and Writing	15
	<p>3.1 Scientific papers: Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.</p> <p>3.2 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.</p>	
UNIT – IV	Chemical Safety & Ethical Handling of Chemicals	15
	<p>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..</p>	

PRACTICALS

PSC4QAP

1. Determination of pK value of H₃PO₄ potentiometrically
2. Estimation of Na⁺ in dairy whitener by flame photometry
3. Spectrophotometric determination of pH of buffer solution.
4. Simultaneous determination of Ti³⁺ and V⁵⁺ spectrophotometrically by H₂O₂ method
5. To analyze Bronze for Zn by complexometric method

PSC4AIP

1. Analysis of Aspirin/paracetamol as per IP with respect to identification, ash and assay
2. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity
3. Determination of the purity of crystal violet
4. Estimation of Ca in Ca-pentathionate/calcium lactate tablets
5. Canned food: Limits test for tin/zinc

PSC4STP

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 : Mn²⁺ by colorimetric method

PSC4IPP/PSC4REP

Project Evaluation/ Industrial Internship

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