Rajarshi Shahu Mahavidyalaya, (Autonomous)
Latur – 413512

DEPARTMENT OF ANALYTICAL CHEMISTRY

[Faculty of Science]

Revised Syllabus as approved by

Board of Studies, Dated: 02.07.2020

Academic Council, Dated: 16.07.2020

B.Sc. (First Year) Analytical Chemistry

(I & II Semester)

(With Effect from 2020-2021)

1. Introduction:

The syllabus of B.Sc. Analytical Chemistry is prepared to give sound knowledge and understanding of Analytical Chemistry, during teaching-learning endeavour to undergraduate students of the B.Sc. Analytical Degree course. The Learning Outcomes-based curriculum framework is designed, which is the pivotal step to cope-up current needs. The goal of the syllabus is to make the study of Analytical Chemistry as a stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make the students capable of studying Analytical Chemistry in academic and industrial courses.

Also, to expose the students to Analytical Chemistry and to built up their interest in various fields of Analytical Chemistry. The new and updated syllabus is based on disciplinary approach with vigor and depth, taking care that the syllabus is not heavy not the same time it is comparable to the syllabi of other Universities at the same level.

The syllabus is prepared after discussions of number of faculty members of the subject and by considering the syllabi of NET, SET, GATE examinations, UGC model curriculum, syllabi of different entrance examinations and syllabi of other Universities.

The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. The uniform grading system will also enable potential employers in assessing the performance of the candidates.

Modified Bloom's taxonomy is kept as key aspect for designing the syllabus. Remembering, understanding the things, applying the knowledge with wisdom, critically analysing and evaluating the things and ultimately creating new things will be the competency of the students.

2. Title of the Programme: B.Sc. Analytical Chemistry

3. Program Learning Objectives of B.Sc. Analytical Chemistry:

- To promote firm understanding of basic facts and concepts in Analytical Chemistry while retaining the excitement of Chemistry
- To make students competent with academic, research and industrial knowledge.

- To expose the students to various emerging areas of chemistry and apprise them with their prevalent in their future studies and their applications to various spheres of chemical sciences.
- To develop problem critical solving skills in students.
- To expose the students to different processes used in industries and their applications.
- To develop ability and to acquire the knowledge of terms, facts, concepts, processes, techniques and principles of subject.
- To develop ability to apply the knowledge, contents and principles of Chemistry (Theory to Practical's).
- To develop skills required in chemical analysis and synthesis in chemical laboratories such as the proper handling of apparatus and chemicals, to develop new modern techniques of analysis and synthesis etc.
- To impart thorough knowledge of instrument handling, data analysis, data retrieval, technology driven aspects.

4. Program Learning Outcomes of B.Sc. Analytical Chemistry:

B.Sc. Analytical Chemistry is designed to develop thorough knowledge of the core concepts and principles of Analytical Chemistry. Undergraduates exploring this programme of study, go through laboratory work that specifically develops their quantitative and qualitative skills, provides opportunities for critical thinking and team work and confront them to techniques useful for applied areas of scientific study.

- **Sound theoretical knowledge**: Students acquire sound theoretical knowledge and understanding of the fundamental concepts, principles and processes in Analytical Chemistry.
- **Quantitative Analytical Instrumentation techniques:** The programme provides ample training in handling basic chemical laboratory instruments and their use in analytical determinations. Undergraduates on completion of this programme can join interdisciplinary branches like chemistry, pharmaceutical industries, material testing and biochemical labs besides standard chemical laboratories as **Quality Control is an integral part of industries and invariably Analytical Chemistry.**

- **Communication Skill:** It is of high requisite to possess such skills. Opportunities to enhance student's ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing. Also, the course attributes effective communication skills, through oral and Poster Presentation.
- **Capacity Enhancement:** Current ear requires students to possess ability to think independently and be able to work productively in groups with some degree of balancing. The Analytical Chemistry course is designed to take care of this important aspect of student development through effective teaching learning process. Students will be able to integrate their knowledge from each of these areas with critical thinking skills in order to become problem solvers.
- **Portable Skills:** Besides communication skills, the programme develops a choice of portable or transferable skills in students that they will adopt to their new work environment after completion of Analytical Chemistry programme. This encompasses problem solving, numeracy and mathematical skills-error analysis, interpretation of data, units and conversions, information retrieval skills, IT skills, organizational skills and many more noteworthy aspects. They will inculcate and understand general laboratory practice guidelines including safety and use of modern chemical instrumentation
- **Employment:** **Find growth oriented employment in industries or government sector**, be accepted at graduate or professional schools or find employment in school systems as instructors or administrators.

5. Advantages of Course:

The B.Sc. Analytical Chemistry course is useful for the students in various aspects and offers them with bright career. The course helps the students in improving their diverse skills in various areas such as laboratory skills, numerical and computing skills, ability to approach to the problems both analytically and logically, time management skills, etc. The B.Sc. Analytical chemistry graduates have many options for their higher studies. Majority of these graduates

opt for master's degree in the same. But they can also choose various specialized areas in this field for the post graduation courses.

6. Duration of the Course: Three year (Each year is called an academic year and is divided into two semesters. Thus there will be a total of six semesters.)

7. Eligibility of the Course: 10+2

8. Strength of the Students: As per the University/College rules.

9. Fees for Course: As per University/College rules.

10. Admission / Selection procedure: Admission by merit through Registration

11. Teacher's qualifications: As per UGC/University/College rules

12. Standard of Passing: As per UGC/University/College rules

13. Nature of question paper with scheme of marking: As per UGC/University/College rules

14. List of book recommended: Included in syllabus

15. List of Laboratory Equipment's, Instruments, and Measurements etc.:

List of major Laboratory Equipment's, Instruments, and Measurements:

Particulars	Quantity	Particulars	Quantity
UV-Visible Spectrometer	01	Flame Photometer	01
FT-IR (Bruker-ATR)	01	Suction Machine	01
Polarimeter (ATAGO)	01	Freezing point Apparatus	02
Polarimeter (Local Make)	01	Heating Mantle	04
Colorimeter	15	pH-Meter	12
Electric Burner	08	Distillation plant	01
Digital Photofluorometer	02	Melting point Apparatus	02
Potentiometer	14	Rotary Shaker	01
Turbidometer	02	Abbe's Refractometer	02
Ultrasonicator	01	Centrifuge machine	03
Conductometer	12	Magnetic Stirrer	12

16. List of Laboratory Equipment's:

The teaching-learning involves theory classes (Lectures), practical classes and Project. The curriculum will be delivered through various **methods including**:

• Chalk and talk	• Power point presentations
• Audio-video tools	• E-learning/E-content
• Virtual labs	• Simulations

• Field trips/Industry visits	• Seminars/workshops (talks by experts)
• Projects	• Models and class discussions

The assessment broadly will comprise of Internal Assessment (Continuous Assessment) and End Semester Examination. The internal assessment will be through class test, Laboratory tests, written assignment(s), tutorials, oral presentation, seminars in class rooms, peer assisted learning, Hands-on learning using videos; presentations; seminars, technology driven learning, Industry visits, worksheets and short projects.

17. Rules and regulations and ordinance if any: As per UGC/University/College rules

18. Course duration: Each theory course is of 60 Contact hours

19. Medium of the language: English

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B.Sc. (First Year) Chemistry

STRUCTURE OF SYLLABUS OF ANALYTICAL CHEMISTRY PROGRAM

Semester – I

Sr No	SEM	Core Courses	Course Title	Total Periods	Periods/ Week	Hrs / Week	Credits	CIA	End Sem Exam	Total Marks
1.	I	U-ANC-150	General Concepts of Analytical Chemistry-I	45	03	2.25	2	20	30	50
		U-ANC-151	Basic Analytical Chemistry & Titrimetry-II	45	03	2.25	2	20	30	50
		U-ANC-152	Analytical Chemistry Laboratory Course-I	45	03	2.25	1	20	30	50
2.	II	U-ANC-249	Errors, Statistical Treatment of Analytical Data and Separation Techniques-III	45	03	2.25	2	20	30	50
		U-ANC-250	Gravimetric Methods of Analysis, Laboratory Reagents and Solvents-IV	45	03	2.25	2	20	30	50
		U-ANC-251	Analytical Chemistry Laboratory Course-II	45	03	2.25	1	20	30	50

STRUCTURE FOR ASSESSMENT

Each Theory and Practical Paper - Max. 50 Marks:

(Weightage as per 60:40 Pattern, Internal 40*+External 60*)

- External: Theory S.E.E. 60 %
- Internal (Continuous Assessment): 40 %

  (Two unit test -30 marks+ Attendance 10 Marks)
- Unit Test I MCQ patterns 30 MCQ questions
- Unit Test II Activity Based./Home Assignment 30 Marks
- Unit test (I+II) = 60 converted to 15 Marks
- Attendance 05 Marks

Note:

Statutory bodies can timely take the requisite decisions and actions to revise the marking frameworks.

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Semester- I

ANALYTICAL CHEMISTRY (Theory)

Course Title: General Concepts of Analytical Chemistry-I

Course Code: U-ANC-150

Marks: 50 **Credits: 02**
Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to make students aware about:

1. Unit operations.
2. Chemical methods for analysis.
3. Green analytical chemistry

Course Learning Outcome:

By the end of the course, the students will be able to:

1. Know Unit operations and chemometrics
2. Learn and understand qualitative and quantitative analysis.
3. Know the chemical methods applied for elemental and compound analysis
4. Understand basic concepts in Green analytical chemistry

Unit – I Introduction to Analytical Chemistry & Chemometrics: 15 Periods

Introduction to Analytical Chemistry: Definitions, Introduction to instrumental & non-instrumental methods of chemical analysis-Electrochemical, Optical, Spectroscopic, Radiochemical, Thermal and Chromatographic Methods. Role of analytical chemistry in sciences.

Chemometrics: Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Normality, Molarity, Molality, Formality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, p-functions (pX, pH, pOH, pM), milliequivalents, milli moles and titer. Numericals.

Unit – II Preliminary Operations in Quantitative Analysis: 10 Periods

1. Introduction to sampling, definitions, crushing and grinding of laboratory samples; moisture in samples and drying, determination of water in sample, decomposition and dissolution of samples, some general considerations. Acid treatment, decomposition by flux treatment, decomposition of organic matter (Organic compounds) for elemental analysis and preparation of solution of sample.

Unit - III Introduction to Coordination Chemistry and Basics of Computer: 15 Periods

Definition of terms: Co-ordination complex, Co-ordination number, Chelate: difference between complex and chelates. Types of chelating agents

Basics of Computer (in brief): Debugging Chemistry Software Products (office, chemsketch, chemdraw, ISI draw, scilab, matlab, and hyperchem-**Any Three**), internet applications

Unit – IV Green Analytical Chemistry: 05 Periods

Introduction to green analytical chemistry: Definitions, principles, clean analytical methods-solid phase extraction, solid phase microextraction; strategies for green analytical chemistry, cost of green analytical chemistry

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Semester- I

ANALYTICAL CHEMISTRY (Theory)

Course Title: Basic Analytical Chemistry and Titrimetry

Course Code: U-ANC-151

Marks: 50 **Credits: 02**

Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to confront students about:

1. SI Units
2. Units of volume, effect of temperature on volume measurement.
3. Principles of Titrimetric Analysis.
4. Calibration of analytical instruments

Course Learning Outcome:

By the end of the course, the students will be able to:

1. Know about the SI units
2. Understand the units of volume, effect of temperature and apparatus for measurement
3. Comprehend the principle of titrimetric analysis.
4. Calibrate analytical instruments

Unit – I SI Units, Measurement of Mass and Volume: 10 Periods

1.1 Definitions of the Seven Base Units (Mass, Length, Time, Temperature, Amount of substance, Electrical current and Luminous intensity), Distinction between mass and weight; Relation between mass and volume

1.2 Units of volume, effect of temperature on volume measurement. Apparatus for precise measurement of volume; pipette, burette and volumetric flask & their calibration.

Unit – II Principles of Titrimetric Analysis – I: 13 Periods

Definition of terms: Titrant, titrand, analyte, end point and equivalence point, indicator, standard titrant, titration. Acid-base titration: Theory of acid base indicators, Theory of acid-base titration, titration of strong acid-strong base, weak acid-weak base, strong acid-weak base with titration curve and choice of indictors.

Unit-III Principles of Titrimetric Analysis – II: 12 Periods

Redox Titration: Theoretical basis of volumetric analysis involving (i) Potassium Permanganate (ii) Potassium dichromate and (iii) Iodine.

Precipitation titration: Titration curve for precipitation reaction, end point detection, Mohr's method and Volhard's method.

Complexometric Titration: Theory of complexometric titration, indicators for EDTA titration,

Types of EDTA titration-direct and back titration

Unit-III Calibration of Analytical Instruments: 10 Period

Definition of Calibration, Need of Calibration, Calibration of- pH meter, potentiometer, Conductometer Colorimeter, UV-Visible spectrophotometer.

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Semester- I

ANALYTICAL CHEMISTRY (Practical)

Course Title: Laboratory Course in Analytical Chemistry-I

Course Code: U-ANC-152

Marks: 50 **Credits: 02**

Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to train students about:

1. Practical aspects and approach of theoretical content such as basics of calibration, titration processes and assay methods
2. Application and implementation of knowledge
3. Cognitive domain of memory

Course Learning Outcome:

By the end of the course, the students will be able to:

1. 3rd and 4th level of Blooms Taxonomy i.e. Application and Analysis
2. Perform titrimetric analysis with all requisite viz calibration, assay, etc

Note: Out of 11 experiments 08 experiments should be completed by each student.

1. Calibration of volumetric apparatus: Pipette / Standard flask.
2. Preparation of standard solution of potassium hydrogen phthalate and standardization of sodium hydroxide solution.
3. Preparation of standard solution of $K_2Cr_2O_7$ and standardization of given $FeSO_4$ solution.
4. Preparation of standard solution of $(COONa)_2$ and standardization of given $KMnO_4$ solution.
5. Preparation of $Na_2S_2O_3$ solution and its standardization using $K_2Cr_2O_7/KIO_3$
6. Preparation of standard solution of NaCl and standardization of given $AgNO_3$ solution.
7. Separation of metal ions (Cu^{2+}, Pb^{2+} and Cd^{2+}) / (Zn^{2+}, Co^{2+} and Ni^{2+}) by paper chromatography.
8. Assay of commercial sodium hydroxide/barium hydroxide.
9. Assay of H_2O_2 solution.
10. Assay of formaldehyde.
11. Determination of alkalinity of water sample.
12. Calibration of pH meter/potentiometer/Conductometer/Colorimeter/UV-Visible spectrophotometer.

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Semester- II

ANALYTICAL CHEMISTRY (Theory)

Course Title: Errors, Statistical Treatment of Analytical Data and Separation Techniques

Course Code: U-ANC-250

Marks: 50 **Credits: 02**

Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to aware students about:

1. Statistical data handling
2. Separation and purification methods

Course Learning Outcome:

By the end of the course, the students will be able to:

1. Know basics of analytical data handling.
2. Understand the principle and handling procedures of chromatographic techniques

Unit – I Errors in Chemical Analysis: 10 Periods

Replicate analysis, reliability of analytical data, mean and median & range precision and accuracy, methods of expressing precision and accuracy: deviation, mean deviation, relative mean deviation, and standard deviation. Errors, absolute error, relative error. Determinate errors, classification of determinate errors and their minimization, indeterminate error and normal frequency distribution curve.

Unit - II Statistical Treatment of Analytical Data: 13 Periods

Statistical treatment of analytical data, confidence limits, students T-test, rejection of data: Q test, 4d rule and 2.5d rule. Graphical representation of results, methods of averages, methods of least squares. Significant figures, Reporting of analytical data, Numaricals

Unit - III Separation Techniques: Introduction, Classification of separation techniques.

Introduction to Chromatographic Techniques: 10 Periods

Introduction, general principle of chromatography, classification of chromatographic techniques. Principle, technique and applications of paper and thin layer chromatographic techniques.

Unit-IV Purification Methods used in Organic Chemistry: 12 Periods

Theory of Sublimation, distillation, fractional distillation & Crystallisation

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Semester- II

ANALYTICAL CHEMISTRY (Theory)

Course Title: Gravimetric Methods of Analysis, Laboratory Reagents and Solvents

Course Code: U-ANC-251

Marks: 50 **Credits: 02**

Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to aware students about:

1. Steps involved in gravimetric analysis and conversion factors
2. Different types of precipitants for gravimetric analysis
3. Classification of solvents and reagents

Course Learning Outcome:

By the end of the course, the students will be able to:

1. Write the steps involved in gravimetric analysis
2. Apply the knowledge of gravimetric conversion factor in analysis
3. Use the precipitants for particular ions in gravimetry
4. Classify the given solvents and reagents

Unit – I Gravimetric Methods of Analysis-I: 12 Periods

Introduction to gravimetric analysis, general principle, entire gravimetric procedure and gravimetric steps. Gravimetric Conversion Factor (GCF) - illustrations with reference to sulfate, chloride, ferric, calcium and phosphate as analyte ions.

Precipitation: Saturation, super saturation, nucleation and crystal growth. Properties of precipitates-partical size, colloidal state; types of precipitates-crystalline, curdy and gelatinous precipitates.

Unit-II Gravimetric Methods of Analysis-II: 12 Periods

Purity of precipitates, co-precipitation, post-precipitation and procedures to minimize. Fractional Precipitation, Factors affecting precipitation. Precipitation from homogeneous solution. Ageing and filtration of precipitate, filter papers, filter mats, Gooch crucible, Sintered glass crucible, washing, drying and ignition of precipitates. Comparison of gravimetric analysis with volumetric analysis.

Unit – III Types of Precipitants and Their Applications: 11 Periods

Inorganic precipitants, organic precipitants, their advantages and disadvantages. Uses of inorganic precipitants: silver nitrate for chloride, dilute sulfuric acid for barium and lead, barium chloride for sulfate and ammonium hydroxide for iron (III). Uses of organic precipitants: dimethyl glyoxime for Nickel, 8-hydroxy quinoline for aluminum and α-benzoinoxime (Cupron) for copper.

Unit-IV Laboratory Reagents & Solvents: 10 Periods

Reagents: Classification of reagents according to their action; (i) acids (ii) bases (iii) salts (iv) complexing agents (v) oxidizing and reducing agents (vi) precipitating agents (vii) chelating agents. Each type to be explained with at least one suitable example. Primary and secondary standards: Definition, characteristics, uses, examples for different types of reactions.

Solvents: Solute, Solvent & Solution, classification of solvents (i) Protic and aprotic (ii) Acidic, basic amphiprotic and neutral (iii) Aqueous and non-aqueous (iv) Polar and non-polar. Each type to be explained with at least one example.

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Semester- II

ANALYTICAL CHEMISTRY (Practical)

Course Title: Laboratory Course in Analytical Chemistry-I

Course Code: U-ANC-252

Marks: 50 **Credits: 02**

Periods: 45 **3 per week**

Learning Objective:

The objective of this course is to train students about:

1. Practical aspects and approach of theoretical content such as experimental procedures for quantitative determination of various ions by volumetric/gravimetric titration
2. Application and implementation of knowledge
3. Cognitive domain of memory

Course Learning Outcome:

By the end of the course, the students will be able to:

1. Perform standardization and volumetric/gravimetric analysis
2. 3rd and 4th level of Blooms Taxonomy i.e. Application and Analysis

Note: Out of 10 experiments 08 experiments should be completed by each student.

1. Determination of free chloride in a sample of water.
2. Determination of acetic acid content in a commercial sample of vinegar.
3. Estimation of HCl and CH_3COOH in mixture using acid base indicators.
4. Estimation of Iodine in the given solution using standard $Na_2S_2O_3$ solution.
5. Preparation of EDTA solution and its standardization using standard Zn^{2+} solution
6. Estimation of Al^{3+} in the given solution using standard EDTA solution (Back Titration)
7. Determination of Carbon Dioxide in a polluted water sample.
8. Determination of Calcium in Calcium Gluconate
9. Determination of iron as iron (III) oxide by Gravimetry.
10. Determination of Ni as Ni $(DMG)_2$ by Gravimetry.

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Reference :

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2. An introduction to analytical chemistry, S. A. Iqbal, M. Satake, Y. Mido and M. S. Shethi.
3. College analytical chemistry: Joshi, Baliga and Shetty, Himalaya Publishing house.
4. Qualitative analysis: Day and Underwood.
5. Qualitative inorganic analysis: A. I. Vogel.
6. Principles of analytical chemistry: Pandit and Soman.
7. Analytical chemistry, G. D. Christian, J. Wiley eastern press Ltd.
8. Analytical chemistry: Alka Gupta.
9. Basic concepts of analytical chemistry: S. M. Khopkar.
10. Advanced pratical organic chemistry: Vishnoi.
11. Qualitative analysis: A laboratory manual: Day and Underwood.
12. Fundamentals of analytical chemistry: D. A. Skoog, D.M. West and H. J. Holler, 7 edition.
13. Analytical chemistry principles: J. H. Kennedy, W. B. S. Saunders pub. Ltd.
14. Analytical chemistry: Principles and Techniques: L. G. Hargis, Prentice Hall.
15. Principles in semi-micro qualitative analysis: G. R. Chatwal edited by M. Arora.
16. Experiments in chemistry: D. V. Jahagirdar.
17. A text book of experimental and calculation in engineering chemistry: S. S. Dara.
18. Analytical chemistry: Pitrzyk and Frank, second edition.
19. Modern analytical chemistry: W. F. Pickering, Marcel Decker INC. New York.
20. Introduction to chromatography: Srivastava and Srivastava.
21. University Practical Chemistry by PC Kamboj, Vishal Publishing Company, Jalandhar.
22. Practical Chemistry (for B.Sc.I, II & III Year Students of All Indian Universities) Dr.O.P. Panday, D.N. Bajpai & Dr. S. Giri, S.Chand & Company, New Delhi.
23. Handbook of Green Analytical Chemistry, Miguel De La Guardia, Salvador Garrigues, Wiley, John Wiley & Sons, Ltd, 2012
24. Green Analytical Chemistry: Theory & Practice, Comprehensive Analytical Chemistry, M. De La Guardia, S. Armenta, Vol. 57, Elsevier The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK Radarweg 29, PO Box 211, 1000 AE Amsterdam, The Netherlands.

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DEPARTMENT OF ANALYTICAL CHEMISTRY

Skeleton of Marks

Time: 1.30 hours (for Theory) Max. Marks = 30

A] Internal (Continuous Assessment) 20 (15+5*) Marks Each

- Unit Test -I (MCQ) 30 Marks
- Unit Test –II (Activity Based Test/Assignments) 30 Marks
- (Unit Test –I+II=60, Converted to 15)

B] Attendance 05* Marks

- Below 75 % 1.0
- 75.1 - 80.00 % 2.0
- 80.1 - 85.0 % 3.0
- 85.1 - 90.0 % 4.0
- 90.1 and above 5.0

C] Semester End Examination 30 Marks

Theory Course- 30 Marks

Practical Course- 30 Marks

(For Practicals 10 Marks are allotted to Practical Record Book and 10 Marks for Attendance)

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Board of Studies in Analytical Chemistry
(Academic Year 2020-2021)

Sr. No.	Name of Member	Designation	Signature
1.	Mr. D.G. Palke	Chairman	
2.	Mr. K.I. Momin	Member	
3.	Mr. K.C. Tayade	Member	
4.	Mr. M.S. Sudewad	Member	
5.	Dr. Mrs. S.S. Makone	Member	
6.	Prof. Dr. Sheshanath V. Bhosale	Member	
7.	Dr. Bhaskar R. Sathe	Member	
8.	Mr. R.S. Patil	Member	
9.	Dr A. R. Karad	Member	
10.	Dr. K. S. Raut	Member	

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