Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College, Vashi, Navi Mumbai

Autonomous College

[University of Mumbai]

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**M.Sc.-II Chemistry**
2	**Eligibility for Admission**	**B.Sc. Chemistry of any recognized University**
3	**Passing marks**	40%
4	**Ordinances/Regulations (if any)**	
5	**No. of Years / Semesters**	**One Year / Two Semesters**
6	**Level**	**P.G.**
7	**Pattern**	**Semester**
8	**Status**	**New (NEP)**
9	**To be implemented from Academic year**	**2024-2025**

AC - / / 2024

Item No-

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 In Chemistry

Program: M.Sc. Chemistry

Course: M.Sc. – II Chemistry

[NATIONAL EDUCATION POLICY (NEP 2020) with effect from the academic year 2024-2025]

Preamble of the Syllabus:

Master of Science (M.Sc.) in Analytical Chemistry is a post-graduation program of Department of Chemistry, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai. The revised syllabus in Chemistry as per National Education Policy (NEP 2020) for **M. Sc. Part–II** program will be implemented from the academic year **2024-25.**

The systematic and planned curricula from these courses through the National Education Policy (NEP 2020) to be implemented would allow students to motivate and encourage learners to understand basic concepts in Chemistry and to understand the real world problems.

The learners are expected to enrich knowledge through thinking and reasoning abilities, numerical problem solving, hands-on activities, study tours, industrial visits and research projects etc.

The learners are expected to develop critical, analytical and reasoning abilities towards real world problems and become familiarize with the recent scientific and technological advancements.

Program Outcomes (POs):

PO-1	**Disciplinary Knowledge and Skills:** Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Chemistry, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	**Communication and Presentation Skills:** Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	**Creativity and Critical Judgement:** Facilitate solutions to current issues based on investigations, evaluation and justification using evidence based approach.
PO-4	**Analytical Reasoning and Problem Solving:** Build critical and analytical attitude in handling the problems and situations.
PO-5	**Sense of Inquiry:** Curiously raise relevant questions based on highly developed ideas, scientific theories and its applications including research.
PO-6	**Use of Digital Technologies:** Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	**Research Skills:** Construct, collect, investigates, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	**Application of Knowledge:** Develop scientific outlook to create consciousness against the social myths and blind faith.
PO-9	**Moral and Ethical Reasoning:** Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	**Leadership and Teamwork:** Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.
PO-11	**Environment and Sustainability:** Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning:** Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSOs):

PSO-1	Problem Analysis – Ability to identify and analyze the Chemistry problems using the basic principles and computational tools.
PSO-2	Acquired skills – Potential to adopt, absorb and develop innovative ideas in the Chemistry and interdisciplinary areas.
PSO-3	Competent to engage themselves in lifelong learning, develop professional ethics and build a team by using their knowledge to serve the society at large with effective communication.

SCHEME OF EXAMINATION FOR EACH SEMESTER

Continuous Internal Assessment: 40% (Unit Test-20 Marks & 10 Marks for- Assignment, Oral, Seminar, Presentation, Group Discussion, Participation in Conf / Sem / Workshop, Open Book Test, Visit to Research Institute etc)

Semester End Examination: 45 Marks (2 ½ hrs duration) will be as follows:

I.	**Theory:**	
	Each theory paper shall be of TWO and HALF Hour duration.	
	Each paper shall consist of FOUR questions. All questions are compulsory and will have internal options.	
	Q – I :	is from Unit – I (15 Marks)
	Q – II :	is from Unit – II (15 Marks)
	Q – III :	is from Unit – III (15 Marks) … for 3 Unit Courses
	Q – IV :	is from Unit – IV (15 Marks) … for 4 Unit Courses
II.	**Practicals:**	The External examination per practical course will be conducted as per the following scheme.

Sr. No.	**Particulars of External Practical Examination**	**Marks**
1	Practicals based on Course CHE501	25
2	Practicals based on Course CHE502	25
3	Practicals based on Course CHE503	50
4	Practicals based on Course CHE504A/ CHE504B	50
	TOTAL =	**150**

Syllabus for M.Sc. Part – II Analytical Chemistry (Theory & Practical)

Course Structure & Distribution of Credits

1. General:

M. Sc. in Analytical Chemistry Program consists of total 12 Core Courses (CC), 04 Discipline Specific Elective (DSE) Courses, spread over four semesters. In addition to these, Research Methodology Course of 4 credits in Sem-I, Internship of 4 credits in Sem – II), Project Dissertation of 4 credits each in Sem – III & Project Dissertation of 6 credits each in Sem IV are made compulsory for all the students. In Sem-III, 3 theory course (CC - 2 & DSE - 1) will be of 4 credits and 1 CC course will be of 6 credits in addition to research projects for 4 Credits. In Sem – IV, 4 theory course (CC - 3 & DSE - 1) will be of 4 credits each in addition to research projects for 6 Credits. The practical courses will be integral part of theory courses and no mention of practical courses separately.

Research projects are made compulsory during Sem – III and IV for all the students. A project (during Sem-III & IV) can be on theoretical Chemistry, experimental Chemistry, applied Chemistry, development Chemistry, computational Chemistry or industrial product development. A student earns 22 (twenty-two) credits per semester and total of 88 (Eighty Eight) credits in four semesters. The course structure is as follows:

Theory Courses:

SEM	Core Courses (CC)			Discipline Specific Elective (DSE) Course		RM
III	**Course - 1:** Quality in Analytical Chemistry - I **(4)** **Course Code – CHEA501**	**Course – 2:** Advance Instrumental Techniques -I **(4)** **Course Code – CHEA502**	**Course – 3:** Bioanalytical Chemistry and Food Analysis **(6)** **Course Code – CHEA503**	**Course – 4A:** Pharmaceutical and Forensic Science **(4)** **Course Code – CHEA504A**	**Course – 4B:** Industrial Pharmacy **(4)** **Course Code – CHEA504B**	**Course – 5:** Research Projects **(4)** **Course Code – CHEA505**

IV	**Course - 1:** Quality in Analytical Chemistry – II **(4)** **Course Code – CHEA551**	**Course – 2:** Advanced Instrumental Techniques- II **(4)** **Course Code – CHEA552**	**Course – 3:** Waste Management and Material Analysis **(4)** **Course Code – CHEA553**	**Course – 4A:** QMS and Audit **(4)** **Course Code – CHEA554A**	**Course – 4B:** IPR and Chemo-informatics **(4)** **Course Code – CHEA554B**	**Course – 5:** Research Projects **(6)** **Course Code – CHEA555**

SEMESTER – III

M.Sc. in Chemistry Program for Semester-III consists of FOUR theory courses and practicals are integral parts of theory courses and research projects. The details are as follows:

Theory Courses (5): 20 hours per week (One lecture is of one-hour duration)

Course Code	Name of the Course	Lectures (Hrs.)	Practicals (Hrs.)	Total (Hrs)
CHEA501	Quality in Analytical Chemistry - I (Credits)	45	30	75
CHEA502	Advance Instrumental Techniques –I (4 Credits)	45	30	75
CHEA503	Bio-analytical Chemistry and Food Analysis (6 Credits)	60	60	120
CHEA504A/ CHEA504B	Pharmaceutical and Forensic Science / Industrial Pharmacy (4 Credits-2T+2P)	30	60	90
CHEA505	Research Projects (4 Credits)	---	120	120
	TOTAL =	**180**	**180**	**480**

SEMESTER - IV

M.Sc. in Chemistry Program for Semester-IV consists of FOUR theory courses and practical are integral part of theory courses and research projects. The details are as follows:

Theory Courses (5): 20 hours per week (One lecture is of one-hour duration)

Course Code	Name of the Course	Lectures (Hrs.)	Practicals (Hrs.)	Total (Hrs)
CHEA551	Quality in Analytical Chemistry – II (4 Credits)	45	30	75
CHEA552	Advanced Instrumental Techniques- II (4 Credits)	45	30	75
CHEA553	Waste Management and Material Analysis (4 Credits)	45	30	75
CHEA554A/ CHEA554B	QMS and Audit / IPR and Chemo-informatics (4 Credits)	30	60	90
CHEA555	Research Projects (6 Credits)	---	180	180
	TOTAL =	**130**	**330**	**495**

The candidate shall be awarded the degree of ***Master of Science in Chemistry*** **(M. Sc. In Analytical Chemistry)** after completing the course and meeting all the evaluation criteria.

2. Passing Standards:

- This course will have 40% Continuous Internal Evaluation (CIE) and 60% Semester End Examination (SEE) (written examination of 2.5 Hours duration for each theory course and practical examination of 4 Hours duration for each practical course). All external examinations will be held at the end of each semester and will be conducted by the college as per the existing norms of the University.
- Continuous Internal Evaluation (CIE) and 60% Semester End Examination (SEE) - shall have separate heads of passing. For Theory

courses, continuous internal evaluation shall carry 40 marks and Semester-end examination shall carry 60 marks for each Theory Course.

- To pass, a student has to obtain minimum grade point E or above separately in CIE and the SEE examinations.
- The external examination for all Theory and Practical courses shall be conducted at the end of each Semester and the evaluation of min projects will be conducted at the end of I & II. The evaluation of Internship work will be conducted at the end of Sem-III and evaluation of Project Dissertation will be conducted at the end of the fourth Semester.
- The candidates shall appear for external examination of 5 theory courses each carrying 60 marks of 2.5 hours duration and two practical courses in each of the semesters – I, II, III & IV, each carrying 100 marks at the end of each semester.
- The candidate shall prepare and submit for practical examination, a certified Journal based on the practical courses carried out under the guidance of a faculty member with minimum number of experiments as specified in the syllabus.
- The candidate shall submit an Internship report or Certificate before appearing for third semester end examination and Project Report / Dissertation for the Project Topic at the end of fourth semester as per the guidelines.

3. Standard point scale for grading:

Marks	**Grade Points**	**Grade**	**Performance**
80.00 and Above	10	O	Outstanding
70 to 79.99	9	A+	Excellent
60 to 69.99	8	A	Very Good
55 to 59.99	7	B+	Good
50 to 54.99	6	B	Above Average
45 to 49.99	5	C	Average
40 to 44.99	4	D	Pass
Less Than 40	1	F	Fail

4. Grade Point Average (GPA) calculation:

1. GPA is calculated at the end of each semester after grades have been processed and after any grades have been updated or changed. Individual assignments / quizzes / surprise tests / unit tests / tutorials / practicals / project / seminars etc. as prescribed by University are all based on the same criteria as given above. The teacher should convert his marking into the Quality-Points and Letter-Grade.
2. Performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). It is the weighted average of the grade points

$$CGPA = \Sigma_{i=1} \square\square\square\square / \Sigma_{i=1} \square\square$$

$\square\square$ = The number of credits earned in the $\square^{th}$ course of a semester.
$\square\square$ = Grade point earned in the $\square^{th}$ course.
$\square$ = 1, 2, ….$\square$ represents number of courses for which the student is registered.

3. The Final remark grade will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade points obtained in all the semesters registered by the learner.

$$CGPA = \Sigma_{j=1} \square_j \square_j / \Sigma_{j=1} \square j$$

$\square\square$ = The number of credits earned in the $\square$th course up to the semester for which the CGPA is calculated.
$\square\square$ = Grade point earned in the $\square$th course*
$\square$ = 1,2,…. $\square$ represents number of courses for which the student is registered up to the semester for which the CGPA is calculated.

M.Sc. – II Analytical Chemistry Theory Courses

SEMESTER – III

Course - 1: Quality in Analytical Chemistry - I (CC)
Course Code: CHEA501 (45 Lectures Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO - 1:	Understand the concept of sampling, Pre-treatment of sampling.Incorrect analytical results, method validation. (2)
CO - 2:	To integrate Measurement of uncertainty, Signal to noise, requirements for maintenance and calibration (6)
CO - 3:	To understand the principles of various chromatographic techniques. (2)
CO - 4:	To summarize various chromatographic techniques and its applications (2)

Unit-1:	**Quality In Analytical Chemistry**	**15 Lectures**
1.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (5L) 1.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis, signal to noise enhancement. (3L) 1.3 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 – 2:	**Chromatographic Techniques –I**	**15 Lectures**
2.1 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) 2.2 Ion chromatography: Principle, instrumentation with special reference to Separation and suppressor columns, applications. (2L) 2.3 Exclusion chromatography: Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves determination of molecular weight of polymers. (5L)		

Unit – 3:	**Chromatographic Techniques –II**	**15 Lectures**

3.1 Supercritical fluid Chromatography: Theory, concept of the critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis. (8L)
3.2 Affinity Chromatography: principle, instrumentation and applications (4l)
3.3 Optimum pressure liquid chromatography (OPLC) (3L)

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.	Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication
4.	Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
5.	Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978
6.	Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996
7.	Ion exchange separation in analytical chemistry O Samuelson John Wiley 2nd ed.1963
8.	Chromatographic and electrophoresis techniques I Smith MenemannInterscience 1960

Course - 2: ADVANCE INSTRUMENTAL TECHNIQUES I (CC)
Course Code: CHEA502 (45 Lectures of Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO - 1:	To understand principle, instrumentation and applications of various spectral methods (2).
CO - 2:	To correlate various advanced Electro analytical Techniques.(3)
CO - 3:	To explain different advance analytical techniques.(2)
CO - 4:	To interpret and correlate different instrumental techniques.(3, 4)

Unit – 1:	**Spectral Method**	**15 Lectures**
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 – 2:	**Electro analytical Methods**	**15 Lectures**
Advanced Electro analytical Techniques:- 3.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L) 3.2 Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry. (3L) 3.3 Potential Step method- Chronoamperomertry (2L) 3.4 Controlled potential technique-Chronopotentiometry (2L) 3.5 Stripping Voltammetry- anodic, cathodic, and adsorption (2L) 3. 6 Chemically and electrolytically modified electrodes and ultra- microelectrodes in voltammetry (3L)		
Unit – 3:	**Miscellaneous Techniques**	**15 Lectures**

Principle, Instrumentation and Applications of:
4.1 Chemiluminesescence 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 ant ferromagnetism, instrumentation and applications of magnetic susceptibility measurements.

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.	Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6th Ed CBS (1986)
4.	Introduction to Instrumental Analysis, R. D. Braun, McGraw Hill (1987)
5.	Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
6.	Electroanalytical Chemistry, J.J .Lingane, 2nd Ed Interscience, New York (1958)
7.	Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980
8.	Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
9.	NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry R. V. Parish. Ellis Horwood, Chichester
10.	Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience Pub. (A series of volumes).
11.	Wilson and Wilson's Comprehensive Analytical Chemistry, Ed. G. Svehla. (A series of Volumes)

Course - 3: BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS (CC)

Course Code: CHE503 (60 Lectures Theory and 60 Hrs Practicals, 6 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO - 1:	To describe & analyse various Composition of body fluids.(2,4)
CO - 2:	To illustrate general processes of immune response, antigen-antibody, reactions, precipitation reactions, radio, enzyme.(2)
CO - 3:	To determine fuel value of food and importance of food nutrients.(3)
CO - 4:	To analyze various food product- Milk, Oils, fats and spices.

Unit – 1:	**Bio-analytical chemistry**	**15 Lectures**

1.1 Body Fluids

1.1.1 Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and Bilirubin in urine leading to diagnosis of diseases. (5L)

1.1.2 Physiological and nutritional significance of vitamins (water Soluble and fat soluble) and minerals. (5L)

1.1.3 Analytical techniques (including microbiological techniques) for vitamins. (5L)

Unit – 2:	**Immunological Methods**	**15 Lectures**

2.1 General processes of immune response, antigen-antibody reactions, precipitation reactions, radio, enzyme and fluoro-immuno assays.(6L)

Determination of (1) Serum Calcium (2) Serum/Plasma Bicarbonate (Titrimetry) (3) Serum sodium and potassium (Flame photometry).

Determination of Serum Chloride (Coulometry) - Determination of (1) Cholesterol (2) Total Protein (3) Blood Urea in Serum (4) Amylase (5) Aspartate Amino Transferase (AST) and Alanine Amino Transferase (ALT) (By Spectrophotometry).

Determination of (1) Thyroxin and (2) Thyroid-Stimulating Hormone (TSH)(by RIA Method)

Unit - 3:	**Food Analysis – I**	**15 Lectures**

3.1 Food Additives – General idea about Food processing and preservation, Chemical preservatives, fortifying agents, emulsifiers, Texturizing agents, flavours, colors, artificial sweeteners, and enzymes. Analysis of food products for flavouring agents and colour. (8L)

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)

3.3 Food packaging – Introduction, types of packing materials, properties and industrial requirements.(2L)		
Unit – 4:	**Food Analysis II**	**15 Lectures**
4.1.Carbohydrates: Definition, classification, and functions, Analysis of carbohydrates from food sample by different methods 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 crude fibbers. **4.2.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. **4.3Analysis 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.		

References:

1.	Molecular Biological and Immunological Techniques and Applications for food, edited by Bert Popping, Carmen Diaz-Amigo, Katrin Hoenicke, John Wiley & sons.
2.	Physiological fluid dynamics vol 3, Nanjanagud Venkatanarayanasastry Chandrasekhara Swamy Narosa Pub. House, 1992
3.	General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.
4.	Bioanalytical Chemistry, S. R. Mikkelesen and E. Corton, John Wiley and sons 2004, Analysis of food and beverages, George Charalanbous, Accademic press 1978
5.	Analytical Biochemistry, D, J. Homes and H. Peck, Longman (1983)
6.	Food Analysis: Theory and practice, Yeshajahu Pomeranz, Clifton E. Meloan, Springer.
7.	Food Analysis, Edited by S. Suzanne Nielsen, Springer
8.	Advance dairy chemistry, vol 3, P. F. Fox, P. L. H. McSweeney Springer.

Course – 4A: Pharmaceutical and Forensic Science (DSE)
Course Code: CHE504A (45 Lectures Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To understand general idea regarding the different process in Pharmaceutical Industry.
CO2	To evaluate and correlate various methods for drug analysis.
CO3	To judge and apply methods of analysis in forensic science and toxic materials.

Unit – 1:	**Pharmaceutical Analysis**	**15 Lectures**

1.1 Definition and classification of drugs, introduction to pharmaceutical formulations, Classification of dosage forms.(2)
1.2 Limit tests, solubility tests, disintegration tests, stability studies, impurity profile of drugs, bioequivalence and bioavailability studies.(3)
1.3Analysis 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)
1.4 Sources of impurities in pharmaceutical products and raw materials. (2L)

Unit – 2:	**Forensic Science**	**15 Lectures**

2.1 Analytical Chemistry in Forensic Science: General idea.(2L)
2.2 Forensic Analysis: Blood, Alcohol in body fluids, systematic drug identification.(5L)
2.3 Analytical Toxicology: Isolation, identification and determination of: (8L)
2.3.1 Narcotics: Heroin, morphine and cocaine.
2.3.2 Stimulants: Amphetamines and caffeine.
2.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax.
2.3.4 Metabolites of drugs in blood and urine of addicts.
2.3.5 Viscera, stomach wash, vomit and postmortem blood for poisons like- Cyanide, arsenic, mercury, insecticides and pesticides.

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.	The Handbook of Drug Laws, M L Mehra, University Book Agency, Ahmedabad, 1997

4.	Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995
5.	Text book of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
6.	Indian Pharmacopeia, Volume I and II.
7.	Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006
8.	Forensic Chemistry, David E Newton, Infobase Publishing, 2007.

Course – 4B: Industrial Pharmacy (DSE)
Course Code: CHE504B (45 Lectures Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To understand general guidelines in Pharmaceutical Industry.
CO2	To illustrate documentation in Pharmaceutical Industry.

Unit - 1	**General Guidelines in Pharmaceutical industry**	15 Lectures
FDA Regulations in the pharmaceutical industry , Concept ,need and the Schedule of Audit, Concept of the sampling in the pharmaceutical industry and M Sampling protocols, Concept of ICH guidelines in the pharmaceutical industry , FDA and SUPAC Guidelines in the pharmaceutical industry.		
Unit - 2	**Documentation in Pharmaceutical Industry**	**15 Lectures**
Audit and Documentations in relation to pharmaceutical industry ,Document filing and the documents BMR in the pharmaceutical industry , Other Documentation for Quality Assurance in the pharmaceutical industry , Process Analytical Technology (PAT),Concept of Raw Material Q.C, Flow of raw materials in manufacturing Facility in industry		

References:

1.	Lachman/Lieberman's the Theory and Practice of Industrial Pharmacy.
2.	Herbert A. Lieberman, Martin A. Rieger, G.S. Banker , Pharmaceutical Dosage Form: Dispersed Systems (Vol.1 &2), 2 nd edition, Marcel Dekker Inc, 1993.
3.	Gilbert S.Banker, C.T. Rhodes, Modern Pharmaceutics, ,4th Edition, Marcel Dekker Inc, 2002.

4.	Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, Pharmaceutical Dosage Form And Drug Delivery Systems, 10th edition, 1995, B.I.WaverlyPvt.Ltd.

Course - 5: Research Projects (CC)
Course Code: CHE505 (120 Hrs, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO 1	**Research Skills Development:** to formulate research questions, conduct literature reviews, design appropriate methodologies, collect and analyze data, and draw conclusions based on evidence.
CO 2	**Critical Thinking:** to develop critical thinking skills by questioning assumptions, analyzing evidence, and synthesizing information to form their own conclusions.
CO 3	**Communication Skills:** to develop effective communication skills, including the ability to articulate ideas clearly, structure arguments logically, and present information in a compelling manner.
CO 4	**Problem-Solving Abilities**: to learn to identify problems, develop strategies for addressing them, and adapt their approach as needed, involve encountering obstacles and challenges that require creative problem-solving skills.

SEMESTER-III (PRACTICALS)

CHEAP501

1. Determination of the pKa 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 in a given mixture using pH-metry.
5. Determination of copper by extractive photometry Using diethyl dithiocarbamate.
6. Determination of mixture of halides Potentiometrically.
7. Determination of aniline and ethanolamine in a mixture of two in acetonitrile by potentiometric titration.

CHEAP502

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.
6. Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide(b) Lane - Eynon method.
7. Analysis of lactose in milk
8. Estimation of Caffeine in tea

CHEAP503

1. To analyse Pyrolusite for: Fe by colorimetry and / or Mn by volumetry.
2. To analyse Magnelium 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).
6. Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method
7. Iodine value of oil / fat

SEMESTER - IV

Course - 1: Quality in Analytical Chemistry II (CC)

Course Code: CHEA551 (45 Lectures of Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	Student should be able to understand the theory and application of , solvent extraction, microfiltration, ultrafiltration, reverse osmosis, dialysis and electro-dialysis.
CO2	To evaluate physical, chemical, spectral and toxicological standardization, qualitative and quantitative estimations.
CO3	To study analytical techniques in nanotechnology, consequences of the nanoscale , (nanoparticles morphology, electronic structure, optical properties)

Unit - I	**Separation Science**	15 Lectures
1.1 Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis. (8L) 1.2 Applications of Solvent extraction in Analytical Chemistry-recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical determination (7L)		
Unit -II	**Separation, Analysis and Standardization of Herbal based products.**	12 Lectures
2.1 Herbs as a raw material: Definition of herb, herbal medicine, herbal Medicinal products, herbal drug preparation. Sources of herbs. Selection, identification and authentication of herbal materials, drying and processing of herbal raw materials, drying and processing of herbal raw material. (6L) 2.2Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction.(3L) 2.3Standardization 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)		
Unit -III	**Advanced Techniques**	12 Lectures
4.1Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) (2L) 4.2Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis and miceller electro kinetic capillary chromatography, instrumentation, detection and applications. (8L) 4.3Introduction 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)		

References:

1.	Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
2.	Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
3.	Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978

4.	Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963
5.	Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
6.	How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
7.	Chromatographic and electrophoresis techniques, I Smith MenemannInterscience 1960

Course - 2: Advanced Instrumental Techniques II (CC)
Course Code: CHE552 (45 Lectures Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To understand the theory, Instrumentation and application of NMR and Raman spectroscopy.
CO2	To study theory, instrumentation and applications of Neutron Activation Analysis, Thermal Analysis, Evolved gas analysis
CO3	To explain theory, Instrumentation and application of Hyphenated techniques- GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS, HPLC-MS, CE-MS

Unit – 1	**Spectroscopic Methods**	15 Lectures
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 Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy (6L)		
Unit – 2	**Radiochemical And Thermal Methods**	15 Lectures

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 – 3	**Hyphenated Techniques**	15 Lectures
4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2 L) 4.2 Interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)		

References:

1.	Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986)
2.	Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J Holler Holt- Saunders 6thEdition (1998)
3.	Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A.
4.	Thermal methods of Analysis, P. J. Haines, Blackie Academic & Professional, London (1995)
5.	Thermal Analysis, 3rdEdition W. W. Wendlandt, John Wiley, N.Y. (1986)
6.	Nuclear Analytical Chemistry, D. Bane, B. Forkman, B. Persson, Chartwell - Bratt Ltd (1984)
7.	Principles and Practices of X-ray spectrometric Analysis, 2 Ed E. P. Bertain, Plenum Press,NY, (1975)
8.	A Complete Introduction to Modern NMR Spectroscopy 1st Edition by Roger S. Macomber
9.	Spectrometric Identification of Organic Compounds Hardcover – by Robert M.Silverstein Wiley
10.	Tandem Techniques (Separation Science Series) 1st Edition by Raymond P. W. Scott John Wiley & Sons Ltd, 1997

Course - 3: Waste Management and Material Analysis. (CC)
Course Code: CHEA453 (45 Lectures Theory and 30 Hrs Practicals, 6 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To discuss various methods of treatment of waste water, permissible limits and removal of heavy metals from waste water.
CO2	To understand the solid waste management process.
CO3	To explain classification, impurities and impact of plastic on environment.
CO4	To analyse geochemical materials and alloys- Dolomite, Ilmenite, Monazite, Hematite, Pyrolusite, Stainless Bronze and Gun metal, Solder alloy

Unit – 1:	**Effluent Treatment**	**15 Lectures**
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 – 2	**Solid Waste Management**	**15 Lectures**
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 (5)		

Unit – 3	**Plastics and Polymers**	**15 Lectures**
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 – 4	**Geochemical & alloy Analysis**	**15 Lectures**
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)		

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.	Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
4.	Solid waste management, K Sasikumar and SanoopGopi Krishna PHI publication (2009)
5.	Handbook of chemical technology and pollution control 3rdEdn Martin Hocking AP Publication (2005).
6.	Solid waste management, SurendrakumarNorthen Book Center (2009)

7.	Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology & Engineering
8.	Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
9.	Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology & Engineering(1960).

Course – 4A: QMS and AUDIT (DSE)
Course Code: CHE554A (45 Lectures Theory and 30 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To understand the Quality management systems and the iso 9000 series of standards registration, certification and auditor competence.
CO2	To evaluate the audit process.
CO3	To apply Conducting the on-site audit

Unit 1:	**QUALITY MANAGEMENT SYSTEMS AND THE ISO 9000 SERIES OF STANDARDS**	**15 Lectures**
The need for and benefits of a QMS • The ISO 9000 series of standards • ISO 9001:2015 fundamentals and vocabulary • Compatibility with other Standards • Legal compliance – ISO Standards • The process approach • The seven quality management principles **PROCESS-BASED QUALITY MANAGEMENT SYSTEMS** • The application of PDCA Cycle • Quality system documented information • Electronic data systems • Control of documents and records • Monitoring and measurement • Infrastructure • Work environment • Product realisation • Monitoring and measurement • Continual improvement.		
Unit 2:	**The Audit Process**	**15 Lectures**

AUDITS: DEFINITION, PRINCIPLES AND TYPES

• Audit definition • Principles of auditing • Types of audits • Certification process • Planning the audit • Audit roles and responsibilities • Good practice at meetings

PREPARING FOR THE ON-SITE AUDIT

• Initial contact with the auditee • Stage 1 audit • Document review • The audit plan • Work documents. DEVELOPING A CHECKLIST

• The audit checklist • Process review • The "Turtle Diagram"

CONDUCTING THE ON-SITE AUDIT

Collecting and verifying information • Opening meeting • Roles and responsibilities of guides • Conducting the audit • Questioning techniques • Controlling the audit • Communication with the audit client and auditee

AUDIT REVIEW

• Audit review meeting • Audit findings • Finding statements • Corrective Action Requests (CARs) • Classification of CARs • Opportunities for improvement

AUDIT REPORTING AND FOLLOW-UP

• Presenting the findings • Reporting on the audit • Audit completion • Corrective action • Management review • Follow-up and close out

References:

1.	ISO Guide 51:1999, Safety aspects — Guidelines for their inclusion in standards
2.	Quantifying uncertainty in measurement, Eurachem, Laboratory of the Government Chemist, UK, 1995.
3.	ISO Guide 34:2000, General requirements for the competence of reference material producers

Course – 4B: IPR and Chemoinformatics (DSE)

Course Code: CHE554B (30 Lectures Theory and 60 Hrs Practicals, 4 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO1	To understand the Introduction to Intellectual Property
CO2	To understand the trade Secrets of Cheminformatics

Unit 1:	**Introduction to Intellectual Property**	**15 Lectures**

Introduction to Intellectual Property: Historical Perspective, Different types of IP, Importance of protecting IP.
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.
Industrial Designs: Definition, how to obtain, features, International design registration
Copyrights: Introduction, how to obtain, Differences from Patents
Trade Marks Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc
Geographical Indications Definition, rules for registration, prevention of illegal exploitation, importance to India.

Unit 2:	**Chemoinformatics**	**15 Lectures**

Introduction to Cheminformatics: History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. 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. Searching Chemical Structures Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization. WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity.

References:

1.	Andrew R. Leach & Valerie J. Gillet (2007) *An Introduction to Cheminformatics.* Springer: The Netherlands.
2.	Gasteiger, J. & Engel, T. (2003) *Cheminformatics: A textbook*. Wiley–VCH Gupta, S. P. *QSAR and Molecular Modeling.* Springer-Anamaya Pub.: New Delhi.

Course - 5: Research Projects (CC)
Course Code: CHE555 (180 Hrs, 6 credits)

Course Outcomes (COs): After completion of this course, students should be able to …

CO 1	**Research Skills Development:** to formulate research questions, conduct literature reviews, design appropriate methodologies, collect and analyze data, and draw conclusions based on evidence.
CO 2	**Critical Thinking:** to develop critical thinking skills by questioning assumptions, analyzing evidence, and synthesizing information to form their own conclusions.
CO 3	**Communication Skills:** to develop effective communication skills, including the ability to articulate ideas clearly, structure arguments logically, and present information in a compelling manner.
CO 4	**Problem-Solving Abilities**: to learn to identify problems, develop strategies for addressing them, and adapt their approach as needed, involve encountering obstacles and challenges that require creative problem-solving skills.

Semester IV (Practical course)

CHEAP551

1. Determination of pK value of H_3PO_4potentimetrically
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
6. Analysis of benzoic acid salicylic acid from medicated powder
7. To study the complex formation between Fe(III) and salicylic acid and determined the stability constant of the complex by Job's variations method
8. Analysis of drugs by non-aqueous titration: Glycine , Sodium Benzoate
9. Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity
10. Determination of the purity of crystal violet
11. Estimation of Ca in Ca-pantothenate/calcium lactate tablets
12. Estimation of wastewater sample for heavy metals (any two elements) by AAS
13. To analyse Magnelium of Mg titrimeterically

14. Estimation of Fe in different materials using the titrimetric method

CHEAP554

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
6. Analysis of water sample: Cr^{+6} by colorimetric method.
7. Analysis of Ni/ Cr from Chrome Steel sample
8. Analysis of Bauxite for Ti by colorimetric method/ Al by gravimetric method/ Fe by volumetric method.