SNDT Women's University, Mumbai

Master of Science in Analytical Chemistry

as per NEP – 2020

Syllabus

(2023-24)

JV Gade
23/02/2024
BOS - Chairperson

Programme Template:

Programme Degree e.g. M.A./M.Com./M.Sc./ M.M.S., etc.		Faculty of Science and Technology M.Sc. Analytical Chemistry
Parenthesis if any (Specialization) e.g. History, Human Development, English, etc.		Analytical Chemistry
Preamble (Brief Introduction to the programme)		To provide access to the field of higher education for women. * To provide Job oriented course to meet the socio-economic demands. * To arrange internship program to provide opportunities for experiential learning. * To enable students for research in emerging areas of study. * To achieve excellence in the academic disciplines, research and extension activities through emphasis on & out qualify in every activity". * To train and develop scientist and technologist for industries and academics.
Programme Specific Outcomes (POs)		After completing this programme, Learner will
	1.	To develop an understanding of the range and uses of analytical methods in chemistry.
	2.	To establish an appreciation of the role of chemistry in quantitative analysis
	3.	To develop an understanding of the broad role of the chemist in measurement and problem solving for analytical tasks.
	4.	To provide an understanding of chemical methods employed for elemental and compound analysis.
	5.	To provide experience in some scientific methods employed in analytical chemistry.
	6.	To develop some understanding of the professional and safety responsibilities residing in working on chemical analysis
	7.	
Eligibility Criteria for Programme		To develop some understanding of the professional and safety responsibilities residing in working on chemical analysis

Intake (For SNDT WU Departments and Conducted Colleges)		50

Structure with course title

Year I

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester I						
115211	Analytical Chemistry Paper I	Major (Core)	4	100	50	50
115212	Food & Biochemical Analysis	Major (Core)	4	100	50	50
115223	Practical Analytical Chemistry	Major (Core)	4	100	50	50
115224	Practical Food and Biochemical Analysis	Major (Core)	2	50	50	0
125211	Drug Laws and Packaging	Major (Elective)	4	100	50	50
135211	Research Methodology	Minor Stream (Core)	4	100	50	50
			22	**550**	**300**	**250**
Semester II						
215211	Analytical Chemistry Paper II	Major (Core)	4	100	50	50
215212	Cosmetics Formulations & Quality Control	Major (Core)	4	100	50	50
215213	Environmental Science	Major (Core)	4	100	50	50
215224	Practical Analytical Chemistry Paper II	Major (Core)	2	50	0	50
225211	Pharmaceutical Analysis	Major (Elective)	4	100	50	50
245221	Practical Pharmaceutical Analysis	OJT	4	100	50	50
			22	**550**	**250**	**300**

Year II

SN	Courses	Type of Course	Credits	Marks	Int	Ext
Semester III						
315211	Analytical chemistry - III	Major (Core)	4	100	50	50
315212	Organic Analysis	Major (Core)	4	100	50	50
315213	Practical Analytical Chemistry	Major (Core)	4	100	50	50
315224	Practical Organic Analysis	Major (Core)	2	50	0	50
325211	Microbiological Methods of Analysis	Major (Elective)	4	100	50	50
355221	Research Project Part – I	RP	4	100	50	50
			22	**550**	**250**	**300**
Semester IV						
415211	Analytical Chemistry - IV	Major (Core)	4	100	50	50
415222	Practical Advanced Anal. Techniques	Major (Core)	4	100	50	50
415223	In-plant training	Major (Core)	4	100	50	50
425211	Advance Environmental Science	Major (Elective)	4	100	50	50
455231	Research Project Part - II	RP	6	150	100	50
			22	**550**	**300**	**250**

Semester I

1.1 Major (Core)

Course Title	**Analytical Chemistry I (115211)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able
	1. **Analyze** the Fundamentals concept of analytical chemistry
	2. **Apply**, how to Prepare different standard solution Theoretically
	3. **Assess** to develop the knowledge of theoretical concepts of volumetric techniques.
	4. **Evaluate** and develop expertise in use of statistical aids to compile, tabulate, and present analytical data.
Module 1(Credit 1) - FUNDAMENTALS OF ANALYTICAL CHEMISTRY	
Learning Outcomes	After learning the module, learners will be able to, 1. **Assess** and understand chemometrics of analytical chemistry. 2. **Analyze** practical and theoretical buffer concepts. 3. **Evaluate** the types of equilibrium in analytical chemistry
Content Outline	● **Concepts of Analytical Chemistry: -** a)Principle and Theory of Electro analytical Techniques, Advantages, Disadvantages and Applications. b)Scope and function of Electro Analytical Technique. ● **Chemometrics**: - a)Data Analysis, Conclusion of a Solution, Percentage by mass, Percentage by Volumetric Mole fraction, Molarity, Normality, Formality. b)Theoretical and practical buffers concepts of formation constant calculation of ppb, ppm and dilution of the solution, Stability and instability constant. Calibration of instruments. ● **Chemical Equilibrium:** a)Theoretical and practical buffers concepts of formation constant calculation of ppb, ppm and dilution of the solution, Stability and instability constant. Calibration of instruments. ● **Chemical Equilibrium:** **a)** Types of equilibrium in Analytical Chemistry: - Homogeneous method of Analysis Condition, Factors, affecting chemical equilibrium. Heterogeneous method of Analysis Condition, Factors affecting chemical equilibrium. b) Classification of Electrolytes: - Acids and Bases: - Strength of Acids and Bases. c) Types Of equilibrium constant in Analytical Chemistry.

<table>
<tr><td colspan="2">Module 2(Credit 1) – VOLUMETRIC METHODS OF ANALYSIS</td></tr>
<tr><td>Learning Outcomes</td><td>After learning the module, learners will be able</td></tr>
<tr><td></td><td>1. Analyze the Qualitative and Quantitative analysis.

2. Evaluate and understand types of titrations.

3. Apply conventional methods of Quantitation.</td></tr>
<tr><td>Content Outline</td><td>1. Qualitative and quantitative method of Analysis: -

A) Interaction to volumetric method of Analysis:-

a) Detection of Analyte by volumetric titration.
b) Principles of Neutralization titration.

B) Quantitative Analysis

a) Gravimetric, Titration, Advantages, Disadvantages of Gravimetric titration, Precipitation Titration, Basic Titration method. Titration in aqueous and non aqueous solvents. Complexometric Titration.
b) Conventional method of Quantitation.
c) Construct sigmoidal and linear segment titration curves.</td></tr>
<tr><td colspan="2">Module 3(Credit 1) – CONCEPTS OF CHROMATOGRAPHIC METHODS</td></tr>
<tr><td>Learning Outcomes</td><td>After learning the module, learners will be able</td></tr>
<tr><td></td><td>1. Assess the extraction methods of analysis.

2. Evaluate the concepts of Chromatographic methods.</td></tr>
<tr><td>Content Outline</td><td>1. Extraction and Chromatographic Methods of Analysis:-
A. Extraction Method

i) Extraction Equilibrium of cation and anion Exchange resins.
ii) Principle and Instrumentation of super critical fluid Extraction. Advantages, Disadvantages and Applications of Supercritical fluid Extraction.
iii) Selection of Parameters influencing extraction including role of dilutants aggregation, third phase formation and counter ION.

2. Chromatographic Methods

i) Principle and Classification of Chromatographic technique.
ii) Technique and application of HPLC and HPTLC.
iii) Size Exclusion Chromatography: - Theory, Type of Packaging, Molecular Mass determination, Purification large Biomolecules</td></tr>
</table>

Module 4(Credit 1) – DATA DOMAIN ANALYSIS AND HYPOTHETICAL TESTING	
Learning Outcomes	After learning the module, learners will be able to
	1. **Analyze** the types of error in analytical chemistry. 2. **Apply** and understand hypothetical and statistics testing. 3. **Assess** data domain analysis.
Content Outline	1. **Data Domain Analysis.** **1. Types of Errors :-** a) Instrumental &Non Instrumental Errors. b) Measurement & Personal Errors, Method c) Errors, Propagation Errors d) Accuracy, Precession, Confidence limit. 2. **Statistics and Hypothetical testing** a) Chi- Test, F- Test , Q- Test, T-Test, Least Square Method. b) Correlation Coefficient Mean and Standard deviation. c) Normal distribution curve, significant figure.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Fundamental of Analytical Chemistry
Project Idea: Analyzing the concepts of Analytical Chemistry

- **Description:** Principle and Theory of Electro analytical Techniques, Advantages, Disadvantages and Applications. Scope and function of Electro Analytical Technique
- **Assessment:** Data Analysis, Conclusion of a Solution, Percentage by mass, Percentage by Volumetric Mole fraction, Molarity, Normality, Formality.

Module 2: Volumetric Methods of Analysis
Project Idea: Evaluating Qualitative and Quantitative methods of Analysis

- **Description:** Gravimetric, Titration, Advantages, Disadvantages of Gravimetric titration, Precipitation Titration, Basic Titration method. Titration in aqueous and Non aqueous solvents. Complexometric Titration
- **Assessment:** Assess Conventional method of Quantitation and Detection of Analyte by volumetric titration.

Module 3: Concepts of Chromatographic Methods.
Project Idea: Analyzing extraction and chromatographic analysis.

- **Description:** Principle and Classification of Chromatographic technique and Principle and Instrumentation of Extraction. Advantages, Disadvantages and Applications of Extraction.
- **Assessment:** Evaluate experimental setup, Selection of Parameters influencing extraction including role of dilutants aggregation, third phase formation and counter ION.

Module 4: Data Domain Analysis
Project Idea: Analyzing Types of Errors and Statistics and Hypothetical testing

- **Description:** Instrumental & No Instrumental Errors, Measurement & Personal Errors, Method, Errors, Propagation Errors, Accuracy, Precession, Confidence limit.

- **Assessment:** Assess experimental design, accuracy of spectral interpretation, clarity of case study presentation, and adherence to safety measures.

References:

1. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2011). *Fundamentals of analytical chemistry*. Cengage Learning, Wiley-VCH Weinheim.
2. Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2009). *Vogel's quantitative chemical analysis* (6th ed.). Pearson Education, ELBS.
3. Fifield, F. W., & Kealey, D. (2000). *Principle & practice of analytical chemistry* (5th ed.). Blackwell Science.
4. Christian, G. D., Dasgupta, P., & Schug, K. (2013). *Analytical chemistry* (7th ed.). John Wiley.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2006). *Principles of instrumental analysis* (6th ed.). Cengage Learning.
6. Ahuja, S., & Jespersen, N. (2006). *Modern instrumental analysis* (1st ed.). Elsevier Science.
7. Harris, D. C. (2005). *Exploring chemical analysis* (3rd ed.). W.H. Freeman.

1.2 Major (Core)

Course Title	**Food and Biochemical analysis (115212)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able
	1) **Analyze** the regulation and legislation related to food safety and officers
	2) **Assess** able to compare quality parameters of various food products.
	3) **Analyze** and perform methods of biochemical analysis.
	4) **Evaluate** the Types, Nutritional value and adulteration test for food products
Module 1(Credit 1) – FOOD LAWS AND REGULATION	
Learning Outcomes	After learning the module, learners will be able 1. **Analyze** and understand food safety standards rules and regulations. 2. **Assess** food additives and food preservatives. 3. **Evaluate** the quality control measures.
Content Outline	A) 1.1 Food laws Regulations and Legislation 1.2 Food Safety and Standards Act 2006 and regulations 2011. 1.3 Function of regulatory enforcement (Roles and responsibilities of officers B) 1:1 Food Additives & Preservatives 1:2 Ideal Characteristics and types of Food Preservatives. 1:3 Free radicals (antioxidants), Emulsifiers and stabilizers, Anti Caking and Bleaching agents, Flavoring agents. C) 1:1 Quality control and standardization of food products in Industry 1:2 Quality control measures, Basic tools of QC. 1: 3 Production cycle of food in industry
Module 2(Credit 1) - FOOD QUALITY PARAMETERS AND COLOR	
	After learning the module, learners will be able to

Learning Outcomes	1. **Analyze** contamination in food. 2. **Assess** and gain knowledge for parameters in food analysis. 3. **Evaluate** food colour with chemical structure.
Content Outline	FOOD QUALITY PARAMETERS AND COLOR A. 1:1 Specifications of food quality Contamination in food (physical, chemical, biological) 1: 2 Prevention methods for contamination B . Test for parameters Determination of Moisture, Ash value, Saponification value, Acid value,Iodine value, Peroxide value in food C Coloring agents in food 1:1 History of food color and types 1:2 Classification of food colors with chemical structures, permitted natural color and extraction methods. 1:3 Health effects of synthetic and natural color
Module 3(Credit 1) - BIOCHEMICAL ANALYSIS	
Learning Outcomes	After learning the module, learners will be able to, 1. **Assess** the preparation and procedures for test analysis. 2. **Apply** the electrolytes sputum test in body. 3. **Evaluate** the body profile test and there test limits.
Content Outline	BIOCHEMICAL ANALYSIS A. 1.1 Preparation and procedure for test , Analysis of blood sample, 1.2 Serum plasma, urinalysis evaluation test. B. 1:1 Detection of Blood sugar and methods for record blood sugar. 1:2 Balance of Electrolytes in body, methods for Sputum test. 1:3 Body profile test for Liver,kidney and thyroid gland Functions, structure and test limit

Module 4(Credit 1) - FOOD ADULTERATION	
Learning Outcomes	After learning the module, learners will be able
	Analyze and gain knowledge of types, nutrition values and adulteration **Evaluate** the tests for dairy products, caffeinated products, bake products, herbivores products and carnivorous products.
Content Outline	FOOD ADULTERATION TEST Types , Nutritional value and adulteration test for Dairy products:- Butter, cheese, Milk, ice cream • caffeinated products :- Tea , coffee and soft drinks • baked products :- wheat flour, bread, biscuits, confectionery. Herbivorous:- Fruit, vegetables, cereals and pulses, honey Carnivorous:- Eggs, fish, meat .

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Food Laws, Regulations, and Food Additives
Project Idea: Food Safety Compliance Analysis
Description:
Students will choose a local food establishment and conduct a comprehensive analysis of its compliance with the Food Safety and Standards Act 2006 and regulations 2011. They will also investigate the use of food additives and preservatives in the establishment's products.
Assessment:
- Written report (50%): Detailed analysis of compliance and additive use
- Presentation (30%): Oral presentation of findings to the class
- Peer evaluation (20%): Feedback from classmates on the presentation

Module 2: Quality Control in Food Industry
Project Idea: Quality Control Plan Development
Description:
Students will develop a quality control plan for a hypothetical food product of their choice. The plan should include quality control measures, basic QC tools, and a description of the production cycle in the food industry.
Assessment:
- QC Plan document (60%): Comprehensive plan including all required elements
- Feasibility analysis (25%): Discussion of the plan's practicality and potential challenges
- Reflection paper (15%): Personal insights on the process of developing the QC plan

Module 3: Food Quality Parameters and Color
Project Idea: Food Color Investigation
Description:
Students will research the history, types, and health effects of food colors. They will then conduct experiments to extract natural food colors and compare them with synthetic alternatives.
Assessment:
- Research paper (40%): Comprehensive overview of food colors
- Laboratory report (40%): Documentation of extraction experiments and comparisons
- Infographic (20%): Visual representation of findings for public education

Module 4: Biochemical Analysis and Food Adulteration
Project Idea: Food Adulteration Detection
Description:
Students will design and conduct experiments to detect common adulterants in various food products such as dairy, baked goods, and beverages. They will also research the potential health impacts of these adulterants.
Assessment:
- Experimental design (30%): Proposal outlining planned detection methods
- Laboratory work (40%): Practical execution of experiments and data collection
- Final report (30%): Analysis of results, discussion of health impacts, and suggestions for consumer awareness

References -

1. Latimer, G. (2012). *Official methods of analysis of AOAC International* (19th ed.). AOAC International.
2. Nielson, S. (2010). *Food analysis*. Springer.
3. Pomeranz, Y., & Meloan, C. E. (Eds.). (2002). *Food analysis: Theory & practice*. Springer.
4. Sawyer, K. (1992). *Pearson composition & analysis of food* (9th ed.). Longman Scientific & Technical.
5. Wetzel, D. B., & Charalambous, G. (1998). *Instrumental methods in food and beverages analysis*. Elsevier Publication.
6. Jacob, M. B. (2006). *Chemical analysis of food and food products* (3rd ed.). CBSPB Publisher.
7. Nollet, L. M. (2004). *Handbook of food analysis* (2nd ed.). CRC Press.
8. Otles, S. (2008). *Handbook of food analysis instruments*. CRC Press.
9. Villavecchia, V. (2012). *Treatise on applied analytical chemistry: Methods and standards for the chemical analysis of industrial and food* (Vols. I & II). Nabu Press.
10. Pico, Y. (Ed.). (2012). *Chemical analysis of food: Techniques and applications*. Academic Press.
11. Otles, S. (2011). *Methods of analysis of food components and additives* (2nd ed.). CRC Press.

1.3 Major (Core)

Course Title	**Practical Analytical Chemistry (115223)**
Course Credits	4
Course Outcomes	After going through the module, learners will be able to**,** **Assess** Gain hands-on experience with various titration and analytical instruments (potentiometer). Learn to set up, calibrate, and operate different analytical instruments. Understand the principles behind each analytical technique. **Discuss** analytical results with the structural features and chemical properties of molecules, essential for roles in quality assurance and research and development
Module 1 (Credit 2) - Analysis of trace metal by Spectrophotometry	
Learning Outcomes	After going through the module, learners will be able to, **Analyze** Learn to process raw experimental data and understand and apply statistical methods to evaluate data quality. **Assess** Identify sources of error in analytical measurements and learn to estimate and report uncertainty in measurements
Content Outline	1. To determine the percentage of acetic acid in vinegar. 2. Estimation of carbonate and hydroxide present together in mixture. 3. Estimation of carbonate and bicarbonate present together in a mixture. 4. Estimation of free alkali present in different soaps/detergents 5. Assay of washing soda. 6. Assay of copper sulfate. 7. Assay of commercial H2O2.
Module 2 (Credit 2) - Analysis of heavy metal by Using Instrumentation Method	
Learning Outcomes	After going through the module, learners will be able to, **Apply** Deepen understanding of chemical equilibria, particularly in complex formation and acid-base reactions and Apply knowledge of redox reactions in analytical contexts **Discuss** Deepen understanding of spectroscopic and electrochemical principles and their applications in chemical analysis
Content Outline	1. To determine the percentage of HgCl2 by complexometric titration. 2. Determination of AgNO3 it's standardization by Mohr's method and determination of bromide in KBr. 3. Determination of chloride by Mohr's method. 4. To determine the iron content of an Unknown sample by redox titration with standardized potassium permanganate Solution. 5. Standardization of KMnO4 with standard sodium oxalate and estimation of Fe(II) using standardized KMnO4 solution. 6. Estimation of percentage of oxalic acid and sodium oxalate in a given mixture. 7. Estimation of Fe(II) and Fe(III) in a mixture by standard K2Cr2O7

	solution.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)-

Module 1: Acid-Base Titration and Complexometric Titration
Project Idea: Quantitative Analysis of Common Substances
Description: Students will perform a series of titrations to analyze and quantify various substances found in everyday products and chemical samples. This project will cover both acid-base and complexometric titration techniques**.**

Activities:
1. Determine the percentage of acetic acid in vinegar.
2. Estimate carbonate and hydroxide present together in a mixture.
3. Estimate carbonate and bicarbonate present together in a mixture.
4. Estimate free alkali present in different soaps/detergents.
5. Assay of washing soda.
6. Assay of copper sulfate.
7. Assay of commercial H_2O_2.
8. Determine the percentage of $HgCl_2$ by complexometric titration.
9. Determine $AgNO_3$ by standardization using Mohr's method and determine bromide in KBr.
10. Determine chloride by Mohr's method.

Assessment:
- Accuracy of results (40%)
- Lab technique and safety practices (20%)
- Lab reports including calculations and error analysis (30%)
- Peer review and collaboration (10%)

Module 2: Redox Titration
Project Idea: Oxidation-Reduction Analysis
Description: Students will explore redox titration techniques to analyze various samples, focusing on standardization of solutions and determination of metal ion concentrations.

Activities:
1. Determine the iron content of an unknown sample by redox titration with standardized potassium permanganate solution.
2. Standardize $KMnO_4$ with standard sodium oxalate and estimate Fe(II) using standardized $KMnO_4$ solution.
3. Estimate the percentage of oxalic acid and sodium oxalate in a given mixture.
4. Estimate Fe(II) and Fe(III) in a mixture by standard $K_2Cr_2O_7$ solution.

Assessment:
- Accuracy and precision of titrations (40%)
- Proper standardization techniques (20%)
- Comprehensive lab reports with calculations and discussion of redox principles (30%)
- Troubleshooting and problem-solving skills (10%)

References-

1. Harris, D. C., & Lucy, C. A. (2020). Quantitative chemical analysis (10th ed.). W. H. Freeman.

2. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of analytical chemistry (9th ed.). Cengage Learning.

3. Harvey, D. (2016). Analytical chemistry 2.0. OpenStax CNX.

4. Rubinson, K. A., & Rubinson, J. F. (2000). Contemporary instrumental analysis. Prentice Hall.

5. Christian, G. D., Dasgupta, P. K., & Schug, K. A. (2013). Analytical chemistry (7th ed.). Wiley.

6. Kellner, R., Mermet, J. M., Otto, M., & Widmer, H. M. (Eds.). (2004). Analytical chemistry: A modern approach to analytical science (2nd ed.). Wiley-VCH.

7. Laitinen, H. A., & Harris, W. E. (1975). Chemical analysis: An advanced text and reference (2nd ed.). McGraw-Hill.

8. Wang, J. (2006). Analytical electrochemistry (3rd ed.). Wiley-VCH.

9. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2014). Introduction to spectroscopy (5th ed.). Cengage Learning.

10. Meier, P. C., &Zünd, R. E. (2000). Statistical methods in analytical chemistry (2nd ed.). Wiley.

1.4 Major (Core)

Course Title	**Practical Food and Biochemical Analysis (115224)**
Course Credits	**2**
Course Outcomes	After going through the course, learners will be able to**,** **Asses** and Develop skills in the identification of organic compounds based on their spectra, preparing for careers in analytical chemistry and pharmaceuticals. **Discuss** organic compounds based on functional group analysis, relevant to roles in quality control and chemical analysis laboratories.
Module 1 (Credit 1) -	
Learning Outcomes	After going through the module, learners will be able to, **Analyze** non-aqueous titrations using solvents other than water, essential for roles in organic compound analysis and pharmaceutical research. **Asses** advanced titration techniques such as potentiometric titrations for accurate endpoint detection, crucial for careers in analytical chemistry and chemical engineering
Content Outline	1.Detection and identification of Milk and Milk Products by A. Titration methods:- 1. 1.Complexometric titration, 2. Oxalate method 3. Protein and lactic acid B. Adulteration test :- viscosity,starch, salt, washing powder etc. 2. Estimation of glucose in honey sample by 1. Willstaters method 2. Cole's ferricyanide method 3. Lane Eynon method 3. Estimation of acetic acid in food samples a. Vinegar b. Tomato sauce 4. Estimation of Salt content in pickle by mohr's method 5. Estimation of oil/fat/butter and determine A. iodine value,
Module 2 (Credit 1) -	
Learning Outcomes	After going through the module, learners will be able to, **Apply** organic titrations to analyze the concentration of various functional groups in organic compounds (carboxylic acids, amines, esters, alcohols), preparing for careers in pharmaceuticals and chemical analysis. **Discuss** analytical results with the structural features and chemical properties of organic molecules, essential for roles in quality assurance and research and development

Content Outline	B. Acid value, C. Saponification value 6. Estimation of benzoic acid in carbonated beverages 7. Estimation of tannin in tea by titration method and by adulteration test. 8. Estimation of caffeine in coffee by titration method and by adulteration test. 9. Estimation of curcumin content in turmeric 10. Determination of Ash value in Ginger 11. Detection of added colour in tomato sauce 12. Estimation of total reducing sugar in jam by Cole's ferricyanide method Tea, Coffee, Honey, carbonated beverages,Jam, Squash, Edible Oil, Pickle, Sauce, Vinegar, milk and Milk products, tomato sauce, turmeric, ginger

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)-

Module 1: Analysis of Beverages, Sweeteners, and Spices

1. Analysis of Tea and Coffee

- Estimation of tannin in tea by titration method and adulteration test

- Estimation of caffeine in coffee by titration method and adulteration test

2. Analysis of Honey and Jam

- Estimation of glucose in honey sample by:

a. Willstaters method

b. Cole's ferricyanide method

c. Lane Eynon method

- Estimation of total reducing sugar in jam by Cole's ferricyanide method

3. Analysis of Carbonated Beverages

- Estimation of benzoic acid in carbonated **beverages**

4. Analysis of Spices

- Estimation of curcumin content in turmeric
- Determination of Ash value in Ginger

Module 2: Analysis of Condiments, Oils, and Dairy Products

1. Analysis of Sauces and Vinegar

- Estimation of acetic acid in food samples:

a. Vinegar

b. Tomato sauce

- Detection of added colour in tomato sauce

2. Analysis of Pickles

- Estimation of Salt content in pickle by Mohr's method

3. Analysis of Edible Oils and Fats

- Estimation of oil/fat/butter and determination of:

a. Iodine value

b. Acid value

c. Saponification value

4. Analysis of Milk and Milk Products

- Detection and identification of Milk and Milk Products by:
  a. Titration methods:
    - Complexometric titration
    - Oxalate method
    - Protein and lactic acid
  b. Adulteration tests:
    - Viscosity
    - Starch
    - Salt
    - Washing powder, etc.

Additional Titration Techniques (can be applied to various food samples)

1. Acid-Base Titration

- Determination of percentage of acetic acid in vinegar
- Estimation of carbonate and hydroxide present together in mixture
- Estimation of carbonate and bicarbonate present together in a mixture
- Estimation of free alkali present in different soaps/detergents
- Assay of washing soda
- Assay of copper sulfate
- Assay of commercial H2O2

2. Complexometric Titration

- Determination of percentage of HgCl2
- Determination of AgNO3, its standardization by Mohr's method, and determination of bromide in KBr
- Determination of chloride by Mohr's method

3. Redox Titration

- Determination of iron content in an unknown sample using standardized potassium permanganate solution
- Standardization of KMnO4 with standard sodium oxalate and estimation of Fe(II)
- Estimation of percentage of oxalic acid and sodium oxalate in a given mixture
- Estimation of Fe(II) and Fe(III) in a mixture by standard K2Cr2O7 solution

References-

1) Pavia, D. L., Kriz, J. S., Vyvyan, J. R. (2012). *Spectroscopy* (4th ed.). Cengage Learning India Pvt Ltd.
2) Sheldon, R. A., Arends, I., Hanefeld, U. (2007). *Green Chemistry & Catalyst*. Wiley-VCH Verlag GmbH & Co.
3) Clark, J. H., Macquarrie, D. J. (Eds.). (2008). *Handbook of Green Chemistry and Technology*. John Wiley & Sons.
4) Vogel, A. I. (2011). *Elementary Practical Organic Chemistry: Small Scale Preparations Part I*. Dorling Kindersley India Pvt. Ltd.
5) Smith, M. B. (Ed.). (2013). *March's Advanced Organic Chemistry* (7th ed.). John Wiley & Sons.
6) Kalsi, P. S. (2004). *Spectroscopy of Organic Compounds* (6th ed.). New Age International.
7) Lancaster, M. (2002). *Green Chemistry: An Introductory Text*. Royal Society of Chemistry.
8) Silverstein, R. M., Bassler, G. C. (1991). *Spectrometric Identification of Organic Compounds*. John Wiley & Sons.

9) Siggia, S., Hanna, J. G. (1979). *Quantitative Organic Analysis Via Functional Groups*. Wiley Interscience.
10) Gunther, H. (2013). *NMR Spectroscopy*. Wiley-VCH

1.5 Major (Elective)

Course Title	**Drug Laws & Packaging – 125211**
Course Credits	4
Course Outcomes	After going through the course, learners will be able
	1.**Analyze** the knowledge of basic regulation and legislation of drugs
	2.**Assess** standards of ISI, AGMARK, ISO, WHO
	3.**Discuss** the importance of products Certification
	4.**Discuss** the importance of GDP, GMP, GLP
Module 1(Credit 1) - Pharmaceutical Legislation and Regulation of Drugs	
Learning Outcomes	After learning the module, learners will be able
	Analyze the role of drug and cosmetic acts. **Assess** the importance of US FDA **Discuss** the role of government authorities.
Content Outline	A) Pharmaceutical legislation and Regulation of drugs: - • Drugs and cosmetics act 1940, Objective, administration of act and rules • Pharmaceutical act 1948, Objective, administration process, function of PCI. US-FDA function, structure of organization, approval process of drugs ICH and its guidelines EU Regulation, purpose of European Medicines Agency (EMA), committee of EMA and their role The role of Govt. Authorities, their qualification, duties, powers and procedure to be followed.
Module 2(Credit 1) Pharmacopoeias and Their Statutory Status	
Learning Outcomes	After learning the module, learners will be able to
	Analyze the statutory status of pharmacopoeia. **Discuss** the importance of European Pharmacopoeia.

Content Outline	A) Statutory status of pharmacopeia:- structure of pharmacopeia, Monograph, extra pharmacopeia (martindale), Penalties for drug law offenses B) Pharmacopeia-IP, Features of various Editions of Indian
	Pharmacopoeia, Ayurvedic pharmacopeia. C) EU-pharmacopeia, British Pharmacopoeia, national formulary, CODEX
Module 3(Credit 1) Food Safety and Quality Standards	
Learning Outcomes	After learning the module, learners will be able to
	Assess the knowledge of food safety and quality. **Analyze** the certification marks issued for different products. **Discuss** the ISO objective and standards
Content Outline	**Food safety and quality:- FSSAI-2006, function** Prevention of Food Adulteration Act, 954, Fruit Products Order(1955,) Meat Food Products Order1973, Vegetable Oil Products (Control) Order, 1947, Edible Oils Packaging (Regulation) Order 1988,Solvent Extracted Oil, De- Oiled Meal and Edible Flour (Control) Order, 1967, Milk and Milk Products Order, 1992 **Certification Marks issued For Different Products** AGMARK (Standardization & grading of Agriculture and allied produce) , Bureau of Indian Standards (BIS),ISI (Indian Standard for Industrial Products), eco mark Certification FPO mark(fruits Products Order) **ISO (International Organization of Standardization)** Objective, ISO standards
Module 4(Credit 1) Good Practices and Packaging	
Learning Outcomes	After learning the module, learners will be able to
	Analyze Good practices **Assess** the packaging **Discuss** and understand packing and labeling

Content Outline	A) Good Practices :-Philosophy of Good manufacturing Practices, Practices, current Good documentation practices (cGDP). Concept of good manufacturing practices (CGMP), Concept of good laboratory practices (CGLP). B) Packaging:- ideal packaging, different type of packaging, factors influence the packaging, packaging material, pharmaceutical packaging Testing C) Packaging and labeling:- Goods safety and standard (packaging and labeling) Regulation

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Pharmaceutical Legislation and Regulation of Drugs
Project Idea: Comparative Analysis of Drug Regulatory Bodies
Description: Students will conduct a comparative analysis of drug regulatory bodies from different regions (India, US, and EU). They will explore the structure, functions, and drug approval processes of these organizations.
Assessment:
- Research paper (40%): In-depth comparison of regulatory bodies
- Presentation (30%): Oral presentation of findings to the class
- Case study analysis (20%): Examining a specific drug approval across different regions
- Peer evaluation (10%): Feedback from classmates on the presentation

Module 2: Pharmacopoeias and Their Statutory Status
Project Idea: Pharmacopoeia Monograph Development
Description: Students will create a mock monograph for a hypothetical drug, following the structure and requirements of different pharmacopoeias (IP, BP, EU-pharmacopoeia).
Assessment:
- Monograph document (50%): Comprehensive monograph including all required elements
- Comparative analysis (30%): Discussion of differences in monograph requirements across pharmacopoeias
- Presentation (20%): Brief presentation explaining the monograph and its development process

Module 3: Food Safety and Quality Standards
Project Idea: Food Safety Compliance Plan
Description: Students will develop a compliance plan for a hypothetical food product, addressing various food safety acts and certification requirements in India.
Assessment:
- Compliance plan (40%): Detailed plan addressing all relevant acts and certifications
- Risk assessment (30%): Identification and analysis of potential food safety risks
- Certification process flowchart (20%): Visual representation of steps to obtain relevant certifications
- Reflection paper (10%): Personal insights on the importance of food safety regulations

Module 4: Good Practices and Packaging
Project Idea: GMP Implementation and Packaging Design
Description: Students will create a GMP implementation plan for a pharmaceutical manufacturing facility and design appropriate packaging for a specific drug product.
Assessment:

- GMP implementation plan (40%): Detailed plan covering all aspects of GMP
- Packaging design project (30%): Design and justification of packaging for a specific drug
- SOP development (20%): Creation of Standard Operating Procedures for key GMP areas
- Labeling compliance check (10%): Ensuring the designed packaging meets labeling regulations

References:

1. *NIIR Project Consultancy Services*. (2010). *Handbook on modern packaging industries* (2nd ed.). Asia Pacific Business Press Inc.
2. Baur, E. (2009). *Pharmaceutical packaging handbook*. Taylor and Francis.
3. Robertson, G. L. (2012). *Food packaging: Principle & practice* (3rd ed.). CRC Press.
4. Mehta. *Handbook of drug laws*. University Book Agency Allahabad.
5. Government of India. *Publications of food drug cosmetic acts and rules*.
6. Malik, V. (2013). *Laws relating to drugs and cosmetics* (23rd ed.). Eastern Book Company.
7. *Indian Pharmacopoeia, British Pharmacopoeia*.

1.5 Minor Stream (Core)

Course Title	**Research Methodology (135211)**
Course Credits	**4**
Course Outcomes	After going through the course, learners will be able
	1. **Analyze** the Standard chemical safety protocol, Literatures survey & review.
	2.**Assess** and presentation of data practically to chemically
	3. **Apply** equipped with the knowledge of chemical safety and disaster management to work in research field/industries.
Module 1(Credit 1) - Standard Chemical Safety Protocol	
Learning Outcomes	After learning the module, learners will be able
	Analyze and understand basic laboratory techniques. **Assess** knowledge On literature survey and review. **Apply** an investigative approach.
Content Outline	**Standard chemical safety protocol** Basic laboratory technique :- fundamental laboratory protocol I and II, handling various chemicals, preparation various concentration of solutions. pH and buffer solutions. Literature survey &review:- (collection of data primary, Secondary, tertiary) , Scientific abstracts, Purposes of the Abstract, Characteristics of the Abstract. Formula index. The investigative approach: Making and recording measurements, SI units (International System of Units) and their use, Scientific method and design of experiments, Project work.

Module 2(Credit 1) - Access and Presentation of Data	
Learning Outcomes	After learning the module, learners will be able
	Analyze the knowledge of data analysis. **Apply** presentation of data. **Discuss** and understand e-library resources for information technology.
Content Outline	**Access and presentation of data** Data Analysis:- variables and their types, Accuracy and Precision Scientific Notation, Significance in Measurement , Using graphs, Presenting data in tables, Hints for solving numerical problems, Descriptive statistics, Choosing and using statistical tests, drawing chemical structures, Chemo metrics, Computational chemistry. E- library resources fir information technology:- e-book, e- journals, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-Databases, ChemSpider, Science Direct, SciFinder, Scopus.
Module 3(Credit 1) - Standard Chemical Safety Procedures	
Learning Outcomes	After learning the module, learners will be able **Analyze** the standard chemical safety procedures. **Assess** safety practices for disposal of waste material. **Discuss** learn spill response.
Content Outline	Standard Chemical safety procedure:- General safety and operational rules, Personal protective equipment's and types , emergency equipment, Material Safety Data Sheet (MSDS), Compressed gas safety. Safety practices for disposal of broken glassware, Chemicals, Centrifuge safety, Treated biomedical wastes and scientific ethics. Spill response:- Chemical spills, Radiation spills, Biohazard spills, Fires, Medical emergency, Accident reporting.
Module 4(Credit 1) - Waste Management and Disaster Awareness	
	After learning the module, learners will be able

Learning Outcomes	**Analyze** acts and rules for waste management. **Assess** the knowledge of nuclear disaster.
Content Outline	The Indian Atomic Energy Act, 1948, The Hazardous and Other Waste (Management and Trans boundary Movement) Rules, 2016, The Bio-Medical Waste Management Rules, 2016, Nuclear Disasters: 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011. Chemical Disaster:- Bhopal Gas Disaster,

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Standard Chemical Safety Protocol
Project Idea: Laboratory Safety Manual Development
Description: Students will create a comprehensive laboratory safety manual incorporating fundamental laboratory protocols, chemical handling procedures, and solution preparation guidelines.
Assessment:
- Safety manual content (40%): Accuracy and completeness of safety protocols
- Literature review (30%): Incorporation of relevant scientific literature
- Practical demonstration (20%): Ability to implement safety procedures in a lab setting
- Peer review (10%): Feedback from classmates on the manual's usability

Module 2: Access and Presentation of Data
Project Idea: Data Analysis and Visualization Portfolio
Description: Students will collect a dataset related to chemical analysis, perform statistical tests, and create a portfolio of data visualizations using various graphing techniques and computational tools.
Assessment:
- Data analysis report (40%): Accuracy of statistical analyses and interpretations
- Visualization portfolio (30%): Quality and appropriateness of data visualizations
- E-resource utilization (20%): Demonstration of effective use of e-library resources
- Presentation (10%): Oral presentation of findings to the class

Module 3: Standard Chemical Safety Procedures
Project Idea: Chemical Spill Response Simulation
Description:
Students will participate in a simulated chemical spill scenario, demonstrating their knowledge of safety procedures, personal protective equipment usage, and proper spill response techniques.
Assessment:

- Practical performance (50%): Ability to respond correctly to the simulated spill
- Written report (30%): Detailed analysis of the response, including MSDS usage
- Team collaboration (10%): Effective teamwork during the simulation
- Reflection essay (10%): Personal insights on safety practices and areas for improvement

Module 4: Waste Management and Disaster Awareness
Project Idea: Case Study Analysis of Chemical/Nuclear Disasters
Description:
Students will conduct an in-depth analysis of a historical chemical or nuclear disaster, focusing on the causes, consequences, and subsequent changes in safety regulations and waste management practices.
Assessment:
- Research paper (40%): Comprehensive analysis of the chosen disaster
- Presentation (30%): Effective communication of findings to the class
- Policy proposal (20%): Suggested improvements to current safety regulations
- Peer discussion (10%): Active participation in class discussions on disaster prevention

References:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A. (2002). *Practical skills in chemistry*. Pearson Education Ltd. [Prentice Hall].
2. Kothari, C. R. (2013). *Research methodology: Methods and techniques*. New Age International.
3. Singh, K. (2012). *Tests, measurements and research methods in behavioral sciences*. Bharti Bhawan Publisher and Distributor.
4. Denscombe, M. (2007). *The good research guide*. McGraw-Hill International.
5. Kumar, R. (2011). *Research methodology* (3rd ed.). Sage Publication Ltd.
6. Taylor, J. C. (Ed.). (2013). *Advances in chemistry research* (Vol. 17). Nova Science Publishers Inc.
7. Oklahoma State University. (1999). *Laboratory safety manual*.
8. Le Compte, M. D., Millroy, W. L., &Preissle, J. (Eds.). *The handbook of qualitative research in education*. Academic Press Inc.
9. Szuprouiez, B. O. *Multimedia networking*. McGraw-Hill.
10. Hillway, T. (2005). *Introduction to research*. Houghton Wiffin Company.

Semester II

2.1 Major (Core)

Course Title	**Analytical chemistry Paper II (215211)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able
	1. **Analyze** the principle and working of different types of instruments used for analysis.
	2. **Apply** these techniques practically.
	3. **Assess** these techniques in research and analysis.
Module 1(Credit 1) - Spectroscopic methods of analysis.	
Learning Outcomes	After learning the module, learners will be able
	Analyze IR spectroscopy and method of analysis. **Assess** and understand process of AAS **Discuss** the derivatives and dual wavelength spectroscopy.
Content Outline	Spectroscopic methods of analysis. Infrared Spectroscopy. • Theory and principle of Infrared Spectroscopy. 1:2 Instrumentation of IR Spectroscopy. • Type of Vibration. • Advantages, Disadvantages and Applications of IR. 1:5 FTIR – Fourier Transform Infrared spectroscopy. Atomic Absorption Spectroscopy. • Theory and Instrumentation of AAS. 1:2 Process of Atomization. • Types of Source. • Type of Detectors. • Applications, Advantages and Disadvantages of AAS Derivatives and Dual Wavelength Spectroscopy. • Theory and instrumentation of Dual Wavelength Spectroscopy. • Application Advantage and Disadvantages of Dual Wavelength Spectroscopy. • Components of Dual Wavelength Spectroscopy.
Module 2(Credit 1) Emission Spectroscopic Methods.	

Learning Outcomes	After learning the module, learners will be able to
	Assess to understand atomic emission spectroscopy **Analyze** and gain knowledge of molecular emission spectroscopy. **Apply** and understand flame emission spectroscopy.
Content Outline	Emission Spectroscopic Methods. Atomic Emission Spectroscopy. • Instrumentation and Theory of AES. • Sources of Nonlinearity in AES. • Line – Width Effects in AES. • Application, Advantage and Disadvantages of AES. Molecular Emission Spectroscopy. • Theory and Instrumentation of MES. • Factors affecting Fluorescence and Phosphorescence. • Qualitative and Quantitative Applications. Chemiluminescence :- Introduction, Principle and types of Chemiluminescence. Flame Emission Spectroscopy. • Introduction and Theory of FES. • Principle and Instrumentation of FES. • Types of Burner and Types of Detector in FES. • Advantages and Disadvantages of FES.
Module 3(Credit 1) - Potentiometric Methods of Analysis :-	
Learning Outcomes	After learning the module, learners will be able, **Analyze** the potentiometry method of analysis. **Assess** the different types of potentiometric titration

Content Outline	**Potentiometric Methods of Analysis :-** • Theory and Instrumentation of Potentiometric methods of analysis. • Components of Potentiometric Cell. • Types of Potentiometric Titration. • Nernst Equation of Potentiometry
Module 4(Credit 1) - Polarography, Stripping Voltammetry, and Coulometry	
Learning Outcomes	After learning the module, learners will be able Analyze and understand polarography. Assess stripping and voltammetry. Assess the coulometry
Content Outline	**Polarography**. • Importance and Development of Voltammetric • Techniques and Comparison With • Classical DC Polarography. • Types of Polarography. • Components of Polarography. • Polarography Curve. • Type of currents. • Merit Demerits and Scope of Polarography. Stripping Voltammetry. • Principle of Stripping Voltammetry. • Types of Stripping Voltammetry. • Graph with Suitable Example of Stripping Voltammetry • Merit Demerit and Scope of Stripping Voltammetry. Coulometry. • Types of Coulometric Methods. a) Controlled Potential Coulometry. b) Controlled Current Coulometry. • Theory and Instrumentation of Coulometry. • Advantage and Limitation of Coulometry.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

Module 1: Spectroscopic Methods of Analysis
Project Idea: Comparative Analysis of Spectroscopic Techniques
Description: Students will conduct a comparative analysis of IR spectroscopy, Atomic Absorption Spectroscopy (AAS), and Dual Wavelength Spectroscopy. They will create a detailed report and presentation explaining the principles, instrumentation, advantages, disadvantages, and applications of each technique.

Assessment:

- Accuracy and depth of understanding for each spectroscopic method
- Quality of comparison between techniques
- Ability to explain complex concepts clearly
- Presentation skills and use of visual aids

Module 2: Emission Spectroscopic Methods
Project Idea: Virtual Laboratory - Emission Spectroscopy Simulation
Description: Students will use online simulation tools or software to perform virtual experiments in Atomic Emission Spectroscopy (AES), Molecular Emission Spectroscopy (MES), and Flame Emission Spectroscopy (FES). They will analyze given samples, interpret the results, and prepare a comprehensive lab report.
Assessment:

- Correct use of virtual instruments and understanding of their components
- Accuracy of sample analysis and data interpretation
- Quality and completeness of the lab report
- Ability to explain the factors affecting each spectroscopic method

Module 3: Potentiometric Methods of Analysis
Project Idea: Potentiometric Titration Experiment and Analysis
Description: Students will design and conduct a potentiometric titration experiment. They will prepare a report detailing the experimental setup, procedure, results, and analysis. The report should include an explanation of the Nernst equation and its application in their experiment.
Assessment:

- Experimental design and execution
- Accuracy of measurements and calculations
- Quality of data analysis and interpretation
- Understanding and application of the Nernst equation
- Clarity and completeness of the experimental report

Module 4: Polarography, Stripping Voltammetry, and Coulometry
Project Idea: Analytical Method Selection and Justification
Description: Students will be given a set of analytical problems related to various sample types. They must select the most appropriate technique (Polarography, Stripping Voltammetry, or Coulometry) for each problem and justify their choice. They will prepare a detailed report explaining their reasoning, including the principles, advantages, and limitations of each chosen method.
Assessment:

- Appropriateness of technique selection for each analytical problem
- Quality and depth of justification for each choice
- Understanding of the principles, merits, and demerits of each technique
- Ability to compare and contrast different analytical methods
- Clarity and organization of the report

References -

1. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2011). *Fundamentals of analytical chemistry*. Cengage Learning, Wiley-VCH Weinheim.
2. Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2009). *Vogel's quantitative chemical analysis* (6th ed.). Pearson Education, ELBS.
3. Fifield, F. W., & Kealey, D. (2000). *Principle & practice of analytical chemistry* (5th ed.). Blackwell Science.
4. Christian, G. D., Dasgupta, P., & Schug, K. (2013). *Analytical chemistry* (7th ed.). John Wiley.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2006). *Principles of instrumental analysis* (6th ed.). Cengage Learning.
6. Ahuja, S., & Jespersen, N. (2006). *Modern instrumental analysis*. Elsevier Science.
7. Harris, D. C. (2005). *Exploring chemical analysis* (3rd ed.). W. H. Freeman.
8. Patnaik, P. (Ed.). (2004). *Dean's analytical chemistry handbook* (2nd ed.). McGraw Hill.
9. Danzer, K. (2007). *Analytical chemistry*. Springer-BBH.

2.2 Major (Core)

Course Title	**Cosmetics Formulation & Quality Control (215212)**
Course Credits	**4**
Course Outcomes	After going through the course, learners will be able to
	1. **Assess** with understanding cosmetic formulation procedures. 2. **Analyze** the benefits and drawbacks of the raw ingredients used in the manufacture of cosmetics. 3. **Evaluate** the significance of quality control procedures in the cosmetics industry. 4. **Assessing** and analyzing cosmetic compositions for personal and 5. **Discuss** professional development.
Module 1(Credit 1) - Fundamentals of Skin and Cosmetic Manufacturing	
Learning Outcomes	After learning the module, learners will be able **Assess** Skin and it's natural composition. **Process** used in manufacturing of cosmetics. **Analyze** and understand commonly used raw material.
Content Outline	Plant layout and factory requirements for cosmetic industry ● Location and surroundings ● Lighting and ventilation ● Waste disposal and sanitation Packaging facilities etc. Skin and its natural composition ● Types of skin ● Anatomy of skin ● Layers of epidermis and skin cell types ● Skin barrier ● Skin pigmentation ● Skin pH, sensitivity, and diseases.
Module 2(Credit 1) - Cosmetic Industry Infrastructure and Requirements	
Learning Outcomes	After learning the module, learners will be able to
	Analyze plant layout and factory requirements in cosmetic industry.

Content Outline	A. Processes used in the manufacturing of cosmetics ● Emulsification ● Mixing ● Gelling ● Compaction ● Molding ● Packaging B. Commonly used raw materials in the cosmetic industry ● Water ● Preservatives ● Colors both natural and synthetic Perfumes both natural and synthetic
Module 3(Credit 1) - Cosmetic Formulations and Applications	
Learning Outcomes	After learning the module, learners will be able
	Analyze the Herbal Preparation products **Assess** the Baby care products and hypoallergic preparation.
Content Outline	A Mainly used cosmetic formulations: ● Skin creams and lotions ● Face Powders and compacts ● Lipsticks and lip balms ● Shampoos and shaving preparations ● Hair grooming preparations (sprays and gels etc.) ● Nail lacquers ● Dentifrices B. Cosmetic products mostly used in recent times. Herbal preparations for: Skin, Nails, Hair, Face, Dentifrices, and Mouth washes etc. C. Baby care products and hypoallergenic preparations: powders, oils, lotions, shampoos, creams etc
Module4(Credit1) - Quality Control and Advanced Topics in Cosmetics	
Learning Outcomes	After learning the module, learners will be able
	• Capable of evaluating the significance of quality control procedures in the cosmetics industry. • Capable of analyzing cosmetic compositions for personal

Content Outline	A. Controlling the quality of the following cosmetics-related raw materials: Goods inspection report, total viable aerobic count, membranefiltration, plate count, serial dilution, and determination of specific bacteria (Escherichia,salmonella,pseudomonas,staphylococcus,etc.) Cosmetics analysis: Lipstick(separation of waxes and oil & analysis of colors), Facepowder (fats & fattyacids,boricacid,zinc,totaltitanium&iron), Creams(typesofemulsion,% water,ash,andchloroformsoluble substance),Shampoo(analysisofnonvolatilematter,borate,sulfate,phosphates,andsurfactants), NailEnamel (BismuthOxyChloride,FreeFormaldehyde). C.Test procedures for cosmetic items: repeated insult, contacturticaria,primaryandsecondaryirritants,skinsensitivity,patch,and photo-patch

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Fundamentals of Skin and Cosmetic Manufacturing
Project Idea: Skin Analysis and Cosmetic Raw Material Study
Description: Students will conduct a detailed analysis of different skin types and create a comprehensive report on commonly used raw materials in the cosmetics industry. They will research the properties, benefits, and potential drawbacks of at least 10 key ingredients.
Assessment: Report quality, accuracy of information, depth of analysis, and presentation skills.

Module 2: Cosmetic Industry Infrastructure and Requirements
Project Idea: Cosmetic Manufacturing Process Simulation
Description: Students will design a simulated plant layout for a cosmetic manufacturing facility, incorporating all necessary elements such as lighting, ventilation, waste disposal, and packaging facilities. They will also create a flowchart detailing the manufacturing processes for a specific cosmetic product.
Assessment: Accuracy and completeness of the plant layout, feasibility of the design, understanding of manufacturing processes, and presentation of the flowchart.

Module 3: Cosmetic Formulations and Applications
Project Idea: Formulation of a Natural Cosmetic Product
Description: Students will develop and create a natural cosmetic product (e.g., herbal face cream, lip balm, or shampoo) using plant-based ingredients. They will document the entire process, including ingredient selection, formulation rationale, and manufacturing steps.
Assessment: Innovation in product concept, appropriate use of natural ingredients, documentation of the formulation process, and the final product's quality and efficacy.

Module 4: Quality Control and Advanced Topics in Cosmetics
Project Idea: Quality Control Analysis of Commercial Cosmetic Products
Description: Students will select three commercial cosmetic products and perform various quality control tests (e.g., pH testing, viscosity measurement, stability testing). They will then analyze and compare the results with industry standards and regulations.
Assessment: Accuracy of testing procedures, depth of analysis, understanding of quality control standards, and the ability to interpret and present findings.

References:

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9. Barel, O., Paye, N., & Maibach, H. I. (2009). *A handbook of cosmetics science and technology* (3rd ed.).
10. Salvador, A., &Chisvert, A. (2011). *Analysis of cosmetic products*. Elsevier.
11. Elsner, P., & Maibach, H. I. (2005). *Cosmeceuticals and active cosmetics* (2nd ed.). Taylor & Francis.

2.3 Major (Core)

Course Title	**Environmental Science (215213)**
Course Credits	4
Course Outcomes	After going through the course, learners will be able
	1. **Analyze** the different types of environmental pollutants and their global impact.
	2. **Asses** the methods for control of environmental pollution.
	3.**Analysis** of pollutants and their management
	4.**Discuss** the Environmental Legislation and Contemporary Environmental Issues
Module 1(Credit 1) - Introduction to Environmental Pollution	
Learning Outcomes	After learning the module, learners will be able
	Analyze the Sources and classification of pollution. 2.to understand the Concepts DO COD & BOD **Assess** the types of pollution
Content Outline	A) Source and classification pollution Composition of air. Particles, ions and radicals in the atmosphere. Chemical formation of inorganic and organic particulate matters, Oxygen and Ozone chemistry. Photochemical smog. B) Inorganic and organic components of soils. Biogeochemical cycles nitrogen, carbon, phosphorus and sulfur C) Types of pollution: - Air, water, noise, soil, thermal marine radioactive.
Module 2(Credit 1) - Pollution Control Methods	
Learning Outcomes	After learning the module, learners will be able to
	Analyze and gain knowledge of Principle and working of instruments used in pollution control. **Asses** the Method to control water pollution. **Discuss** and understand the concept of noise control.
Content Outline	Methods to control of pollution: - A) Principle and working of Electrostatic precipitation, wet & dry scrubber, filters, gravity and cyclonic separation, Adsorption, absorption and condensation of gaseous effluent. B) Methods of control of water pollution: water and wastewater treatment Primary, Secondary and Advanced

	treatment methods. (Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).) C) Modifications in Pesticides and synthetic Fertilizers for improving soil.
Module 3(Credit 1) - Analysis of Pollutants and Waste Management	
Learning Outcomes	After learning the module, learners will be able to
	Analysis of pollutants. **Assess** Hazardous waste management. **Discuss** and understand the concept of e-waste, plastic waste and fly ash.
Content Outline	Analysis of pollutants and their management A) Analysis of gasses CO, CO2, NO2, SO2, H2S. Analysis of toxic heavy metals Cd, Cr, As, Pb, Cu,Hg B) Hazardous waste management: Treatment Methods neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. C) e-waste: classification, methods of handling and disposal. Fly ash: sources, composition and utilization. Plastic waste: sources, consequences and management.
Module 4(Credit 1) - Environmental Legislation and Contemporary Issues	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze the Environmental legislation and contemporary environmental issue. 2. Assess the Environmental disaster.
Content Outline	Environmental Legislation and Contemporary Environmental Issues A) Environmental (Protection) Act, 1986 and Rules 1986, The Plastic Waste Management Rules 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time. B) Environmental Disasters: Minamata Disaster, Love Canal Disaster

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Introduction to Environmental Pollution
Activity: Pollution Source Analysis Project
Description: Students will conduct a local environmental survey to identify and classify various

pollution sources in their community or a designated area.
Task:
1. Identify at least five different pollution sources (e.g., industrial, vehicular, domestic).
2. Classify these sources based on the type of pollution they produce (air, water, soil, noise).
3. Collect and analyze air samples for particulate matter.
4. Create a report that includes:
   - A map of the identified pollution sources
   - Classification of pollutants
   - Analysis of air samples
   - A brief explanation of the potential impacts on local ecosystems and human health

Assessment: Evaluate based on the accuracy of source identification, proper classification, quality of analysis, and understanding of environmental impacts.

Module 2: Pollution Control Methods
Activity: Wastewater Treatment Plant Design
Description: Students will design a small-scale wastewater treatment system for a hypothetical community.
Task:
1. Design a wastewater treatment system that includes primary, secondary, and advanced treatment methods.
2. Create a flowchart of the treatment process.
3. Explain the principles behind each treatment stage.
4. Discuss how the system addresses BOD, COD, and pH control.
5. Propose methods for sludge management.

Assessment: Evaluate based on the feasibility of the design, accuracy of the treatment processes, understanding of wastewater parameters, and overall system efficiency.

Module 3: Analysis of Pollutants and Waste Management
Activity: Environmental Audit and Waste Management Plan
Description: Students will conduct an environmental audit of a local business or institution and develop a waste management plan.
Task:
1. Perform an environmental audit, identifying types and quantities of waste produced.
2. Analyze the current waste management practices.
3. Develop a comprehensive waste management plan that includes:
   - Strategies for reducing waste generation
   - Methods for proper segregation of waste (including e-waste and plastic waste)
   - Proposals for recycling and reuse
   - Safe disposal methods for hazardous waste
4. Include a section on how to handle and dispose of any toxic heavy metals if present.

Assessment: Evaluate based on the thoroughness of the audit, practicality and effectiveness of the proposed waste management plan, and understanding of different waste types and their management.

Module 4: Environmental Legislation and Contemporary Issues
Activity: Mock Environmental Tribunal
Description: Students will participate in a mock environmental tribunal, focusing on a hypothetical environmental disaster scenario.
Task:
1. Divide the class into groups representing different stakeholders (e.g., affected community, industry representatives, environmental agencies, legal experts).
2. Present a hypothetical environmental disaster scenario (inspired by real cases like Minamata or Love Canal).
3. Each group must:
   - Research relevant environmental laws and regulations
   - Prepare arguments and evidence supporting their position
   - Participate in a mock tribunal hearing
   - Propose solutions or compensations based on environmental legislation
4. Conclude with a class discussion on the effectiveness of current environmental laws and

potential improvements.
Assessment: Evaluate based on the quality of research, understanding of environmental legislation, strength of arguments presented, and ability to propose realistic solutions within the legal framework.

Reference:

1. De, A. K. (2005). *Environmental chemistry* (5th ed.). New Age International Publication.
2. Wark, K., & Werner, C. (2000). *Air pollution* (3rd ed., D. Liptak, Ed.). CRC Press LLC.
3. Mahajan, S. P. (2008). *Environmental pollution control in process industries*. Tata McGraw Hill Publishing Co. Ltd.
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2.4 Major (Core)

Course Title	**Practical Analytical Chemistry-II**
Course Credits	2
Course Outcomes	After going through the course, learners will be able to**,** **Asses** Gain hands-on experience with various analytical instruments (potentiometer, spectrophotometer, polarograph, etc.). Learn to set up, calibrate, and operate different analytical instruments. Understand the principles behind each analytical technique. **Discuss** analytical results with the structural features and chemical properties of molecules, essential for roles in quality assurance and research and development
Module 1 (Credit 1) -	
Learning Outcomes	After going through the module, learners will be able to **Analyze** Learn to process raw experimental data and understand and apply statistical methods to evaluate data quality. **Asses** Identify sources of error in analytical measurements and learn to estimate and report uncertainty in measurements
Content Outline	Conductometry Estimation of chloride Estimation of boric acid Estimation of strong and weak acid in the mixture. Estimation of HCl and H2SO4 in a mixture. Potentiometry Estimation of copper. Estimation of Fe(II) ions
Module 2 (Credit 1) -	
Learning Outcomes	After going through the module, learners will be able to, **Apply** Deepen understanding of chemical equilibria, particularly in complex formation and acid-base reactions and Apply knowledge of redox reactions in analytical contexts **Discuss** Deepen understanding of spectroscopic and electrochemical principles and their applications in chemical analysis

Content Outline	Spectrophotometrically Assay of streptomycin sulphate capsule. Estimation of iron in milk powder. Estimation of phosphorus in milk powder. To determine the capacity of cation exchange resin. To determine the capacity of anion exchange resin.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)-

Module 1: Conductometry and Potentiometry
Project Idea: Comparative Analysis of Electrochemical Techniques
Description: Students will perform a series of conductometric and potentiometric titrations to analyze various samples. They will compare the effectiveness and accuracy of these techniques for different types of analytes.
Experiments:
1. Conductometric estimation of chloride
2. Conductometric estimation of boric acid
3. Conductometric estimation of strong and weak acids in a mixture
4. Conductometric estimation of HCl and H2SO4 in a mixture
5. Potentiometric estimation of copper
6. Potentiometric estimation of Fe(II) ions

Assessment:
Laboratory performance (40%): Technique, accuracy, and precision in conducting experiments
Data analysis report (30%): Interpretation of results, error analysis, and comparison of methods
Method selection justification (20%): Explanation of why specific methods are better suited for certain analytes
Oral presentation (10%): Presentation of findings to the class

Module 2: Spectrophotometry and Ion Exchange
Project Idea: Application of Spectroscopic and Ion Exchange Techniques in Real-world Samples
Description: Students will apply spectrophotometric and ion exchange techniques to analyze components in pharmaceutical and food samples. They will explore the principles behind these techniques and their practical applications.
Experiments:
1. Spectrophotometric assay of streptomycin sulphate capsule
2. Spectrophotometric estimation of iron in milk powder
3. Spectrophotometric estimation of phosphorus in milk powder
4. Determination of the capacity of cation exchange resin
5. Determination of the capacity of anion exchange resin

Assessment:
Laboratory performance (40%): Technique, accuracy, and precision in conducting experiments
Comprehensive report (30%): Detailed analysis of results, including spectral interpretations and resin capacity calculations
Method validation (20%): Evaluation of the suitability of spectrophotometric methods for pharmaceutical and food analysis
Group presentation (10%): Presentation on the applications of spectrophotometry and ion exchange in industry

Additional Components for Both Modules:
- **Pre-lab quizzes (**5% of total grade): Short quizzes before each practical to ensure

students understand the theoretical principles.

- **Lab notebook evaluation** (10% of total grade): Regular checks of students' lab notebooks for proper documentation of procedures, observations, and calculations.
- **Peer review session**s (5% of total grade): Students review and provide constructive feedback on each other's reports, promoting critical thinking and collaborative learning.
- **Troubleshooting exercises (**5% of total grade): Scenarios where students must identify and solve common problems in analytical procedures.
- **Safety and good laboratory practice assessment** (5% of total grade): Continuous evaluation of students' adherence to safety protocols and good laboratory practices.

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2.5 Major (Elective)

Course Title	**Pharmaceutical Analysis (225211)**
Course Credits	**4**
Course Outcomes	After going through the course, learners will be able
	1. **Analyze** the active pharmaceutical components in medicinal products.
	2. **Assess** the administration method and dosage type.
	3. **Discuss** the consulting and contrasting pharmacopeias for various parameters and studies.
	4. **Apply** the fundamental QA and QC concepts in the pharmaceutical sectors.
Module 1(Credit 1) - Introduction to Pharmaceutical Analysis and Pharmacopoeias	
Learning Outcomes	After learning the module, learners will be able to
	1. **Analyze** the Classification of doses form 2. **Discuss** the Scope of pharmaceutical analysis.
Content Outline	A) Introduction to pharmaceutical Analysis: • Definition and scope of Pharmaceutical Analysis • Importance and objectives of pharmaceutical analysis • Classification of analytical technique B) Introduction to Indian Pharmacopoeia (IP) and other pharmacopeial standards • Pharmacopoeia and its importance. • Dosage form: A brief description of each dosage form, including tablets, capsules, injections, ointments, creams, oral solutions, and aerosols etc.
Module 2(Credit 1) - Analytical Methods in Pharmaceutical Industry	
Learning Outcomes	After learning the module, learners will be able to

	• **Discuss** the application of analytical methods used pharmaceutical industries. • **Analyze** and understand the Sustain and control released formation.
Content Outline	Application of Analytical methods used in the pharmaceutical industry •Tests to determine the authenticity, purity, and dosage of medicines. •Impurities and limit tests for (As, Pb, Fe, Chloride, Sulphate etc.) •Sustained and Control release formulations.
Module 3(Credit 1) - Quality Assurance and Quality Control in Pharmaceuticals	
Learning Outcomes	After learning the module, learners will be able
	1. **Analyze** and understand quality assurance 2. **Asses** the quality control
Content Outline	Principles and tests for quality control in the pharmaceutical industry: raw materials and finished products A) Quality Assurance (QA), the idea of Total Quality Management, and the role of documentation in QA. B) . Quality Control (QC) - Change control management, out of specifications, Deviation reporting, Stability studies, Quality control, laboratory duties, regular controls, equipment calibration, standard test protocols.
Module 4(Credit 1) - Analysis of Chemotherapeutic Agents and Pharmaceutical Products	
Learning Outcomes	After learning the module, learners will be able
	1. **Discuss** the Analysis of Chemotherapeutic agents 2. **Analyze** and dissolution and disintegration. 3. **Assess** microbial testing and preparation of pharmaceutical products
Content Outline	A) Introduction, Type, Properties, and Method of Analysis of Chemotherapeutic Agents. B) Dissolution and disintegration, drug testing, Biron capsules, vitamin C tablets, Aspirin, streptomycin sulphate, lactate, laxatives and antacid. C) Microbial testing for water used to prepare pharmaceutical products. Testing of various pharmaceutical products for sterility using appropriate microbiological media.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

Module 1: Introduction to Pharmaceutical Analysis and Pharmacopoeias
Project Idea: Comparative Study of Dosage Forms and Pharmacopoeial Standards
Description: Students will conduct a comprehensive study comparing different dosage forms (e.g., tablets, capsules, injections) and their respective analytical techniques. They will also compare analytical standards across different pharmacopoeias (e.g., Indian Pharmacopoeia, USP, BP) for a selected drug.
Assessment:
- Depth of understanding of various dosage forms and their characteristics
- Accuracy in describing analytical techniques for each dosage form
- Quality of comparison between different pharmacopoeial standards
- Presentation skills and clarity of the report

Module 2: Analytical Methods in Pharmaceutical Industry
Project Idea: Impurity Profiling and Limit Test Analysis

Description: Students will perform a series of limit tests (e.g., for As, Pb, Fe, Chloride, Sulphate) on given samples. They will also conduct an impurity profiling exercise for a selected pharmaceutical product, identifying potential impurities and proposing analytical methods for their detection.
Assessment:
- Accuracy in performing limit tests and interpreting results
- Thoroughness of impurity profiling exercise
- Understanding of sustained and controlled release formulations
- Quality and completeness of the laboratory report

Module 3: Quality Assurance and Quality Control in Pharmaceuticals
Project Idea: Design a Quality Management System for a Pharmaceutical Product
Description: Students will design a comprehensive Quality Management System (QMS) for a hypothetical pharmaceutical product. This should include elements of both Quality Assurance (QA) and Quality Control (QC), such as documentation procedures, change control management, stability studies, and equipment calibration protocols.
Assessment:
- Comprehensiveness of the QMS design
- Understanding of QA and QC principles
- Inclusion of all required elements (documentation, change control, stability studies, etc.)
- Practicality and applicability of the proposed system
- Clarity and organization of the presentation

Module 4: Analysis of Chemotherapeutic Agents and Pharmaceutical Products
Project Idea: Comprehensive Analysis of a Pharmaceutical Product
Description: Students will perform a complete analysis of a given pharmaceutical product (e.g., Aspirin tablets or Vitamin C capsules). This should include:
1. Chemical analysis for active ingredient content
2. Dissolution and disintegration tests
3. Microbial testing (if applicable)
4. Impurity profiling

Students will prepare a detailed analytical report of their findings.
Assessment:
- Accuracy and precision of analytical procedures
- Correct interpretation of dissolution and disintegration test results
- Understanding and application of microbial testing procedures
- Comprehensiveness of the impurity profile
- Quality and clarity of the analytical report
- Ability to relate findings to quality control standards

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2.6 OJT

Course Title	**Practical Pharmaceutical Analysis ()**
Course Credits	**4**
Course Outcomes	After going through the course, learners will be able to**,** 1) **Asses** and Develop skills in the identification of organic compounds based on their spectra, preparing for careers in analytical chemistry and pharmaceuticals. **2) Discuss** organic compounds based on functional group analysis, relevant to roles in quality control and chemical analysis laboratories.
Module 1 (Credit 2) - Quantitative Analysis of Pharmaceutical Preparations	
Learning Outcomes	After going through the module, learners will be able to 1) **Analyze** non-aqueous titrations using solvents other than water, essential for roles in organic compound analysis and pharmaceutical research. **2) Asses** advanced titration techniques such as potentiometric titrations for accurate endpoint detection, crucial for careers in analytical chemistry and chemical engineering.
Content Outline	• Analysis of aspirin • Analysis of sodamint tablet • Analysis of A. Calcium tablet, B. Calcium pantothenate tablet • Analysis of ointment by Whitefield A. Benzoic acid B. Salicylic acid • Assay of milk of magnesia (laxative drugs) by AComplexometric titration, B. Acid base titration • Analysis of Iron tablet for its Iron content • Assay of isoniazid tablet • Assay of phenylephrine solution
Module 2 (Credit 2) - Quality Control Tests and Limit Tests in Pharmaceutical Analysis	
Learning Outcomes	After going through the module, learners will be able to, 1. **Apply** organic titrations to analyze the concentration of various functional groups in pharmaceuticals compounds (Ear drop), preparing for careers in pharmaceuticals and chemical analysis. 2. **Discuss** analytical results with the structural features and chemical properties of organic molecules, essential for roles in quality assurance and research and development.

Content Outline	• Assay of sulfacetamide eye drops
	• Weight variation of tablet and capsule.
	• Limit test of Chloride for
	  ○ Insoluble substance
	• b.Coloured substance
	  ○ Sodium benzoate
	  ○ Sodium bicarbonate.
	• Limit test for sulphate
	• Limit test for Iron

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)-

Module 1: Quantitative Analysis of Pharmaceutical Preparations
Content:
1. Analysis of aspirin
2. Analysis of sodamint tablet
3. Analysis of Calcium tablet and Calcium pantothenate tablet
4. Analysis of ointment by Whitefield method (Benzoic acid and Salicylic acid)
5. Assay of milk of magnesia (laxative drugs) by Complexometric titration and Acid base titration
6. Analysis of Iron tablet for its Iron content
7. Assay of isoniazid tablet
8. Assay of phenylephrine solution
9. Assay of sulfacetamide eye drops

CCE Activity:
Project Idea: Comparative Analysis of Pharmaceutical Preparations
Description: Students will perform quantitative analysis on two different pharmaceutical preparations from the list above. They will compare their results with the labeled content and industry standards, and prepare a comprehensive report detailing their methodology, results, and conclusions.
Assessment: Accuracy of analytical techniques, data interpretation, report quality, and presentation skills.

Module 2: Quality Control Tests and Limit Tests in Pharmaceutical Analysis
Content:
1. Weight variation of tablet and capsule
2. Limit test of Chloride for:
   a. Insoluble substance
   b. Colored substance
   c. Sodium benzoate
   d. Sodium bicarbonate
3. Limit test for sulphate
4. Limit test for Iron

CCE Activity:
Project Idea: Quality Control Assessment of Pharmaceutical Products
Description: Students will conduct a series of quality control tests on given pharmaceutical products, including weight variation and relevant limit tests. They will prepare a detailed report on their findings, discussing the importance of these tests in ensuring drug safety and efficacy.

Assessment: Precision in conducting tests, understanding of quality control standards, data analysis skills, and the ability to draw meaningful conclusions from the results.

Additional Components for Both Modules:

- **Pre-lab quizzes (**5% of total grade): Short quizzes before each practical to ensure students understand the theoretical principles.
- **Lab notebook evaluation** (10% of total grade): Regular checks of students' lab notebooks for proper documentation of procedures, observations, and calculations.
- **Peer review session**s (5% of total grade): Students review and provide constructive feedback on each other's reports, promoting critical thinking and collaborative learning.
- **Troubleshooting exercises (**5% of total grade): Scenarios where students must identify and solve common problems in analytical procedures.
- **Safety and good laboratory practice assessment** (5% of total grade): Continuous evaluation of students' adherence to safety protocols and good laboratory practices.

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