Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science, Commerce, Baramati

(Autonomous)

DEPARTMENT OF CHEMISTRY

(Faculty of Science and Technology)

Two Year M.Sc. Degree Program Chemistry

M.Sc. II Analytical Chemistry

(2022 Pattern)

Choice Based Credit System Structure and Syllabus

(To be implemented from June 2022)

PSCHA-231
Analytical Method Development & Validation, Nanotechnology
(48 L+ 12 T) (4 Credit)

Course Objectives :

1. Acquire a comprehensive understanding of assay validation, inter-laboratory transfer, and the essential principles of analytical method development.
2. Develop statistical competency in error identification, precision, accuracy, and the application of statistical measures in analytical techniques.
3. Familiarize students with worldwide regulations governing analytical methods and their implications in a global context.
4. Attain proficiency in conducting dissolution studies, including the use of USP type-I and II apparatus, calibration, and adherence to regulatory guidelines.
5. Gain a thorough understanding of the structure, bonding, and production methods of carbon-based nanomaterials, including nanotubes and nanodiamond.
6. Apply knowledge of carbon-based nanomaterials to real-world applications, such as catalysis, energy storage, water purification, and biomedical technologies.
7. Master the use of advanced tools, including X-ray diffraction, Scanning Electron Microscopy, and Atomic Force Microscopy, for nanostructure identification in nanotechnology.

Course Outcomes (COs):

CO1. Students will demonstrate an understanding of assay validation, inter-laboratory transfer, and the ability to develop a comprehensive method validation report.
CO2. Students will be proficient in identifying and categorizing errors, applying validation parameters, and interpreting statistical measures in analytical processes.
CO3. Students will have an awareness and understanding of worldwide regulations governing analytical methods and their implications on a global scale.
CO4. Students will demonstrate expertise in conducting dissolution studies, using USP type-I and II apparatus, and ensuring adherence to regulatory guidelines.
CO5. Students will possess in-depth knowledge of the structure, bonding, and production methods of carbon-based nanomaterials, including nanotubes and nanodiamond.
CO6. Students will be able to apply knowledge of carbon-based nanomaterials to practical applications in catalysis, energy storage, water purification, and biomedical technologies.
CO7. Students will demonstrate proficiency in identifying nanostructures using advanced tools such as X-ray diffraction, Scanning Electron Microscopy, and Atomic Force Microscopy.

SECTION- I
Analytical Method Development & Validation
(24 L+ 06 T) (2 Credit)

1. Assay Validation and Inter Laboratory Transfer (4 L)

Introduction, fundamental definitions, Essential principles of method transfer, method validation report, the inter-laboratory qualification (ILQ) process.

2. **Statistical Analysis and analytical Figure of Merit (14 L)**
Introduction, Errors (gross errors, systematic errors, random errors), accuracy, how to reduce systematic errors Validation parameters: Accuracy, precision, mean and standard deviation, calibration, (Linear response functions (linear regression-errors in slope and the intercept, error in the estimate of concentration, standard additions), non-linear response functions and Weighted regression analysis, internal standards), selectivity and specificity (Chromatographic methods), limit of detections (spectrophotometric methods, Chromatographic methods and related techniques, receptor binding assay), limit of Quantification, sensitivity, ruggedness and robustness, analyte stability in the sample matrix, mean and standard deviation, reliability of results, confidence interval, comparison of results, comparison of two means of two sample.

3. **Overview of World Wide Regulation (2 L)**

4. **Specific methods and Applications: Dissolution Studies (4 L)**
Introduction, Dissolution test, Apparatus – USP type –I and II, Sampling and analytical instrumentation, Single point test Vs. Dissolution profile, Calibration, regulatory guidelines, analytical validation, linearity, accuracy, precision, specificity.

SECTION II
Nanotechnology
(24 L+ 06 T) (2 Credit)

1. **Forms of Carbon: (4 L)**
Structure and bonding in Graphite, Diamond like Carbon (DLC) and other allotropes of carbon, carbon nanotubes and structure of C60**.**

2. **Production of Carbon based nanomaterial: (6 L)**
Production of carbon nanotubes (Single walled and multi walled), arc discharge method, Laser ablation, Chemical vapour deposition, Pyrolatic technique, purification and separation of carbon nanotubes, diamond synthesis routes, preparation of nanodiamond**.**

3. **Applications of carbon-based nanomaterial: (6 L)**
Catalysis applications of nanoforms of carbon, supercapacitor, battery applications, water purification, solar cell applications, sensor and FET, Biological applications.

4. **The basic tools of nanotechnology (6 L)**
Nanostructure identification by using X-ray diffraction methods (XRD), Scanning Electron Microscope (SEM), Scanning Probe Microscope (SPM), Scanning Transmission Electron Microscopy (STEM), Atomic Force Microscopy (AFM)

5. **Biomedical applications (6 L)**
Introduction, biological science, photodynamic therapy in targeted drugs, biomedical sensorand biosensor, quantum dot technology in cancer treatment, nanoparticles as drug carrier

References:

1. Development and validation of Analytical Methods, Progress Pharmaceutical and Biomedical Analysis, Vol-3, Edited by Chitofer M. Riley and Tomas W. Rosanske (Elvier)
2. Vogel's Textbook of quantitative Chemical Analysis, sixth Ed., Mendham, Denney, Barnes, Thomas, Pub: Pearson Education.
3. Handbook of modern pharmaceutical analysis, edited by SatinderAhuja and Stephen Scypinski, Academic Press, Separation science Series, Vol-3
4. HPLC method Development for pharmaceuticals, Edited by SatinderAhuja and Henrik Rasmussen, Academic Press, Separation science Series, Vol-8
5. Practical HPLC method Development, Snyder, Kirkiand, Glajch, Wiley India Pvt. Ltd.
6. Introduction to nanotechnology , C.P. Poole, Jr. & F.J. Owens, John Wiley & sons (2009)
7. Nano biotechnology, Subbiah Balagi, MJP publishers, India (2010)
8. The Chemistry of nanomaterials Volume,1 C.N.Rao, A Muller & A.K.Cheetham,
9. Nano, the essentials, T.Pradeep, Tata McGraw Hill new Delhi,2007
10. Nanostructures & nanomaterial's -Synthesis-properties and applications, G. Cao, Imperical college press, London 2004.

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Analytical Method Development & Validation, Nanotechnology
Course Code: PSCH 231
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	0	0	2	0	0	0	0	2
CO 2	0	3	0	0	0	0	0	0	2
CO 3	0	0	3	0	0	0	0	0	2
CO 4	2	0	0	3	0	0	0	0	2
CO 5	0	0	0	0	3	3	0	0	0
CO 6	0	0	0	0	3	3	0	0	0
CO 7	0	0	0	0	0	0	3	0	0

Justification of mapping

PO1: Disciplinary Knowledge
CO1: Students will demonstrate an understanding of assay validation, inter-laboratory transfer, and the ability to develop a comprehensive method validation report.
CO4: Students will demonstrate expertise in conducting dissolution studies, using USP type-I and II apparatus, and ensuring adherence to regulatory guidelines
PO2: Critical Thinking and Problem Solving
CO2: Students will be proficient in identifying and categorizing errors, applying validation parameters, and interpreting statistical measures in analytical processes.
PO3: Social competence
CO3: Students will have an awareness and understanding of worldwide regulations governing analytical methods and their implications on a global scale.
PO4: Research-related skills and Scientific temper
CO1: Students will demonstrate an understanding of assay validation, inter-laboratory transfer, and the ability to develop a comprehensive method validation report.
CO4: Students will demonstrate expertise in conducting dissolution studies, using USP type-I and II apparatus, and ensuring adherence to regulatory guidelines
PO5: Trans-disciplinary knowledge
CO5: Students will possess in-depth knowledge of the structure, bonding, and production methods of carbon-based nanomaterials, including nanotubes and nanodiamond.
CO6: Students will be able to apply knowledge of carbon-based nanomaterials to practical applications in catalysis, energy storage, water purification, and biomedical technologies.
PO6: Personal and professional competence
CO6: Students will be able to apply knowledge of carbon-based nanomaterials to practical applications in catalysis, energy storage, water purification, and biomedical technologies.
PO7: Effective Citizenship and Ethics
CO7: Students will demonstrate proficiency in identifying nanostructures using advanced tools such as X-ray diffraction, Scanning Electron Microscopy, and Atomic Force Microscopy.
PO9: Self-directed and Life-long learning
CO1: Students will demonstrate an understanding of assay validation, inter-laboratory transfer, and the ability to develop a comprehensive method validation report.
CO2: Students will be proficient in identifying and categorizing errors, applying validation

parameters, and interpreting statistical measures in analytical processes.
CO3: Students will have an awareness and understanding of worldwide regulations governing analytical methods and their implications on a global scale.
CO4: Students will demonstrate expertise in conducting dissolution studies, using USP type-I and II apparatus, and ensuring adherence to regulatory guidelines.

PSCHA 232
Electrochemical Methods and Food Analysis
(48 L+ 12 T) (4 Credit)

Course Objectives:

1. Grasp the current-voltage relationship during electrolysis, Faraday's laws, and instrumentation in coulometric methods
2. Master polarographic principles, instrumentation, and applications, including linear scan polarography, hydrodynamic voltammetry, pulse polarography, and cyclic voltammetry.
3. Acquire knowledge of amperometry principles, instrumentation, and applications, including amperometry titrations and chrono-amperometry.
4. Understand the definition, classification, and functions of carbohydrates, and Analyse them using various methods such as volumetric determination, colorimetric analysis, and estimation of starch.
5. Learn protein definitions, Analyse proteins using Kjedahl's and Lowry methods, estimate amino acids, and perform polyacrylamide gel electrophoresis.
6. Master the estimation of oil in oilseeds, determination of saponification value, iodine value, acid value, peroxide value, and identification and quantification of fatty acids in lipids.
7. Understand the legislation and determination of food preservatives, including SO2, nitrate, nitrites, boric acid, benzoic acid, 4-hydroxybenzoate, and saccharine. Analyse milk and milk products for composition and potential adulteration.

Course Outcomes (COs):

CO1. Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.
CO2. Apply polarographic principles, instrumentation, and techniques such as linear scan polarography, hydrodynamic voltammetry, pulse polarography, and cyclic voltammetry for various applications.
CO3. Exhibit proficiency in amperometry principles, instrumentation, and applications, including amperometry titrations and chrono-amperometry.
CO4. Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.
CO5. Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.
CO6. Demonstrate proficiency in estimating oil in oilseeds, determining saponification value, iodine value, acid value, peroxide value, and identifying fatty acids in lipids.
CO7. Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

SECTION I
Electrochemical Methods of Analysis
(24 L+ 06 T) (2 Credit)

1. Coulometry **(6 L)**

Current voltage relationship during an electrolysis, Operating cell an at fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis, Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiostatic coulometry-Instrumentation and applications, coulometric titrations (Amperostatic coulometry)-Apparatus and

applications, advantages and limitations, problems.

2. Voltammetry and polarographic methods of analysis (14 L)

A) Polarography (linear scan polarography):
Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppressors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis – analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys., problems.

B) Hydrodynamic Voltametry and its applications:
Volatametric detectors in chromatography, flow injection analysis, Volatametric oxygen sensors, amperometric titration).

C) Pulse Polarography:
Different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography, Stripping method. Voltametry Withultra microelectrode, Applications of these technique Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography, Determination of Pb in tap water by stripping method.

D) Cyclic Voltametry:
Principle of cyclic Voltammetry, cyclic voltamogram of $K_3[Fe(CN)_6]$ and parathion, criteria of reversibility of electrochemical reactions, quasireversible and irreversible processes.

3. Amperometry: (4 L)
Principle, Instrumentation, typical applications, amperometric titrations, chrono-amperometry and chrono-potentiometry.

SECTION II
Food analysis
(24L+ 06 T) (2 Credit)

1. Carbohydrates: (5 L)
Definition, classification, and functions, Analysis of carbohydrates from food sample by different method
i) volumetric determination by Fehling's solution, ii) Colorimetric analysis of carbohydrates by Folin Wu method, Nelson Somyogi method, iii) total carbohydrates by Anthrone method, iv) Estimation of starch by anthrone method, v) Determination of amylase, vi) Estimation of pectic substances (gravimetric and colorimetric method), vii) Estimation of crude fibers

2. Proteins: (5 L)

Definitions and functions, Analysis of proteins by Kjedahl's method, analysis of protein by Lowry method, Estimation of amino acids by colorimetric method, Estimation of food grain for methionine content, Protein digestibility in vitro, Protein efficiency and net protein ratio, Determination of net protein utilization, digestibility and biological value, Polyacrylamide gel electrophoresis of proteins**.**

3. **Analysis of Lipids (4 L)**
   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**.**

4. **Determination of food preservatives: (6 L)**
   Definition, SO_2 legislation and determination by Tanners method, Nitrate and nitrites legislation and determination, boric acid legislation and determination, Benzoic acid legislation and determination, 4-hydroxybenzoate legislation and determination, ascorbic acid legislation and determination. Sweeteners: Saccharine identification and determination, Colors: Identification by general methods, Natural colors.

5. **Milk (2 L)**
   Analysis of milk and milk products: Composition of milk, analysis of milk with respect to pH, acidity, fates, casein content, lactose content, mineral content, adulteration of milk.

References:

1. Biochemical Methods, S Sadashivan, A.Manickam; New Age Publication, 3rd Edn
2. Introduction to instrumental analysis, R. D. Broun, Mc Graw Hill (1987)
3. Instrumental methods of chemical analysis, H. willard, L.Merrit, J.A. Dean and F.A.Settle. Sixth edition CBS (1986)
4. Fundamentals of analytical chemistry, D. A. Skoog, D. M. West and H. J. Holler sixth edition (1992)
5. Principles of Instrumental Analysis, Skoog, West, Niemann.
6. Vogel Text Book of quantitative analysis 6th Ed.
7. J. chemical education, 60,302 to 308 (1983)
8. Cyclic Voltammetry and frontiers of electrochemistry, N.Noel and K.I. Vasu IBH, New Delhi (1990)

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Electrochemical Methods & Food analysis **Course Code:** PSCH 232
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	0	2	2	2	0	0	3
CO 2	2	3	0	1	0	0	0	0	2
CO 3	0	0	3	0	0	0	2	0	0
CO 4	2	2	0	3	2	2	0	0	2
CO 5	2	2	0	2	3	1	0	0	2
CO 6	2	1	0	2	1	3	0	0	2
CO 7	1	1	3	1	0	0	3	0	1

Justification of mapping

PO1: Disciplinary Knowledge
CO1: Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.
C02: Apply polarographic principles, instrumentation, and techniques such as linear scan polarography, hydrodynamic voltammetry, pulse polarography, and cyclic voltammetry for various applications.
CO4: Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.
CO5: Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.
CO6: Demonstrate proficiency in estimating oil in oilseeds, determining saponification value, iodine value, acid value, peroxide value, and identifying fatty acids in lipids.
CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.
PO2: Critical Thinking and Problem Solving
CO1: Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.
CO2: Apply polarographic principles, instrumentation, and techniques such as linear scan polarography, hydrodynamic voltammetry, pulse polarography, and cyclic voltammetry for various applications.
CO3: Exhibit proficiency in amperometry principles, instrumentation, and applications, including amperometry titrations and chrono-amperometry.
CO4: Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.
CO5: Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.
CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

PO3: Social competence

CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

PO4: Research-related skills and Scientific temper

CO1: Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.

CO4: Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.

CO5: Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.

CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

PO5: Trans-disciplinary knowledge

Potential alignment with CO1, CO4, CO5, CO6

CO1: Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.

CO4: Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.

CO5: Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.

CO6: Demonstrate proficiency in estimating oil in oilseeds, determining saponification value, iodine value, acid value, peroxide value, and identifying fatty acids in lipids.

PO6: Personal and professional competence

CO6: Demonstrate proficiency in estimating oil in oilseeds, determining saponification value, iodine value, acid value, peroxide value, and identifying fatty acids in lipids.

CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

PO7: Effective Citizenship and Ethics

CO3: Exhibit proficiency in amperometry principles, instrumentation, and applications, including amperometry titrations and chrono-amperometry

CO7: Apply knowledge of food preservatives legislation and determination methods, and Analyse milk and milk products for composition, pH, acidity, and potential adulteration.

PO9: Self-directed and Life-long learning

CO1: Demonstrate an understanding of the current-voltage relationship, Faraday's laws, and mastery in coulometric methods and instrumentation.

CO2: Apply polarographic principles, instrumentation, and techniques such as linear scan polarography, hydrodynamic voltammetry, pulse polarography, and cyclic voltammetry for various applications.

CO4: Apply knowledge of carbohydrates to conduct analyses using volumetric determination, colorimetric methods, and estimation of starch.

CO5: Apply protein analysis techniques, including Kjedahl's and Lowry methods, amino acid estimation, and polyacrylamide gel electrophoresis.

CO6: Demonstrate proficiency in estimating oil in oilseeds, determining saponification value, iodine value, acid value, peroxide value, and identifying fatty acids in lipids.

PSCHA 233
Pharmaceutical Analysis
(48 L+ 12 T) (4 Credit)

Course Objectives:

1. Develop proficiency in handling laboratory apparatus for pharmaceutical tests and assays, with a focus on proper cleaning of glassware.
2. Understand the definitions of drugs and cosmetics, substandard drugs, and the role of the FDA in pharmaceutical industries, particularly in the development and approval of new drugs.
3. Acquire skills in conducting biological assays, including tests for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
4. Develop proficiency in microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.
5. Master physical tests and determinations, such as disintegration and dissolution tests, moisture content determination, limit tests for various substances, and various methods of sterilization.
6. Learn the techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
7. Develop skills in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

Course Outcomes (COs):

CO1. Demonstrate mastery in using laboratory apparatus and glassware for pharmaceutical tests and assays, ensuring proper cleaning protocols.
CO2. Understand the role of the FDA in pharmaceutical industries, particularly in the development, selection of areas, and application phases for new drugs.
CO3. Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
CO4. Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.
CO5. Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6. Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7. Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

SECTION I
Tests, Assay and Roll of FDA
(24 L+ 06 T) (2 Credit)

1. **A) Apparatus for test and assay, cleaning of glassware (6 L)**
   B) Role of FDA in Pharmaceutical Industries:
   Definitions of Drug & Cosmetics, Substandard Drugs, Role of FDA, Introduction to New Drug, Development of New Drugs- Selection of Area, Phase I, Phase II, Phase III Applications to FDA for formulation and marketing of new drug. Stability studies and Shelf life fixation.

2. **Biological Tests & Assay: (5 L)**
   Introduction to biological assay, Biological assay of Heparin sodium, Determination of Amylase activity, Determination of Photolytic Activity, Test for Insulin in solution, Biological Assay of Tetanus Antitoxin, Test for Undue Toxicity.

3. **Microbiological Tests and Assays: (7 L)**
   Microbiological test for Antibiotics. Standard preparation and units of activity, Test organisms and Inoculums, Cylinder-plate assay receptacles, Turbidimetric assay receptacles, Assay Designs, Cylinder plate or Cup-plate method, Two level fractional assay, Test for Sterility.

4. **Physical Test, Determinations, Limit tests and Sterilization: (6 L)**
   A) Disintegration Test for Tablets and Capsules, B) Dissolution Test for Tablets and Capsules, C) moisture / water content by Karl-Fischer titration, limit tests for arsenic, heavy metals, iron, lead, sulphate, chloride, D) Ash, sulphated ash, E) Methods for Sterilization Steam Sterilization, Dry heat sterilization, Sterilization by Filtration, Gas Sterilization, Sterilization by Ionizing radiation, Sterilization by heating with Bactericides, Water for Pharmaceutical use.

SECTION II
Analysis and quality control
(24 L+ 06 T) (2 Credit)

1. **Analysis of vegetable Drugs (4 L)**
   Vegetable drugs: Sampling, foreign organic matter, ash value, acid soluble ash, acid insoluble ash, sulphated ash, Extraction of alkaloids.

2. **Sources of Impurities in Pharmaceutical raw materials & finished products, Shelf life of pharmaceutical product:**
   Raw materials, Method of manufacture, Atmospheric contaminations, Cross contamination, Microbial contamination, Container contamination, Packaging errors, Chemical instability, Temperature effect and Physical changes, shelf life of pharmaceutical product and determination of shelf life.

3. **Standardization and quality control of different raw materials and dosage form: (16 L)**

Analysis of raw materials with respect to identification, other or related substances, loss on drying, and Assay as per IP, i) adrenaline, ii) Niacin amide iii) Cephalexin, iv) ferrous fumarate, v) isoniazid and vi) paracetamol. Problems based on assay of these materials. Brief introduction to different dosage forms with the IP requirements Analytical methods for the following- Tablets, different types of tablets, uniformity in weight (aspirin) additives used in tablet manufacture, capsules, types of capsules, (Rifampicin) Powders (Sodium benzoate), Solutions (saline NaCl) Suspensions (barium sulphate –limit test for impurity) Mouthwashes, (Ointments (salicylic acid) and creams Dimethicone by IR) Injections (Mannitol), ophthalmic preparations (sulphacteamine), Aerosols (salbutamol), BProblems based on assay of these materials.

References:

1) Indian Pharmacopeia, Volume I and II.
2) Practical Pharmaceutical chemistry, A.H.Beckett & J.B.Stenlake, third edition, volume 1.
3) Remington‘s Pharmaceutical sciences.
4) Ansel’s Pharmaceutical Analysis

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Pharmaceutical Analysis **Course Code:** PSCHA 233
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	0	0	0	0	0	2	0	2
CO 2	0	3	0	2	0	0	3	0	2
CO 3	2	2	3	0	0	0	3	0	2
CO 4	2	2	2	3	0	0	3	0	2
CO 5	2	1	0	0	3	1	3	2	2
CO 6	2	0	1	0	2	3	2	0	2
CO 7	2	2	2	3	1	2	3	1	2

Justification of mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate mastery in using laboratory apparatus and glassware for pharmaceutical tests and assays, ensuring proper cleaning protocols.

CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.

CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.

CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.

CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.

CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO2: Critical Thinking and Problem Solving

CO2: Understand the role of the FDA in pharmaceutical industries, particularly in the development, selection of areas, and application phases for new drugs.

CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.

CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.

CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.

CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO3: Social competence

CO1: Demonstrate mastery in using laboratory apparatus and glassware for pharmaceutical tests and assays, ensuring proper cleaning protocols.

CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.

CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO4: Research-related skills and Scientific temper

CO2: Understand the role of the FDA in pharmaceutical industries, particularly in the development, selection of areas, and application phases for new drugs.
CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.
CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO5: Trans-disciplinary knowledge

CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.
CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO6: Personal and professional competence

CO1: Demonstrate mastery in using laboratory apparatus and glassware for pharmaceutical tests and assays, ensuring proper cleaning protocols.
CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO7: Effective Citizenship and Ethics

CO2: Understand the role of the FDA in pharmaceutical industries, particularly in the development, selection of areas, and application phases for new drugs.
CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.

CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO8: Environment and Sustainability

CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PO9: Self-directed and Life-long learning

CO1: Demonstrate mastery in using laboratory apparatus and glassware for pharmaceutical tests and assays, ensuring proper cleaning protocols.
CO2: Understand the role of the FDA in pharmaceutical industries, particularly in the development, selection of areas, and application phases for new drugs.
CO3: Demonstrate proficiency in conducting various biological assays, including those for heparin sodium, amylase activity, photolytic activity, insulin, tetanus antitoxin, and undue toxicity.
CO4: Exhibit skills in conducting microbiological tests for antibiotics, including standard preparation, assay designs, and tests for sterility.
CO5: Demonstrate proficiency in physical tests, determinations, and sterilization techniques, ensuring compliance with industry standards.
CO6: Apply techniques for sampling and analyzing vegetable drugs, including assessments of foreign organic matter, ash values, and alkaloid extraction.
CO7: Demonstrate mastery in the standardization and quality control of raw materials and dosage forms, including the analysis of raw materials for identification, related substances, loss on drying, and assay.

PSCHA 234
Characterization Techniques
(48 L+ 12 T) (4 Credit)

Course Objectives:

1. Understand the principles of Electron Spectroscopy for Chemical Analysis (ESCA) and its applications.
2. Acquire knowledge of X-ray methods, including absorption, fluorescence, and diffraction, for chemical analysis.
3. Explore surface characterization techniques using various microscopes, including X-ray and electron microscopy.
4. Grasp the laws of photochemistry and principles of chemiluminescence, including measurement and applications.
5. Understand the principles of fluorescence and phosphorescence, their apparatus, and applications in analysis.
6. Comprehend the principles of supramolecular chemistry and its applications, especially in photosystems.
7. Acquire proficiency in NMR spectroscopy, including 1H and 13C nuclei, for qualitative and quantitative analysis.

Course Outcomes (COs):

CO1. Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2. Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3. Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4. Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5. Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6. Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7. Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

SECTION I
Spectroscopic techniques
(24L+ 06 T) (2 Credit)

1. **Electron spectroscopy: (6 L)**
Introduction, principle of electron spectroscopy for chemical analysis (ESCA). Satellite peaks, spectral splitting, chemical shifts in FSCA. Apparatus used for ESCA, X-ray source, samples, Analysers, Detectors, Chemical analysis using ESCA, Applications, Auger electron microscopy and Ultraviolet photoelectron spectroscopy.

2. **X- ray Methods of Analysis (10 L)**
Principle, Theory- X-ray spectral lines, X-ray tube, X-ray emission, Absorptive Apparatus: Sources, Collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, readout device, Chemical analysis using X-ray

absorption, X-ray Fluorescence- instrumentation and chemical analysis, X-ray Diffraction, Chemical analysis with X-ray diffraction, numerical problems.

3. **An Introduction to Microscopy (surface characterization techniques) (8 L)**
Limitations of the Human Eye, the X-ray Microscope, the Transmission Electron Microscope, the Scanning Electron Microscope, Scanning Transmission Electron Microscope, Analytical Electron Microscopy, Scanning-Probe Microscopes, the transmission electron microscope**.**

SECTION II
Luminescence and NMR Study
(24L+ 06 T) (2 Credit)

1. **Photochemistry (2L)**
Introduction, Laws of Photochemistry, interaction of radiation with matter, Theory of Photoluminescence, Jablonski diagram

2. **Chemiluminescence (6 L)**
Introduction, principle, types. Measurement of chemiluminescence, Instrumentation, quantitative chemiluminescence, Gas phase Chemiluminescence analysis, Chemiluminescent titrations, electro-chemiluminescence.

3. **Fluorescence and phosphorescence (4L)**
Introduction, Fluorescence, electron transitions during photoluminescence, factors affecting photoluminescence, luminescent apparatus, optical excitative sources, wavelength selectors, detectors ad readout devices, photo luminescentspectra, photo luminescent analysis, analysis of non-photoluminating compounds, specific examples of analysis using photoluminescence, problems

4. **Supramolecular Chemistry (4L)**
Practical applications, Host-Guest supramolecular photochemistry, Supramolecular chemistry in photosystems: photosynthesis, water oxidation

5. **Nuclear magnetic resonance spectroscopy (12 L)**
1H-NMR: Introduction, theory, Instrumentation, Chemical shifts, spin-spin splitting, protons on heteroatom's, coupling protons with other nuclei, solvents, qualitative and quantitative analysis, problems.
13C NMR: Introduction, interpretation 13C NMR spectra, Chemical shifts, Spin coupling, quantitative analysis, problems.
NMR: introduction, 1H - 1H connectivity, 1H - 13C connectivity, 13C - 13C connectivity, Through space 1H - 1H proximity, option and how to use them, problems.

References:

1. Introduction to instrumental analysis, R.D. Braun, MC. Graw Hill-Interl. edn.
2. Analytical spectroscopy, Kamlesh Bansal- First edition.
3. Instrumental methods of chemical analysis, Willard, Dean and Merittee- Sixth edition.
4. Analytical chemistry principles, John H Kenedey- 2nd edn, Saunders college publ.
5. Spectroscopic identification of organic compounds Silverstrine, Bassler, Morrill, 5th edn. John Wiley and sons.

6. Analytical chemistry, Ed by kellner. Mermet, otto, Valcarcel, Widmer, Second Ed., Wiley- VCH.
7. Vogel's Textbook of quantitative Chemical Analysis,., Mendham, Denney, Barnes, Thomas, Sixth Ed ,Pub: Pearson Education.
8. Electron microscopy in the study of material, P.J Grundy and G.A.Jones, Edward Arnold.

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Characterization Techniques **Course Code:** PSCHA 234

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	2	3	3	3	3	0	3
CO 2	3	3	2	3	3	3	3	0	3
CO 3	3	3	3	2	2	2	3	0	3
CO 4	3	3	2	3	3	3	3	0	3
CO 5	3	3	2	3	3	3	3	0	3
CO 6	3	3	2	3	3	3	3	0	3
CO 7	3	3	2	3	3	3	3	0	3

Justification of Mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO2: Critical Thinking and Problem Solving

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO3: Social competence

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of

chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO4: Research-related skills and Scientific temper

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO5: Trans-disciplinary knowledge

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO6: Personal and professional competence

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.
CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.
CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.
CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.
CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.
CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.
CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and

quantitative analysis in both 1H and 13C nuclei.

PO7: Effective Citizenship and Ethics

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.

CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.

CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.

CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.

CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.

CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.

CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

PO9: Self-directed and Life-long learning

CO1: Demonstrate proficiency in understanding ESCA principles, apparatus usage, and applications in chemical analysis.

CO2: Demonstrate mastery in understanding X-ray spectral lines, emission, absorption, and applying X-ray methods for chemical analysis.

CO3; Exhibit expertise in microscopy techniques, recognizing limitations of the human eye, and understanding various types of microscopes for surface characterization.

CO4: Apply knowledge of photochemistry laws, Jablonski diagram, and principles of chemiluminescence in practical analytical contexts.

CO5: Apply knowledge of fluorescence and phosphorescence principles in practical applications, including photoluminescent analysis.

CO6: Apply knowledge of supramolecular chemistry principles in practical applications, especially in host-guest interactions and photosystems.

CO7: Demonstrate proficiency in using NMR spectroscopy techniques for qualitative and quantitative analysis in both 1H and 13C nuclei.

Practical Course- I
PSCHA 235
Analysis of Materials (4 Credit)

Course Objectives:

1. Develop proficiency in analyzing ilmenite ore using appropriate analytical techniques.
2. Acquire skills in the analysis of dolomite ore for calcium, magnesium, and silicate material.
3. Master the techniques for analyzing bronze with a focus on copper and tin content.
4. Learn analytical methods for determining nickel and chromium in nichrome alloy.
5. Gain expertise in determining nitrogen, phosphorous, and potassium levels in fertilizer samples.
6. Develop skills in determining iron content in detergent samples.
7. Master techniques for the accurate determination of organic carbon in soil samples.

Course Outcomes (COs):

CO1. Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2. Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3. Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4. Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
CO5. Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6. Provide reliable and accurate determinations of iron content in detergent samples.
CO7. Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

1. Analysis of ilmenite ore
2. Analysis of Dolomite ore for Ca, Mg and silicate material
3. Analysis of Bronze with respect to copper and tin
4. Analysis of nichrome alloy with respect to nickel and chromium
5. Determination of nitrogen, phosphorous and potassium from fertilizer
6. Determination of iron detergent sample
7. Determination of organic carbon from soil sample
8. Determination of COD from waste water sample
9. Determination of magnesium from talcum powder
10. Determination of calcium from plaster of paris
11. Determination of total cation concentration in waste water sample by cation exchange resin
12. To determine phosphoric acid in cold drink by molybdenum blue method
13. Analysis of Zn- chrome pigment for zinc and chromium.
14. Quantitative analysis using cyclic voltammetry of anyone – Vit.C / nitrobenzene/ any other substance for which your department has develope cyclic Quetta method

(Note: Minimum 12 experiments should be completed in this course.)
Report on industrial visit or study tour.

References:

1. Lab manual: selected experiments of Pharmaceutical analysis, Anees A Siddiqui.
2. Experiments in chemistry, D.V.Jahagirdar.
3. Pharmacopeia of India
4. Vogel's textbook of quantitative chemical analysis, sixth Ed.
5. Environmental chemistry by A.K.De.
6. Biochemical methods, Sadashivam and Manickem, Narosa publication
7. Quantitative inorganic analysis: Elementary Instrul. Analysis A. Vogel, 3rd ed. ELBS

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Analysis of Materials **Course Code:** PSCHA 235

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO 1	3	3	2	3	3	3	3	0	3
CO 2	3	3	0	2	3	0	0	0	0
CO 3	3	3	2	3	0	0	3	0	2
CO 4	3	3	0	3	0	0	0	0	0
CO 5	3	3	2	0	3	0	3	0	2
CO 6	3	3	0	0	0	3	0	0	0
CO 7	3	3	2	0	0	0	3	0	2

Justification of Mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO2: Critical Thinking and Problem Solving

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO3: Social competence

Potential alignment with CO1, CO3, CO5, CO7
CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.

CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO4: Research-related skills and Scientific temper

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO5: Trans-disciplinary knowledge

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO6: Personal and professional competence

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO7: Effective Citizenship and Ethics

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

PO9: Self-directed and Life-long learning

CO1: Demonstrate proficiency in analyzing ilmenite ore, producing accurate and reliable results.

CO2: Successfully determine the composition of dolomite ore, specifically focusing on calcium, magnesium, and silicate material.
CO3: Accurately analyze bronze, providing precise measurements of copper and tin content.
CO4: Determine the composition of nichrome alloy accurately, focusing on nickel and chromium content.
C05: Effectively analyze fertilizer samples, determining nitrogen, phosphorous, and potassium concentrations.
CO6: Provide reliable and accurate determinations of iron content in detergent samples.
CO7: Accurately determine the organic carbon content in soil samples, reflecting a strong understanding of the analysis techniques.

Practical Course II
PSCHA 236
Instrumental Analysis (4 Credit)

Course Objectives :

1. Develop proficiency in determining the amount of each p-nitrophenol from a given sample using spectrophotometric titration.
2. Master the determination of the strength of phosphoric acid through potentiometric titration using a standard solution of sodium hydroxide.
3. Acquire skills in determining sodium (Na) and potassium (K) concentrations in a water sample using flame photometry, employing the binary/internal standard method.
4. Learn the method of determining boric acid concentration using conductometry.
5. Understand and apply the conductivity measurement method to determine the relative strength of acetic acid, chloroacetic acid, and trichloroacetic acid through measuring their Ka values.
6. Develop proficiency in determining the amount of copper and bismuth or copper and iron (III) from a given mixture using spectrophotometric titration with standard EDTA solution.
7. Master the pH metric titration technique for anthranilic acid and glycine with NaOH.

Course Outcomes (COs):

CO1. Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2. Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3. Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4. Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5. Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6. Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7. Master the technique of pH metric titration for anthranilic acid and glycine.

1. To determine amount of each p-nitrophenol from the given sample by spectrophotometric titration.
2. Determination of strength of phosphoric acid by potentiometric titration using standard solution of sodium hydroxide.
3. Determination of Na and K from water sample by flame photometry binary method/ internal standard method.
4. Determination of boric acid by conductomtery.
5. Determination of relative strength of acetic acid, chloro acetic acid and trichloro acetic acid through measuring their Ka value by conductivity measurement method.
6. Determination of amount each copper and bismuth or copper and iron (III) from given mixture by spectrophotometric titration using standard EDTA solution.
7. P^H metric titration of anthranilic acid and glycine with NaOH.

8. Analysis of alcohol from wine by GC.
9. Analysis of paracetamol/caffeine/metformin hydrochloride by HPLC
10. Determination of sulphate and chloride and turbidimteric method
11. Determination of Ranitidine content in tablet.
12. Cyclic voltammetric study of Fe(II)/Fe(III) system basic principles and calculation of basic parameters from CV

(Note: Minimum 16 experiments should be completed in this course)

References:

1. Lab manual: selected experiments of Pharmaceutical analysis, Anees A Siddiqui.
2. Experiments in chemistry, D.V.Jahagirdar.
3. Pharmacopeia of India
4. Vogel's textbook of quantitative chemical analysis, sixth Ed.
5. Environmental chemistry by A.K.De.
6. Biochemical methods, Sadashivam and Manickem, Narosa publication
7. Senior practical physical chemistry. B.D. Khosla and V.S. Garge (R.Chand and Co).
8. Analytical chemistry by Gary Christian, 6^{th} edition, 2008

Choice Based Credit System Syllabus
(2022 Pattern)

Class: M.Sc. II (SEM. III) **Subject:** Analytical Chemistry
Course: Instrumental Analysis Course Code: PSCH-236
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	2	0	3	2	3	0	0	2
CO2	3	3	0	3	2	3	0	0	2
CO3	3	2	3	0	0	0	0	0	0
CO4	3	0	0	3	2	3	0	0	0
CO5	3	2	0	0	3	2	0	0	2
CO6	3	2	0	3	2	3	0	0	0
CO7	3	3	0	0	0	0	3	0	0

Justification of Mapping

PO1: Disciplinary Knowledge

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO2: Critical Thinking and Problem Solving

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO3: Social competence

Potential alignment with CO1, CO3, CO7
CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO4: Research-related skills and Scientific temper

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.

CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO5: Trans-disciplinary knowledge

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO6: Personal and professional competence

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO7: Effective Citizenship and Ethics

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.
CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.
CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.
CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.
CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.
CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.
CO7: Master the technique of pH metric titration for anthranilic acid and glycine.

PO9: Self-directed and Life-long learning

CO1: Demonstrate proficiency in determining p-nitrophenol concentrations using spectrophotometric titration.

CO2: Demonstrate mastery in determining the strength of phosphoric acid through potentiometric titration.

CO3: Exhibit competence in determining Na and K concentrations in water samples using flame photometry.

CO4: Demonstrate proficiency in determining boric acid concentrations using conductometry.

CO5: Apply skills to measure the Ka values of acetic acid derivatives using conductivity measurements.

CO6: Demonstrate competence in determining copper and bismuth or copper and iron (III) concentrations in mixtures using spectrophotometric titration.

CO7: Master the technique of pH metric titration for anthranilic acid and glycine.