



स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण-२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्याबाबत.

परिपत्रक

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४-२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण-२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्यात येत आहे.

01	B.Sc. III Year Botany	10	B.Sc. III Year Biochemistry
02	B.Sc. III Year Chemistry	11	B.Sc. III Year Agriculture Microbiology
03	B.Sc. III Year Mathematics	12	B.Sc. III Year Electronics
04	B.Sc. III Year Zoology	13	B.Sc. III Year Seed Technology
05	B.Sc. III Year Microbiology	14	B.Sc. III Year Horticulture
06	B.Sc. III Year Geology	15	B.Sc. III Year Analytical Chemistry
07	B.Sc. III Year Environment & Earth Science	16	B.Sc. III Year Agrochemical & Fertilizers
08	B.Sc. III Year Statistics	17	B.Sc. III Year Industrial Chemistry
09	B.Sc. III Year Dairy Science	18	B.Sc. III Year Industrial Microbiology

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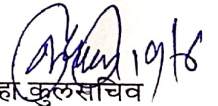
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सहा कुलसचिव

शैक्षणिक (१-अभ्यासमंडळे) विभाग

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SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY

NANDED – 431 606 (MS)

UNDER GRADUATE PROGRAMME OF SCIENCE & TECHNOLOGY

B.Sc. THIRD YEAR
SUBJECT — ANALYTICAL CHEMISTRY

With Effect from the Academic Year 2026–2027

(As per NEP-2020)

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From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement “Enlightened Student: A Source of Immense Power”, is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve the 3Es, the equity, the efficiency and the excellence in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the cumulative grade point average (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the Choice Based Credit System (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses. SRTM University has been producing a good number of high calibre graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario. Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like startups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals. The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science based to the discipline-specific-based curriculum. All the recommendations of the Sukanu Samiti given in the NEP Curriculum Framework-2023 have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various

Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the Government of Maharashtra regarding NEP-2020. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines. We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory On Job Training, Internship program for science background students is praise worthy and certainly help the students to imbibe firsthand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. M. K. Patil

Dean Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University,

Nanded

From the Desk of Chairman

Board of Studies in Chemistry

It gives me great pleasure to present the revised syllabus for **B.Sc. Third Year (Semester V & VI) – Analytical Chemistry**, prepared in accordance with the guidelines of the **National Education Policy (NEP) 2020** and the academic framework of **Swami Ramanand Teerth Marathwada University, Nanded**.

The present curriculum has been carefully designed to ensure a balanced integration of **fundamental concepts, practical skills, and emerging trends in Analytical chemistry**. Emphasis has been placed on **application-oriented learning, interdisciplinary approach, skill development, and employability enhancement**, which are essential in the contemporary scientific and industrial landscape.

Special features of this syllabus include the introduction of courses such as **Applications of Software in Chemistry, Green Chemistry, Industrial Chemistry components, and Field Project/On-Job Training**, which aim to bridge the gap between theoretical knowledge and real-world applications. The inclusion of **Indian Knowledge System (IKS)** further enriches the curriculum by connecting traditional scientific wisdom with modern chemistry.

The syllabus also incorporates **modern pedagogical approaches, outcome-based education (OBE), and continuous assessment methods**, ensuring that students develop critical thinking, analytical ability, and research aptitude.

I sincerely appreciate the valuable contributions of all **Board of Studies members, subject experts, and faculty colleagues** who have actively participated in designing and refining this curriculum.

I am confident that this revised syllabus will significantly contribute to the **holistic academic and professional development of students**, preparing them to meet the challenges of higher education, research, and industry.

Dr. D. R. Munde

Chairman

Board of Studies in Chemistry

Swami Ramanand Teerth Marathwada University, Nanded

Details of the Board of Studies Members in the subject Chemistry under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr. No.	Name	Address	Designation
1.	Dr. D. R. Munde	Science College, Nanded	Chairman
2.	Dr. Sangeeta S. Makone	School of Chemical Sciences, SRTMU, Nanded	Member
3.	Dr. Yogesh S. Nalwar	Toshniwal ACS College, Sengaoon	Member
4.	Dr. Anil B. Chidrawar	Degloor College, Degloor	Member
5.	Dr. A. S. Bondge	Shivneri Mahavidyalaya, Shirur (Anantpal)	Member
6.	Dr. B. C. Khade	D. S. M. College, Parbhani	Member
7.	Dr. Suresh D. Dhage	ACS College, Gangakhed	Member
8.	Dr. Krishna Chaitanya	School of Chemical Sciences, SRTMU, Nanded	Member
9.	Dr. Shivraj B. Sirsat	Yeshwant Mahavidyalaya, Nanded	Member
10.	Dr. Jaman Angulwar	Dayanand Science College, Latur	Member
11.	Dr. Nitish Kumar S. Kaminwar	Lal Bahadur Shastri College, Dharmabad	Member
12.	Dr. S. P. Hungirgekar	Shivaji University, Kolhapur	Member
13.	Dr. Siddhnath V. Bhosale	Principal Scientist, CSIR–IICT, Hyderabad	Expert Member
14.	Dr. P. Bhaskar Reddy	Associate Vice President, R&D Biophore Pharmaceuticals Pvt. Ltd., Hyderabad	Industry Expert
15.	Dr. Ratnashil T. Sonkamble	Maharashtra Mahavidyalaya, Nilanga	Member
16.	Dr. N.V. Shitole	Shri Shivaji college Parbhani	Invitee Member
17.	Dr. A. R. Shinde	Sanjeevane Mahavidyalaya, Chapoli	Invitee Member

ABBREVIATIONS USED

Abbreviation	Full Form
POs	Program Outcomes
PS	Program Structure
PSOs	Program Specific Outcomes
COs	Course Outcomes
TLP	Teaching-Learning Process
AM	Assessment Method
DSC	Discipline Specific Core
DSE	Discipline Specific Elective
GE	Generic Elective
OE	Open Elective
VSC	Vocational Skill Course
SEC	Skill Enhancement Course
IKS	Indian Knowledge System
AEC	Ability Enhancement Course
VEC	Value Education Course
OJT	On Job Training (Internship)
FP	Field Project
CEP	Community Engagement Project
CC	Co-curricular Courses
RM	Research Methodology
RP	Research Project
MJ	Major Course
MN	Minor Course

INTRODUCTION TO UNDERGRADUATE DEGREE IN ANALYTICAL CHEMISTRY

As per the guidelines of the **University Grants Commission (UGC)** and the framework adopted by **Swami RamanandTeerthMarathwada University, Nanded**, the **Undergraduate (UG) Programme in Analytical Chemistry** is structured under the **National Education Policy (NEP)** with a flexible **Four-Year (Eight Semesters)** framework, with an option to exit after **Three Years (Six Semesters)**.

The **Teaching–Learning Process (TLP)** is designed to be **student-centric, outcome-based, and skill-oriented**, integrating theory, practical, vocational, and experiential learning components. The curriculum ensures a **strong foundation in core Chemistry subjects** along with opportunities for advanced learning and interdisciplinary exposure.

The programme includes a combination of the following course types:

- **Major (DSC/MJ – Discipline Specific Core / Major Courses)**
- **Minor (MN/DSE – Discipline Specific Electives)**
- **Vocational Skill Courses (VSC)**
- **Skill Enhancement Courses (SEC)**
- **Indian Knowledge System (IKS)**
- **Open/Generic Electives (OE/GE)**
- **Ability and Value Enhancement Courses (AEC/VEC)**
- **Field Projects, Internships (OJT), and Community Engagement Projects (CEP)**

This structure promotes a multidisciplinary and interdisciplinary approach, allowing students to explore diverse academic areas alongside their core discipline. The programme offers flexibility in course selection, credit accumulation, and academic progression, enabling students to design their learning pathway based on their interests, aptitude, and career aspirations.

Furthermore, the provision of multiple entry and exit options ensures that students can obtain Certificate, Diploma, Degree, or Honours Degree at different stages, thereby enhancing employability and supporting higher education opportunities.

Overall, the UG Programme in Analytical Chemistry under SRTMU aims to develop scientific knowledge, practical skills, critical thinking, research aptitude, and professional competence, preparing students for higher studies, research, and diverse career opportunities in industry, academia, and allied fields.

PROGRAM DURATION AND EXIT OPTIONS

The duration of the **Undergraduate (UG) Programme in Analytical Chemistry** at **Swami Ramanand Teerth Marathwada University, Nanded** shall be **four years (Eight Semesters)** under the NEP framework. Students shall have **multiple entry and exit options** as per NEP guidelines:

- Students completing only three years (Six Semesters) will be awarded a Bachelor of Science (B.Sc.) Degree in Chemistry.
- Students exiting after the first year (Two Semesters) will be awarded an Undergraduate Certificate in Chemistry, provided they have earned the prescribed credits.
- Students exiting after the second year (Four Semesters) will be awarded an Undergraduate Diploma in Chemistry, subject to fulfilment of required credits.
- Students completing the four-year programme (Eight Semesters) will be awarded a Bachelor of Science in Chemistry (Honours / Honours with Research) as per university regulations.

Students who exit the programme at any stage (Certificate/Diploma) shall be eligible for re-entry within a maximum period of three years, subject to university rules and availability of seats.

The credit framework is designed to ensure flexibility in academic progression:

- Minimum credits per semester: 18
- Maximum credits per semester: 26
- Recommended credits per semester: 22

Table 1: Awards and Required Credits

Sr. No.	NCrF / NHEQF Level	Type of Award	Stage of Exit/ Programme Duration	Credits Required
1	Level 4.5	Undergraduate Certificate in Chemistry	After successful completion of First Year (Semester I & II)	44
2	Level 5.0	Undergraduate Diploma in Chemistry	After successful completion of Second Year (Semester III & IV)	88
3	Level 5.5	Bachelor of Science (B.Sc.) in Chemistry	After successful completion of Third Year (Semester V & VI)	132
4	Level 6.0	Bachelor of Science in Chemistry (Honours / Honours with Research)	After successful completion of Fourth Year (Semester VII & VIII)	176

OBJECTIVES OF THE PROGRAM

- To strengthen students' understanding of fundamental and advanced concepts in Physical, Organic, and Inorganic Chemistry.
- To develop the ability to apply chemical principles to solve theoretical and practical problems in Analytical chemistry.
- To enhance laboratory skills and experimental techniques required for qualitative and quantitative analysis.
- To promote critical thinking, analytical ability, and scientific reasoning among students.
- To familiarize students with the applications of Analytical chemistry in industry, environment, health, and daily life.
- To develop awareness about green chemistry, safety practices, and environmental sustainability.
- To encourage research orientation, innovation, and higher learning in the chemical sciences.

PROGRAM OUTCOMES

After successful completion of the B.Sc. Analytical Chemistry programme, students will be able to:

PO1: Disciplinary Knowledge

Demonstrate comprehensive knowledge of fundamental and advanced concepts in **Physical, Organic, and Inorganic Chemistry**, including theoretical and practical aspects.

PO2: Problem Analysis

Apply chemical principles, mathematical tools, and scientific reasoning to identify, formulate, and solve complex theoretical and experimental problems.

PO3: Critical Thinking

Develop critical thinking and analytical skills to evaluate scientific data, interpret results, and draw logical conclusions.

PO4: Experimental Skills & Laboratory Competence

Perform qualitative and quantitative chemical analysis using standard laboratory techniques, instruments, and modern tools with accuracy and precision.

PO5: Modern Tool Usage

Utilize contemporary chemical software, instrumentation, and ICT tools for data analysis, simulation, and research applications.

PO6: Environment and Sustainability

Understand the role of Analytical chemistry in environmental protection and sustainable development, including principles of **green chemistry** and pollution control.

PO7: Ethics and Safety

Follow ethical practices, laboratory safety protocols, and professional responsibilities in academic and industrial settings.

PO8: Communication Skills

Communicate scientific information effectively through oral presentations, laboratory reports, and technical writing.

PO9: Lifelong Learning

Recognize the need for continuous learning and professional development in the field of chemical sciences and related disciplines.

PO10: Research and Innovation

Develop research aptitude, creativity, and innovation skills for pursuing higher studies, research, and entrepreneurship.

PO11: Teamwork and Leadership

Work effectively as an individual and as a member or leader in multidisciplinary teams.

PO12: Application in Society and Industry

Apply chemical knowledge in solving real-life problems related to **industry, health, agriculture, and environment**.

PROGRAM SPECIFIC OUTCOMES

After completion of the programme, students will be able to:

PSO1: Core Chemistry Competence

Acquire in-depth knowledge of core areas such as:

- Thermodynamics, kinetics, and quantum chemistry
- Organic reaction mechanisms and synthesis
- Coordination chemistry, spectroscopy, and materials chemistry

PSO2: Laboratory Proficiency

Develop hands-on skills in:

- Volumetric, gravimetric, and instrumental analysis
- Organic synthesis and purification techniques
- Handling modern instruments like pH meter, conductometer, spectrophotometer, etc.

PSO3: Application of Chemical Knowledge

Apply chemical concepts in:

- Industrial processes (fertilizers, polymers, pharmaceuticals)
- Environmental monitoring and pollution control
- Health, food chemistry, and daily life applications

PSO4: Green Chemistry and Sustainability

Implement principles of green chemistry, waste minimization, and eco-friendly practices in laboratory and industrial contexts.

PSO5: Research Orientation

Design and conduct basic research experiments, analyze data, and present findings scientifically.

PSO6: Interdisciplinary Understanding

Integrate chemistry with related fields such as **biology, physics, environmental science, and material science**.

PSO7: Employability and Skill Development

Develop skills relevant to:

- Chemical industries
 - Quality control laboratories
 - Teaching and academic research
 - Competitive examinations and higher education
-

GENERAL GUIDELINES FOR THE SELECTION OF SUBJECTS

1. A student has to choose three subjects from the same faculty in the first year. At the start of the second year, he/she has to opt for one subject as the Major subject and one (from the remaining two subjects) as the Minor subject; the last one will be dropped by the student.
2. A student cannot select a subject as Major or Minor other than the subjects taken in the first year.
3. OE (Open Elective) is to be chosen compulsorily from a faculty other than that of the Major.
4. SEC is to be selected from the basket of Skill Courses approved by the university.
5. VSC, FP/OJT/CEP should be related to the Major subject.
6. AEC, VEC, IKS (Generic), and CC will be provided by the university separately.

TEACHING-LEARNING PROCESS

- a.** Courses will be taught through the traditional chalk-and-talk method, laboratory work, ICT-enabled teaching–learning tools, project work, seminars, case studies, field work, internships, hands-on training, etc.
- b.** Students will be engaged in various student-centric activities including experiential learning, problem-solving methodologies, participative learning, and ICT-based teaching–learning processes.
- c.** ICT tools in Basic and Advanced Chemistry software will be used to make the teaching–learning process efficient and engaging.
- d.** Critical, analytical, and problem-solving abilities will be developed through project-based learning, internships, industrial visits, and hands-on training.
- e.** Problem-solving methodologies such as quizzes, review of books and research papers, workshops, and research-based competitions will be employed.
- f.** Vocational and skill training will be conducted through vocational and skill-based courses.
- g.** Students will be introduced to advanced laboratory instruments for hands-on training.

METHODS OF ASSESSMENT

The primary objective of assessment is to evaluate the attainment of learning outcomes of the course in alignment with the broader goals of strengthening core theoretical knowledge, developing practical laboratory skills, and promoting research aptitude among students.

The assessment system shall be based on **Continuous Internal Evaluation (CIE)** and **End Semester University Examination (ESE)** as per the norms of **Swami Ramanand Teerth Marathwada University, Nanded**.

Continuous Internal Evaluation (CIE)

During the semester, students' performance and mastery of the prescribed learning outcomes will be evaluated through various academic activities such as:

- Short answer tests
- Class tests
- Seminars and presentations
- Group discussions
- Quizzes and MCQs
- Assignments and tutorials
- Project work

Each theory and practical course shall carry **10 marks for internal assessment (for each-credit course)**. The internal assessment will be conducted by the respective colleges as per university guidelines.

End Semester Examination (ESE)

The End Semester Examination will be conducted by **Swami Ramanand Teerth Marathwada University, Nanded** for both theory and practical courses. Each credit course shall carry **15 marks for the End Semester Examination (ESE)**.

Scheme of Examination

- Total marks for 2-credit course: 50 (20 Internal + 30 ESE)
- Total marks for 4-credit course: 100 (40 Internal + 60 ESE)
- Internal examinations will be conducted by the respective colleges.
- External examinations will be conducted by SRTMU, Nanded at the end of each semester.

Marks distribution under CA (40%)

Sr. No.	Continuous Assessment Modes	For 4 Credit (Marks)	For 2 Credit (Marks)	For 3 Credit (Marks)
1	Class Test	20	10	15
2	Assignment, Presentation, Viva, Quiz, Open Book, etc.	12	06	09
3	Attendance	08	04	06
	Total	40	20	30

STRUCTURE OF T.Y. B.SC. ANALYTICAL CHEMISTRY

B.Sc. Third Year — Semester V (Level 5.5)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching (Hrs/wk)	
			Theory	Practical	Total	Theory	Practical
Major	SACHCT1301	Modern Techniques of Chemical Analysis - I	03	–	03	03	03
	SACHECP1301	Practical based on SACHCT1301	--	02	02	--	04
	SACHCT1302	Applied Analytical Chemistry - I	03	--	03	03	03
	SACHECP1302:	Practical based on SCHECT1302	--	02	02	--	04
	SACHIKS1301:	Subject Specific IKS- IKS in Chemistry	02	--	02	02	02
Elective	SACHET1301A / SACHET1302A	Elective Paper (Theory)	02	–	02	02	02
	SACHEP1301	Elective Paper (Practical)	–	02	02	–	04
Vocational Course	SACHVC1301	Vocational Skill Course	–	02	02	–	04
Field Project	SACHFP1301	Field Project	–	04	04	–	08
Total Credits			10	12	22	10	34

B.Sc. Third Year — Semester V**Examination Scheme**

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col(6+7) /Col(8+9) (10)
			Continuous Assessment (CA)			ESA	CA (8)	ESA (9)	
			Test I (4)	Test II (5)	Avg TI & TII (6)	(7)			
Major	SACHCT1301	Modern Techniques of Chemical Analysis - I	30	30	30	45	–	–	75
	SACHECP1301	Practical based on SACHCT1301	50	–	–	–	20	30	30
	SACHCT1302	Applied Analytical Chemistry - I	75	30	30	30	45	–	75
	SACHECP1302:	Practical based on SCHECT1302	50	–	–	–	20	30	30
	SACHIKS1301:	Subject Specific IKS- IKS in Chemistry	50	20	20	30	30	20	30
Elective	SACHET1301A / SACHET1302A	Elective Paper (Theory)	20	20	20	30	–	–	50
	SACHEP1301	Elective Paper (Practical)	–	–	–	–	20	30	50
Vocational Course	SACHVC1301	Vocational Skill Course	–	–	–	–	20	30	50
Field Project	SACHFP1301	Field Project	–	–	–	–	40	60	100

B.Sc. Third Year — Semester VI (Level 5.5)**Teaching Scheme**

Subject	Course Code	Course Name	Credits Assigned			Teaching (Hrs/wk)	
			Theory	Practical	Total	Theory	Practical
Major	SACHCT1351	Modern Techniques of Chemical Analysis - II	03	–	03	03	03
	SACHCT1352:	Applied Analytical Chemistry - II	03	--	03	03	03
	SACHCT1353:	Green Chemistry	02	--	02	02	02
	SACHCP1351:	Practical based on SACHCT1351	--	02	02	–	04
	SACHCP1352:	Practical based on SACHCT1352	--	02	02	–	04
Elective	SACHET1351A / SACHET1351B	Elective Paper (Theory)	02	–	02	02	–
	SACHEP1351	Elective Paper (Practical)	–	02	02	–	04
Vocational Course	SACHVC1351	Vocational Skill Course	–	02	02	–	04
Field Project	SACHOJT1351	Field Project	–	04	04	–	08
Total Credits			10	12	22	10	32

B.Sc. Third Year — Semester VI**Examination Scheme**

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col(6+7) / Col(8+9) (10)
			Continuous Assessment (CA)			ESA	CA (8)	ESA (9)	
			Test I (4)	Test II (5)	Avg TI & TII (6)	(7)			
Major	SCHECT1351	Modern Techniques of Chemical Analysis - II	30	30	30	45	--	--	75
	SCHECT1352	Applied Analytical Chemistry - II	30	30	30	45	--	--	75
	SCHECT1353	Green Chemistry	20	20	20	30	--	--	50
	SCHECP1351	Practical based on SACHCT1351	50	--	--	--	20	30	50
	SCHECP1352	Practical based on SACHCT1352	50	--	--	--	20	30	50
Elective	SCHEET1351	Elective Paper (Theory)	20	20	20	30	--	--	50
	SCHEEP1351	Elective Paper (Practical)	50	--	--	--	20	30	50
Vocational Course	SCHEVC1351	Vocational Skill Course (02 Cr.)	--	--	--	--	20	30	50
OJT	SCHEOJT1351	On Job Training / OJT (04 Cr.)	--	--	--	--	40	60	100

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
B.Sc. Third Year - Analytical Chemistry
SACHCT1301 - Modern Techniques of Chemical Analysis - I

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Modern Techniques of Chemical Analysis - I SACHCT1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Core Major
Credits	3
Total Hours	45 Hours
Formative Assessment Marks	30
Summative Assessment Marks	45
Total Marks	75

Course Objectives

- To develop conceptual understanding of infrared, ¹H NMR, mass, and fluorescence spectroscopic techniques.
- To familiarize students with instrumentation, experimental techniques, and analytical principles of selected spectroscopic methods.
- To enable interpretation of spectral data for qualitative analysis and structural elucidation.
- To cultivate analytical reasoning for selecting suitable spectroscopic methods in chemical analysis.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the theory, instrumentation, and applications of infrared spectroscopy.	Remember/ Understand	PO1, PO2
CO2	Interpret ¹ H NMR spectra using chemical shift, proton equivalence, and spin-spin coupling concepts.	Apply/ Analyze	PO2, PO4
CO3	Describe the working principle, ion formation, and analytical applications of mass spectrometry.	Understand/ Apply	PO1, PO3

CO4	Evaluate fluorescence measurements and identify suitable analytical applications of fluorescence spectroscopy.	Analyze/Evaluate	PO4, PO5
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Prerequisites

- Basic knowledge of the concerned branch of chemistry and related laboratory skills.

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Infrared Spectroscopy	Range of IR-radiation, Theory- Requirements for I R radiation absorption, Different normal modes of vibrations of atoms in a poly atomic molecule, Instrumentation and Experimental Technique. Application of IR spectroscopy.	12
II	¹ H NMR Spectroscopy	Theory of ¹ H NMR, Instrumentation, Experimental technique, NMR spectra, Number of signals equivalent and non-equivalent protons, Chemical Shift, Measurement of Chemical Shift, Factors affecting chemical shift, Spin-spin coupling, functional groups and chemical shifts, Applications of ¹ HNMR spectra in structure determination and identification of compounds.	13
III	Mass Spectrometry	Theory, Instrumentation, recording of mass spectrum, Resolution of mass spectrometer, Types of ions produced in a mass spectrometer, interpretation of mass spectra, Applications of mass spectrometry	12
IV	Fluorescence Spectroscopy	Theory, Relation between fluorescence intensity and concentration, Single and Double beam filter fluorometers, Applications.	8

Total Hours: 45 Hours

Recommended Textbooks / Reference Books

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Modern Techniques of Chemical Analysis – I (Practical) SACHCP1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Core Major Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To develop operational skills for analytical instruments such as flame photometer, potentiometer, conductometer, and polarograph.
- To train students in classical and instrumental methods for the analysis of ores, soil, water, and biochemical samples.
- To develop skill in separation techniques including ion-exchange chromatography and paper/TLC chromatography.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Perform selected instrumental and classical analytical experiments with precision.	Apply	PO3, PO4
CO2	Analyze results obtained from environmental, ore, biochemical, and chromatographic samples.	Analyze	PO4, PO5
CO3	Carry out chromatographic separations and ion-exchange procedures for analytical applications.	Apply	PO3, PO6
CO4	Maintain laboratory records and demonstrate safe laboratory practices.	Apply	PO6, PO8

List of Experiments / Activities

Twelve experiments should be completed

1. Analysis of ores & Soil.

1. Estimation of Na/ K by flame photometer in a cold drink.
2. Estimation of aluminum in bauxite gravimetrically.
3. Determination of calcium in dolomite by flame photometer.
4. Estimate the amount of lead present in solution of lead nitrate by conductometric titration with sodium sulphate
5. Polarographic determination of trace quantity of lead/ Cadmium/ Zinc in sample solution.
6. Determination of Silver in an alloy by Volhard's method

2. Analysis of biochemical's.

1. Estimation of Na/ K in saline/ORS by flame photometer.
2. Determine of sugar in sugarcane /soft drinks by Folin –Wu-Method.
4. Determination of SO₂ in sugar (Ref: System of Technical control for cane sugar factories in India – R. M. Verma Sugar Technologists Assoc. of India, Kanpur)
5. Colorimetric determination of lead / magnesium on leaves using solvent extraction.
6. Colorimetric determination of manganese and chromium in mixture.

3. Chromatographic Techniques

1. Determination of Capacity of cation exchange resin.
2. Determination of Capacity of anion exchange resin.
3. Separation of cobalt and nickel on an anion exchange resin and their subsequent determination by direct back EDTA titration.
4. Paper/Thin layer chromatography separation of metals/ amino acids / Sugars from a mixture.
5. Chromatographic separation of plant leaf pigments.
6. Determination of magnesium and Zinc in a mixture by ion exchange separation and complexometric titration.
7. Separation of cadmium and zinc on an anion exchanger and their subsequent determination by EDTA titration.
8. Determination the refractive strength of chloroacetic acid and acetic acid by conductivity measurements

4. Analysis of water

1. Potentiometric determination of fluoride in drinking water/ river water using Fluoride- ion selective electrode.
2. Determination of available chlorine in bleaching powder volumetrically using an external Indicator.
3. Determination of cell constant of conductivity cell

5. Elemental Analysis

1. Determination of concentration of ferrous ion by potentiometric titration.
2. Iodometric determination of copper.
3. Estimation of ferrous and ferric iron in a mixture by potentiometry.
4. Determination of copper and Nickel in a mixture by volumetric methods.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHCT1302 - Applied Analytical Chemistry - I

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Applied Analytical Chemistry - I SACHCT1302
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Core Major
Credits	3
Total Hours	45 Hours
Formative Assessment Marks	30
Summative Assessment Marks	45
Total Marks	75

Course Objectives

- To develop understanding of environmental, soil, food, and cosmetic analysis.
- To familiarize students with sampling and analytical methods used in applied chemistry.
- To apply analytical techniques for quality assessment of water, soil, food products, and cosmetics.
- To cultivate awareness of pollution monitoring and consumer product analysis.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain analytical concepts involved in air and water pollution monitoring.	Remember/ Understand	PO1, PO2
CO2	Apply methods for analysis of industrial effluents and physico-chemical properties of soil.	Apply/ Analyze	PO3, PO4
CO3	Interpret analytical data related to milk, flour, fish, honey, and other food products.	Analyze	PO4, PO5
CO4	Describe the composition and outline analysis of selected cosmetic products.	Understand/ Apply	PO1, PO6

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Environmental Analysis: Air and Water	<p>Analysis of Air: Composition of natural atmospheric air, pollution, pollutants in air, causes of pollution, sampling of air, Determination of i) particulate matter suspended and settled ii) Sulphur dioxide iii) Nitrogen dioxide iv) Carbon mono and dioxide as pollutants.</p> <p>Analysis of Water: Introduction to potable water quality standards, objectives of water analysis. Methods of measurement of water quality parameters: Physical parameters - pH, conductivity, total dissolved solids. Determination of chemical parameters – Temporary and Permanent Hardness, Dissolved oxygen, Chemical Oxygen Demand and Bio chemical Oxygen Demand.</p>	12
II	Industrial Effluents and Soil Analysis	<p>Analysis of Industrial Effluents: Introduction, definition, preliminary treatment of industrial effluent sample, estimation of toxic metals like Hg & Zn in industrial effluents.</p> <p>Analysis of Soil: Introduction, Methods of soil sampling, Determination of (i) Bulk density (ii) specific gravity (iii) water holding capacity (iv) moisture content (v) Loss on ignition (vi) soil pH. Chemical Analysis of Soil: Determination of (i) Total nitrogen, (ii) Nitrate Nitrogen (iii) organic matter (iv) Potassium and Sodium.</p>	12
III	Analysis of Food and Food Products	<p>Composition and Analysis of</p> <p>Milk: Introduction, definition, general composition of milk. Determination of specific gravity, Total solids, fat, Protein, Lactose and Acidity.</p> <p>Wheat flour: Introduction, types of wheat flour, general composition of wheat flour. Determination of moisture, ash fat, protein, fibre, acidity, pH & starch.</p> <p>Fish: Introduction, assessment of raw fish for its spoilage, Chemical methods for assessment of spoilage Determination of moisture, total fat, ash, chloride, Nitrogen and total phosphorus.</p> <p>Honey: Introduction, definition determination of total solids, moisture, ash, free acid pH and glucose.</p>	16
IV	Analysis of Cosmetics	Introduction to cosmetics, definition, General characteristics, composition and analysis in outline of the following (i) Face Powders (ii) Hair dyes.	5

Total Hours: 45 Hours**Recommended Textbooks / Reference Books**

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Applied Analytical Chemistry - I (Practical) SACHCP1302:
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Core Major Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To familiarize students with conductometric, potentiometric, spectrophotometric, and routine analytical procedures used in food, fertilizer, and environmental analysis.
- To develop competence in gravimetric, titrimetric, and instrumental methods for applied analysis.
- To strengthen analytical accuracy, data handling, and report-writing skills.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Perform analytical experiments related to fertilizers, food, pharmaceuticals, and environmental samples.	Apply	PO3, PO4
CO2	Use instrumental methods such as spectrophotometry, conductometry, and potentiometry in sample analysis.	Apply/Analyze	PO3, PO4
CO3	Interpret analytical data and evaluate quality parameters of food, soil, and commercial products.	Analyze	PO4, PO5
CO4	Record observations systematically and follow laboratory safety practices.	Apply	PO6, PO8

List of Experiments / Activities

1. Estimation of Nitrogen from given sample of fertilizer by Kejaldal method.
2. Determination of COD, BOD and dissolved oxygen from waste water sample.
3. Estimation of chloride from food sample by Volhard titration method.
4. Determination of sodium carbonate in washing soda.
5. Determination of volume strength of commercial hydrogen peroxide using KMnO_4
6. Determination of Silica in soil.
7. Determination of magnesium in soil.
8. Determination of soil pH.
9. Moisture content in pharmaceutical/food sample by Karl-fisher titration method.
10. Estimation of pesticide residue by TLC method
11. Estimation of Mg from given sample of talcum powder.
12. Estimation of alcohol in the given sample by diffusion oxidation method
13. Determination of commercial vinegar by potentiometric titration and its confirmation by conductometric method.
14. Determine the amount of phosphate from given sample of fertilizer/detergent using spectrophotometric method.
15. Estimate the reducing sugar by 3, 5 dinitro salicylic acid in the given food sample by Spectrophotometric method.
16. . Determination of bicarbonate in detergents using back titration.
17. Determination of iron content in foods by spectrophotometry.
18. Isolation of piperine from black pepper and its determination as crude piperine.
19. Determination of Carbon dioxide in carbonated beverages.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHIKS1301 - Indian Knowledge System in Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Indian Knowledge System in Chemistry SACHIKS1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	IKS
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To introduce students to the rich chemical heritage of India from prehistoric to ancient periods.
- To develop an understanding of Indian philosophical concepts of matter and atomic theories.
- To explore applications of chemistry in ancient Indian medicine, textiles, metallurgy, and daily life.
- To examine traditional chemical techniques from a modern scientific perspective.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain early chemical traditions and material advancements from prehistoric to Harappan India.	Understand	PO1, PO3
CO2	Analyze Vedic and philosophical concepts of matter, including Vaisheshika and Jain atomic theories.	Analyze	PO2, PO4
CO3	Evaluate applications of chemical knowledge in ancient Indian medicine, textiles, and household materials.	Evaluate	PO5, PO10
CO4	Apply knowledge of ancient chemical techniques such as metallurgy, distillation, sublimation, and fermentation.	Apply	PO3, PO6

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Early Chemical Traditions	Pre-Harappan developments, pottery techniques, copper extraction, Harappan ceramic technology, faience, pigments, glazed pottery, construction materials.	7
II	Vedic Knowledge and Philosophical Concepts of Matter	Chemical knowledge in Vedic texts, atomic theories, chemical affinity, and traditional views on matter.	7
III	Applications of Chemistry in Ancient India	Ayurveda and Rasashastra, dyes, metal crafting, glazed pottery, oils, cosmetics and construction materials.	8
IV	Ancient Chemical Techniques and Processes	Metallurgy, distillation, sublimation, calcination and fermentation in ancient India.	8

Total Hours: 30 Hours**Recommended Textbooks / Reference Books**

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHET1301A - Fundamentals of Analytical Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Fundamentals of Analytical Chemistry SACHET1301A
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Elective
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To study the key elements of a QA/QC programme.
- To develop understanding of laboratory validation, accreditation, and quality standards.
- To gain knowledge of statistics, probability, and hypothesis testing relevant to analytical chemistry.
- To strengthen interpretation of analytical data and sampling methodology.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the principles of laboratory quality management and QA/QC practices.	Remember/ Understand	PO1, PO2
CO2	Describe quality assurance standards and validation procedures relevant to analytical work.	Understand/ Apply	PO2, PO3
CO3	Apply statistical tools for data collection, presentation, and interpretation.	Apply/ Analyze	PO3, PO4
CO4	Interpret probability distributions and hypothesis tests for analytical decision making.	Analyze/ Evaluate	PO4, PO5

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Introduction to QA/QC	Laboratory quality management, Laboratory Accreditation, Validation of laboratory tests, Key Elements of a QA/QC Program, proficiency testing, quality control testing, quality assurance monitoring, procedure manual, laboratory reports, laboratory records, laboratory security, Personnel and Training, Validation of Analytical Procedures, Equipment, Standard Operating Procedures, Study protocols, The Final report, Archiving, Storage and Retrieval, Inspection and Compliance. Regulatory aspects of quality control, Quality 63 assurance and quality management ISO, WHO and US certification	8
II	Quality Assurance Standards	Quality Assurance Standards for Forensic DNA Testing Laboratories: References, Scope, Definitions, Quality Assurance Program, Organization and Management Personnel, Facilities, Evidence Control, Validation, Analytical Procedures, Equipment Calibration and Maintenance, Reports.	7
III	Statistics and Data Analysis	Basic definitions and applications of statistics, sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data. Methods of data presentation-graphical representation by histogram, polygon, ogive curves and pie diagram. Measures of central tendency: mean, median and mode; measures of dispersion: range, mean deviation, standard deviation, variance, quartile, standard error and coefficient of variation; correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons coefficient of correlation, skewness and kurtosis.	8
IV	Probability and Hypothesis Testing	Introduction to probability theory, various definitions of probability, Basic terms: random experiments, event, trial, sample space, independent and mutually exclusive events; conditional probability, Addition and multiplication theorem, Baye's theorem, likelihood ratio and discriminating power. Distribution of data: normal, binomial and Poisson distribution. Test of hypothesis: introduction and concepts; test for small and large sample: Z-test, t-test, chisquare test, F-test and ANOVA.	7

Total Hours: 30 Hours

Recommended Textbooks / Reference Books

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.

- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
 SACHET1302A - Bio-organic Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Bio-organic Chemistry SACHET1302A
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Elective
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To study carbohydrates, stereochemistry, vitamins, alkaloids, and selected organometallic compounds.
- To strengthen conceptual foundations in structure, reactivity, and stereochemistry of organic molecules.
- To relate bio-organic compounds to their sources, functions, and applications.
- To cultivate interpretation of stereochemical and structural features of organic molecules.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the classification, structures, and reactions of carbohydrates.	Remember/ Understand	PO1, PO2
CO2	Apply stereochemical concepts including optical and geometrical isomerism.	Apply/Analyze	PO2, PO4
CO3	Describe the source, structure, and significance of selected vitamins and alkaloids.	Understand	PO1, PO3
CO4	Discuss preparation, properties, and structures of selected organometallic compounds.	Understand/Apply	PO2, PO3

.Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Carbohydrates	Introduction, Definition and Classification. Reactions of Monosaccharide (Glucose): a) Addition reactions, b) Ether formation, c) Reduction of glucose, d) Oxidation of glucose, e) Osazone formation with mechanism. 4. Open and cyclic structure of glucose. 5. Mutarotation with Mechanism. 6. Epimerization. 7. Inter-conversions: a) Glucose to Fructose, b) Fructose to Glucose, c) Glucose to Mannose.	7
II	Stereochemistry	Introduction 2. Concept and Types of isomerism (a) Structural isomerism, (b) Stereoisomerism. 3. Types of Structural isomerism. 4. Types of Stereoisomerism. 5. Optical Isomerism: a) Concept of Asymmetric Carbon atom, Chiral centre, b) Optical Activity (Plane polarized light, dextro and laevo forms, racemic mixture), c) Element of Symmetry [Plane, Centre, and Axis], d) Concept of Enantiomers, e) Concept of Diastereomers f) Relative specification of configuration (D and L Notations), g) Absolute specification of configuration (R and S notations) [Examples: i) Lactic acid, ii) Glyceraldehyde, iii) Bromo chloro iodomethane, iv) 2-Chlorobutane, v) 1-Bromo-1-Chloro ethanol, vi) 1-Chloro ethylamine, vii) 1-Chloro-1-propanol, viii) Glyceric acid, ix) α -Deutero ethyl bromide, x) 1-Phenyl ethanol, xi) Mendelic acid, xii) 1-Phenyl ethylchloride, xiii) Lactonitrile, xiv) α -Bromo propanoic acid, xv) 2-Iodo octane and xvi) Cinnamic acid dibromide]. 6. Geometrical Isomerism (Cis-trans isomerism), E and Z System of nomenclature [Examples: i) Meleic acid, ii) 1-Chloro-2-bromo-2-iodoethene, iii) 3-Hexene, iv) 1,2-Diphenylethene, v) 2-Pentene, vi) 1-Deuterium hexane, vii) 3-Methyl-3-haxene, viii) Phenyl oxime, ix) 1-Bromo-1,2-dichloroethene, x) 2-Chloro-3-methyl-2-pentenoic acid, xi) Cinnamic acid and xii) Crotonic acid.	8
III	Vitamins and Alkaloids	A) Vitamins: Introduction and classification, Source, structure and deficiency diseases of the following vitamins: a) Vitamin A, D, E and K (Fat Soluble) b) Vitamin B ₁ , B ₂ , B ₃ , B ₆ , B ₁₂ and C (Water Soluble) B) Alkaloids: Introduction, occurrence and extraction, classification and general properties, determination of chemical constitution of a) Ephedrine: b) Nicotine.	8
IV	Organometallic Compounds	1) Definition 2) Nomenclature and classification of organometallic compounds 3) Preparation, properties, structure of organolithium. 4) Preparation, properties, structure of ferrocene.	7

Total Hours: 30 Hours

Recommended Textbooks / Reference Books

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded**Faculty of Science & Technology****SACHEP1301 - Organic and Inorganic Estimations and Preparations**

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Organic and Inorganic Estimations and Preparations SACHEP1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Elective Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To develop skill in quantitative estimation of selected organic compounds.
- To train students in synthesis, purification, and yield calculation of selected organic compounds and drug molecules.
- To strengthen competence in gravimetric estimation of inorganic analytes.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Perform quantitative estimations of selected organic compounds using appropriate analytical methods.	Apply	PO3, PO4
CO2	Synthesize and purify selected organic compounds and drug molecules.	Apply/Analyze	PO3, PO4
CO3	Carry out gravimetric estimation of selected inorganic constituents with accuracy.	Apply	PO3, PO5
CO4	Record observations, calculate percentage yield, and maintain proper practical records.	Apply	PO6, PO8

List of Experiments / Activities

1. Quantitative analysis: (estimation) any five.

- a) Estimation of glycine by Sorenson's method.
- b) Estimation of glucose by iodination method.
- c) Estimation of unsaturation (cinnamic acid).
- d) Estimation of ascorbic acid.
- e) Estimation of formaldehyde.

2. Synthesis of Drugs:

- a) Synthesis of Aspirin (Acetylsalicylic Acid)
- b) Synthesis of Paracetamol (Acetaminophen)
- c) Synthesis of Benzimidazole
- d) Synthesis of Schiff's Base

3. Inorganic Estimations

1. Gravimetric estimation of Iron as Fe_2O_3 .
2. Gravimetric estimation of Ba as BaSO_4
3. Gravimetric estimation of Nickel as $\text{Ni}(\text{DMG})_2$.
4. Gravimetric estimation of Aluminium as $\text{Al}(\text{Oxalate})_3$.
5. Gravimetric estimation of zinc as ZnO
6. Gravimetric estimation of Chloride as AgCl

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHVC1301 - Chemistry Skills and Data Analysis

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Chemistry Skills and Data Analysis SACHVC1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Value Added / Skill Course
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To introduce students to safe working practices and essential operations in a chemistry laboratory.
- To familiarize students with laboratory apparatus, balances, distillation assemblies, and routine handling techniques.
- To develop practical competence in common laboratory operations, purification methods, and documentation.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Demonstrate safe laboratory practices and interpret safety documentation such as MSDS and hazard labels.	Apply	PO6, PO8
CO2	Handle common laboratory apparatus, balances, and purification assemblies correctly.	Apply	PO3, PO4
CO3	Differentiate types of laboratory water, distillation methods, and vacuum systems used in laboratory operations.	Understand/Apply	PO1, PO3
CO4	Prepare records, charts, and procedural notes related to laboratory skills and data handling.	Apply/Create	PO6, PO7

List of Experiments / Activities

1. Carry out preparation of the indicative MSDS (Material Safety Data Sheet) of given set of chemicals as per Standard MSDS format.
2. Carry out detailed survey of the Chemical Abstract Service (CAS) Registry Number and identify the given set of CAS RN and explain the different sections of CAS RN.
3. Design an illustrative chart exhibiting creativity at transaction of Common Safety Symbols along with its description. Associate appropriate safety symbol with each of the given set of chemicals.
4. Draw and elucidate the National Fire Protection Association Hazard Labels.
5. Care and Use of Analytical Balance: Mass and Weight, Two-Pan Balance and Electronic Balance
6. Explore and differentiate between different forms of water for Laboratory Use: Distilled (Grade I to III), De-ionized and tap water, and carry out conductance measurement /other analytical investigations for the differentiation purpose.
7. Introduction to Gas absorption traps and their importance
8. Use of melting point apparatus
9. Experimental determination of the boiling point using various methods
10. Hand on training for working with typical assemblies of apparatus for distillation and refluxing
11. To Purify given organic solvents simple distillation
12. To Purify given organic solvents fractional distillation
13. To Purify given organic compound by steam distillation
14. Explore and imbibe knowledge about types of Vacuum Pump; Water and Oil Pump and their applications
15. Performing Evaporation of the solvent in the laboratory.
16. Investigate Conventions for Drying of the recrystallized material

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHFP1301 - Field Project in Analytical Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Field Project in Analytical Chemistry SACHFP1301
Year of Implementation	Academic Year 2026-2027
Semester	V
Paper Type	Field Project
Credits	4
Total Hours	120 Hours
Formative Assessment Marks	40
Summative Assessment Marks	60
Total Marks	100

Course Objectives

- To provide field-level exposure to applied analytical chemistry in environmental, industrial, agricultural, or community settings.
- To develop skills in sampling, onsite observations, data collection, and preliminary analysis.
- To train students in scientific reporting, interpretation of field data, and communication of findings.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Conduct field visits and identify analytical problems associated with water, soil, food, or industrial samples.	Apply	PO3, PO10
CO2	Collect, document, and organize field data and samples using standard procedures.	Apply/Analyze	PO3, PO4
CO3	Interpret field observations in the context of analytical chemistry and quality assessment.	Analyze/Evaluate	PO4, PO5
CO4	Prepare and present a concise field project report with conclusions and recommendations.	Apply/Create	PO6, PO7

List of Experiments / Activities

Sr. No.	Title of Experiment / Activity
1	Planning of field visit and selection of site/problem.
2	Sampling of water, soil, food, fertilizer, or industrial/environmental material.
3	Recording of field observations and sample metadata.
4	Preliminary analytical measurements or sample preparation.
5	Data tabulation and interpretation.
6	Preparation of field project report and oral presentation.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
 Semester VI

SACHCT1351 - Modern Techniques of Chemical Analysis - II

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Modern Techniques of Chemical Analysis – II SACHCT1351
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Core Major
Credits	3
Total Hours	45 Hours
Formative Assessment Marks	30
Summative Assessment Marks	45
Total Marks	75

Course Objectives

- To familiarize students with electroanalytical and chromatographic techniques used in modern chemical analysis.
- To develop understanding of conductometric, potentiometric, polarographic, and amperometric methods.
- To introduce ion-exchange, size-exclusion, and supercritical fluid chromatography along with computer applications in analytical chemistry.
- To develop analytical reasoning for selecting appropriate modern techniques in quantitative and separation analysis.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the principles and applications of conductometric and potentiometric techniques.	Remember/ Understand	PO1, PO2
CO2	Apply electroanalytical concepts to polarography and amperometry.	Apply/Analyze	PO2, PO4
CO3	Describe the principles and applications of ion-exchange and size-exclusion chromatography.	Understand/Apply	PO1, PO3
CO4	Discuss the role of computers, microprocessors, and AI in modern analytical chemistry.	Analyze/Evaluate	PO4, PO5

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Electroanalytical Techniques - I	<p>Conductometry: Conductance, specific conductance, Equivalent conductance, molecular conductance, Effect of dilution, measurement of conductance- conductivity cell, wheat stone bridge apparatus. Conduct metric Titrations, apparatus for conductometric titrations, Types of conductometric titrations -Acid base, Precipitation and Redox titrations.</p> <p>Potentiometry: Electrode Potential, Standard electrode potential, Nernst equation, EMF of an electrolytic cell, reference, indicator and ion selective electrodes. Theory of potentiometric titrations, Types of potentiometric titrations- Acid base, Redox and precipitation titrations.</p>	12
II	Electroanalytical Techniques - II	<p>Polarography: Principle of DC polarography, polarogram, Limiting current, Residual current, Migration current, Diffusion Current, IIAKovic equation, Kinetic Current, Decomposition potential, half wave potential. Instrumentation, dropping mercury electrode, dissolved oxygen electrode. Analytical applications of polarography.</p> <p>Amperometry: Theory of amperometric titrations, typical titration curves, Apparatus with rotating Platinum microelectrode and applications.</p>	12
III	Separation Techniques - I	<p>Ion Exchange Chromatography: Principle, ion exchange resins & their types- cation exchange resins anion exchange resins, ion exchange reactions, ion exchange equilibria, properties of ion exchange resins, ion exchange capacity, Techniques- Batch & Column method and applications</p>	10
IV	Separation Techniques - II and Computers	<p>Size Exclusion chromatography: Principle Gel-materials, Technique, instrumentation and applications.</p> <p>Super Critical Fluid Chromatography: Principle, instrumentation and applications</p> <p>Computers in Analytical Chemistry: Role of computers and Microprocessors in Analytical Chemistry. Applications of Artificial intelligence in modern analytical chemistry.</p>	11

Total Hours: 45 Hours

Recommended Textbooks / Reference Books

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHCT1352 - Applied Analytical Chemistry - II

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Applied Analytical Chemistry – II SACHCT1352
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Core Major
Credits	3
Total Hours	45 Hours
Formative Assessment Marks	30
Summative Assessment Marks	45
Total Marks	75
Status	Revised

Course Objectives

- To provide knowledge of pharmaceutical, clinical, fuel, and solvent extraction analysis.
- To develop understanding of analytical methods used for drug evaluation, blood chemistry, fuel characterization, and extraction separations.
- To apply analytical principles to quality control and routine applied analysis of pharmaceutical and clinical samples.
- To strengthen competence in interpretation of analytical data in applied chemistry.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain classification and analytical aspects of selected pharmaceutical compounds.	Remember/ Understand	PO1, PO2
CO2	Describe the composition of blood and methods for estimation of selected clinical analytes.	Understand/ Apply	PO2, PO3
CO3	Apply principles of solvent extraction based on distribution equilibria in analytical separations.	Apply/Analyze	PO3, PO4
CO4	Interpret analytical parameters used in the characterization of fuels.	Analyze	PO4, PO5

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Pharmaceutical Analysis	Introduction, definition, sources of drug, pharmacopeia standards, classification of drugs on the basis of their effects, therapeutic action and structure. Definition and analysis of followings classes of drugs with one specific example of each: (i) Antiseptics and Disinfectants (ii) Analgesics (iii) Antipyretics (iv) Antibiotics.	10
II	Clinical Analysis	Introduction, composition of Blood, Non cellular/ plasma and cellular components, Normal range of concentration of important constituents, collection and preservation of blood for plasma, serum, glucose and CO ₂ analysis. Estimation of sodium, potassium, calcium, and bicarbonate, Blood glucose, Blood urea.	12
III	Separation of Solvent Extraction	Introduction, theoretical principles – Nernst distribution law, Distribution constant, Distribution ratio, Efficiency of extraction, Percentage extraction, amount of solute extracted and left Unextracted, Sequence of extraction process, Extraction equilibria, factors favoring extraction, Techniques of extraction, Analytical applications.	11
IV	Analysis of Fuels	Introduction, theoretical principles – Nernst distribution law, Distribution constant, Distribution ratio, Efficiency of extraction, Percentage extraction, amount of solute extracted and left Unextracted, Sequence of extraction process, Extraction equilibria, factors favoring extraction, Techniques of extraction, Analytical applications.	12

Total Hours: 45 Hours

Recommended Textbooks / Reference Books

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHCT1353 - Green Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Green Chemistry SACHCT1353
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Core Major
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To introduce the principles, need, and scope of green chemistry in sustainable development.
- To familiarize students with renewable energy sources, green solvents, and nontraditional synthetic methodologies.
- To develop awareness regarding hazards, risk minimization, and environmentally benign chemical processes.
- To encourage application of green chemistry principles in synthesis, analysis, and resource utilization.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the twelve principles of green chemistry and concepts of hazard, risk, and sustainability.	Remember/ Understand	PO1, PO10
CO2	Describe renewable energy resources and their relevance to sustainable chemical practice.	Understand	PO1, PO10
CO3	Analyze the role of green solvents and solvent-free processes in chemical synthesis.	Apply/Analyze	PO3, PO4
CO4	Discuss microwave-assisted and sonochemical methodologies as alternative synthetic approaches.	Understand/Apply	PO2, PO5

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Basic Green Chemistry	Introduction, The twelve principles of Green Chemistry, Hazards and Green Chemistry Green chemistry and challenges, Green Chemistry Awareness initiatives, Presidential of Green chemistry challenges awards green chemistry in India. Typical real-world Cases of of green chemistry	8
II	Renewable Energy Sources	Introduction Biomass energy Resources of biomass energy, methods of extraction of biomass energy, benefits and constrains of biomass energy. Bio-fuels Syn gas, biodiesel, advantages over Petro diesel fuel. Solar energy solar power as heat energy, solar power as fuel solar power as electrical energy, concentrated solar power (CSP)	7
III	Green Solvents	Role of solvent, Solvent free processes, Solvent free organic synthesis thermal solvent free reactions, advantages and disadvantages. photochemical solvent free reaction. Water as solvent, Chemical synthesis in a aqueous media, high temperature water, disadvantages. Super critical fluids, Supercritical carbon dioxide i) Hydrogenation ii) Hydroformylation iii) Oxidation, advantages and disadvantages. Ionic liquids synthesis and applications of ionic liquids. Bio solvents, alcohols, glycerol.	7
IV	Synthetic Methodologies	Alternative nontraditional synthetic methodologies. Microwave synthesis, difference between normal and microwave reaction, advantages of microwave Chemistry, limitations of microwave Chemistry, how to convert a conventional reaction into a microwave reaction, applications of microwave Chemistry to organic synthesis. Sonochemistry, ultrasound and its chemical effects, Sono chemical reactions.	8

Total Hours: 30 Hours

Recommended Textbooks / Reference Books

1. Anastas, P.T.; Warner, J.C. (1998), Green Chemistry, Theory and Practice, Oxford University Press.
2. Lancaster, M. (2016), Green Chemistry An Introductory Text. 2nd Edition, RSC Publishing.
3. Cann, M. C.; Connely, M. E. (2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.
4. Matlack, A.S. (2001), Introduction to Green Chemistry, Marcel Dekker.
5. Alhuwalia, V. K.; Kidwai, M.R. (2005), New Trends in Green chemistry, Anamalaya Publishers.
6. Green Chemistry J. N. Gurtu and Kusum Sharma.

Swami Ramanand Teerth Marathwada University, Nanded**Faculty of Science & Technology****SACHCP1351 - Modern Techniques of Chemical Analysis – II Practical-**

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Modern Techniques of Chemical Analysis – II Practical- SACHCP1351
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Core Major Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To familiarize students with practical analysis of environmental, food, pharmaceutical, clinical, cosmetic, and fuel samples.
- To develop competence in titrimetric, colorimetric, and routine applied analytical methods.
- To strengthen interpretation of analytical results for real-world samples.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Perform analytical experiments related to environmental and food samples using standard methods.	Apply	PO3, PO4
CO2	Carry out pharmaceutical, clinical, and cosmetic analyses with appropriate procedures.	Apply/Analyze	PO3, PO4
CO3	Interpret experimental data for quality assessment of selected fuels and consumer products.	Analyze	PO4, PO5
CO4	Maintain proper records and follow safe laboratory practices.	Apply	PO6, PO8

List of Experiments / Activities

1. Environmental Analysis.

1. Colorimetric estimation of traces of nitrogen in the sample of water using Nessler's reagent.
2. Determination of dissolved oxygen in water by Winkler's method.
3. Determination of nitrate nitrogen/ nitrite nitrogen/ phosphate in a sample of water by colorimetry.
4. Determination of total hardness, calcium hardness and magnesium hardness of a water sample.
5. Determination of chemical oxygen demand (C.O.D) of a waste water sample.
6. Estimation of carbon/ organic matter in a soil sample by chromic acid digestion.

2. Food & Food product analysis.

1. Determination of nitrogen in wheat flour.
2. Estimation of lipids in egg yolk.
3. Estimation of protein in milk by formal titration/ casein nitrogen.
4. Analysis of milk for its lactose/ total solid/
6. Determination of total acidity, fixed acidity and volatile acidity in pickles / titratable acidity in fruits/ fruits juices.
7. Determination of sodium bicarbonate in carbonated drinks/ soda water/ soft drinks and determination of caffeine in cola drinks/ carbonated beverages.
8. Determination of water extractives and tannin in a Tea Coffee sample.
9. Determination of ether extractives and caffeine in tea/ Coffee samples.
10. Determination of vanillin in vanilla extract/ food sample.

3. Pharmaceutical, Clinical & Cosmetics analysis:

1. Determination of glucose in honey by Wilstatter's method.
2. Analysis of acetyl salicylic acid.
3. Estimation of micro nutrients Zinc/Copper/ Maganese in a soil sample.
4. Determination of acid value of rosin.
5. Determination of pH of Hair shampoos.
6. Assay of isomiazide.
7. Ultraviolet spectrophotometric determination of Aspirin, Penacetin, and caffeine in APC tablets using solvent extraction.
8. Estimation of blood glucose.
9. Estimation of serum bicarbonate.
10. Estimation of blood urea.

4. Fuel Analysis:

1. Determination of moisture in coal
2. Determination of Ash in coal.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHCP1352 - Applied Analytical Chemistry – II Practical

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Applied Analytical Chemistry – II Practical SACHCP1352
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Core Major Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To develop practical skill in calibration, composition analysis, and instrumental evaluation of food, commercial, and environmental samples.
- To train students in refractometric, conductometric, potentiometric, spectrophotometric, and chromatographic procedures.
- To improve precision, error analysis, and analytical interpretation skills.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Calibrate selected laboratory measurements and estimate composition or purity of given samples.	Apply	PO3, PO4
CO2	Use chromatographic, conductometric, potentiometric, flame photometric, spectrophotometric, and refractometric methods in analysis.	Apply/Analyze	PO3, PO4
CO3	Interpret analytical data and calculate relevant physical and chemical parameters.	Analyze	PO4, PO5
CO4	Maintain systematic practical records and demonstrate safe use of instruments.	Apply	PO6, PO8

List of Experiments / Activities

1. Calibration of weight and calculation of errors in it.
2. Estimation of polyphenols present in tea sample.
3. Ash content of milk powder.
4. Estimation of chlorine in bleaching powder
5. Determine Empirical formula using mole ratio method.
6. Determination of Phosphoric acid content of soft drink
7. Determine % purity of commercial sample of NaOH
8. To separate chlorophyll from green leaves by paper chromatography.
9. Analysis of the given sample of antacid using standard HCl and NaOH solutions.
10. Estimation of aspirin from aspirin tablets.
11. Determination of percentage purity of common salt using a cation exchanger.
12. Determination of potassium content of a commercial salt sample by flame photometry.
13. Determination of acetic acid content of a vinegar sample by potentiometric titration with sodium hydroxide using quinhydrone.
14. Determination of Cr (VI) in the given solution as dichromate by the method of least squares spectrophotometrically.
15. Determine the concentration of KCl solution by titrating it with standard solution of AgNO₃ conductometrically.
16. Determination of acid value of rosin.
17. Spectrophotometric determination of lead on leaves using solvent extraction.
18. Spectrophotometric determination of manganese and chromium in mixture.
19. Determine the percentage composition of the mixture by refractometer.
20. To determine equivalent conductance at infinite dilution of strong electrolyte (any one from KCl, NaCl, KNO₃ and HCl).
21. Determine the specific refraction of given liquid A and B and determine percentage composition of the mixture C of liquid A and B.
22. Determine the molar refractions of methyl acetate, ethyl acetate and n-hexane and carbon tetrachloride and calculate the atomic refraction of C, H and Cl atoms.
23. Study the variation of refractive index with composition of mixture of carbon tetrachloride and ethyl acetate and determine the composition and molar refraction of given unknown mixture.
24. Determine the concentration of a given solution of an optically active substance by polarimetric measurements.
25. Determined the specific and molecular rotation of an optically active substance and hence find out the intrinsic rotation of the substance.
26. Determined the relative strength of given two acids by polarimetric measurements

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHET1351A - Physical Methods in Analytical Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Physical Methods in Analytical Chemistry SACHET1351A
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Elective
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To introduce important physical methods used in analytical and bioanalytical chemistry.
- To develop understanding of microscopy, electrophoresis, centrifugation, and spectroscopic techniques.
- To relate physical methods with analytical and forensic applications.
- To strengthen interpretation of analytical data obtained through instrumental physical methods.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain principles and applications of different microscopic techniques.	Remember/ Understand	PO1, PO2
CO2	Describe electrophoretic techniques and immunoassays used in analytical and forensic work.	Understand/ Apply	PO2, PO3
CO3	Interpret separation principles underlying centrifugation and ultracentrifugation.	Apply/Analyze	PO3, PO4
CO4	Discuss the scope of major spectroscopic methods used for analytical detection and structure-related studies.	Analyze	PO4, PO5

Prerequisites

- Basic knowledge of the concerned branch of chemistry and related laboratory skills.

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Microscopy	Principle, working and forensic applications of different types of microscopes, light, Fluorescence, Comparison microscope, Phase contrast microscope, Stereoscopic microscope, Polarizing microscope, Fluorescent microscopy, Infra-red microscopy, Laser scanning co focal Microscopy, Differential interference microscopy, Atomic force microscope.	8
II	Electrophoresis	Theory and general principles, various factors affecting electrophoresis, low and high voltage electrophoresis, horizontal and vertical Electrophoresis. Electrophoretic techniques – Sodium dodecyl sulphate (SDS), Agarose Gel Electrophoresis (AGE), Polyacrylamide Gel Electrophoresis (PAGE), 2-D gel electrophoresis, Western blotting, Isoelectric focusing (IEF), Gel immuno-diffusion, complement fixation, radio immuno assay (RIA), ELISA, and 30 fluorescence immunoassays for detection of viruses including Hepatitis, Influenza, HIV and others, Immunoassays: SRID, ELISA-PCR, Immuno fluorescence and their applications.	8
III	Centrifugation	Differential centrifugation, Density gradient centrifugation: Rate Zonal, Isopycnic. Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications, Ultra centrifugation.	7
IV	Spectroscopy	Ultra violet and visible spectrophotometry: Types of sources, wavelength selection, filters-cells and sampling devices, detectors, resolution, qualitative and quantitative methods for detection, Fluorescence and phosphorescence spectrophotometry, Atomic absorption spectrometry, Atomic Emission spectrometer, X-ray spectroscopy, Infrared spectrophotometry, Raman Spectroscopy, Mass spectrophotometer, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction, surface plasma resonance methods and their applications in forensic biology	7

Total Hours: 30 Hours**Recommended Textbooks / Reference Books**

- Skoog, D. A., West, D. M. and Holler, F. J., Fundamentals of Analytical Chemistry.
- Christian, G. D., Analytical Chemistry, John Wiley & Sons.
- Chatwal, G. R. and Anand, S., Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- Willard, H. H., Merritt, L. L. and Dean, J. A., Instrumental Methods of Analysis.
- Lancaster, M., Green Chemistry: An Introductory Text, RSC Publishing.

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHET1352A - Organic Spectroscopy

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Organic Spectroscopy SACHET1352A -
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Elective
Credits	2
Total Hours	30 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To familiarize students with UV, IR, and PMR spectroscopy for elucidation of organic molecules.
- To develop ability to correlate spectral features with structure and functional groups.
- To provide practice in interpretation of spectral problems and identification of simple organic compounds.
- To strengthen the use of spectroscopy as a modern analytical tool in organic chemistry.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain the basic principles and terminology used in UV, IR, and NMR spectroscopy.	Remember/ Understand	PO1, PO2
CO2	Apply spectroscopic techniques to analyze simple organic molecules.	Apply/Analyze	PO3, PO4
CO3	Interpret UV, IR, and PMR spectral data for structure elucidation.	Analyze	PO4, PO5
CO4	Identify simple organic compounds by combining information from multiple spectral methods.	Apply/Create	PO3, PO6

Prerequisites

- Basic knowledge of the concerned branch of chemistry and related laboratory skills.

Detailed Syllabus

Unit No.	Unit Title	Topics	Hours
I	Ultraviolet Spectroscopy	Introduction, Electromagnetic radiations; Characteristics of EMR: a) Wave length b) Wave number, c) Frequency, d) Energy of EMR. ii) Electromagnetic spectrum; Meaning of Spectroscopy, types of Spectroscopy and advantages of Spectroscopic methods. Introduction of UV, Types of Electronic Transitions, Terms used in UV Spectroscopy Chromophore, Auxochrome, Bathochromic Shift, Hypochromic Shift, Hypochromic and Hyperchromic effects. Effect of conjugation on position of UV and Visible bands. Calculation of λ_{\max} by Woodward-Fieser rules for conjugated dienes and enones. Spectral problems based on UV.	8
II	Infra-red Spectroscopy	Introduction, Theory of molecular vibrations (Basic Principles and Types of Vibrations), Functional group region and Fingerprint region, Characteristic absorption of various functional groups, Interpretation of IR spectra of following organic compounds: a) Ethane, b) Ethene, c) Ethyne, d) Benzene, e) 1-Propanol, f) 2-Propanol, g) t-Butyl alcohol, h) Phenol, i) Acetone, j) Acetophenone, k) Acetaldehyde, l) Benzaldehyde, m) Benzoic acid, n) Methyl benzoate and o) Phenyl cyanide.	8
III	NMR Spectroscopy	Introduction, Principle of NMR Spectroscopy, Magnetic and non-magnetic nuclei PMR-Spectroscopy: Spinning nuclei, magnetic moment and magnetic field, processional motion, energy states for proton in magnetic field (Orientations) and nuclear resonance. Equivalent and non-equivalent protons. Number of absorption signals in the following compounds: a) Acetone, b) Cyclobutene, c) Methanol, d) Ethylbenzene, e) Ethylamine, f) Mesitylene, g) Diethyl ether, Shielding and deshielding effects: (Example of Acetylene and Benzene) Chemical shift, measurement of chemical shift by delta scale and tau scale TMS as reference, Advantages of TMS. Peak area (integration) and Spin-spin splitting (n+1) rule. Interpretation of PMR Spectra of following compounds: a) Ethyl bromide, b) Ethyl alcohol, c) Acetaldehyde, d) 1,1,2-tribromo ethane, e) Ethyl acetate, f) Toluene, g) Acetophenone, h) Ethylamine, i) Acetic acid, j) Benzoic acid.	9
IV	Applications of IR, UV and NMR	Organic Molecules: a) n-Propyl alcohol, b) iso-Propyl alcohol, c) tert-Butyl alcohol, d) Acetic acid, e) Ethylamine, f) Ethyl cyanide, g) Ethyl methyl ketone, h) Ethyl acetate, i) Ethyl benzene, j) Phenyl acetaldehyde, k) Phenol, l) Ethyl methyl ether, m) Ethylene glycol, n) Propionamide and o) Propionaldehyde.	5

Total Hours: 30 Hours

Recommended Textbooks / Reference Books

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHEP1351 - Spectral Study of Organic Compounds

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Spectral Study of Organic Compounds SACHEP1351
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Elective Practical
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To develop practical skill in using UV, IR, and NMR spectral data for structural analysis of organic molecules.
- To strengthen understanding of Woodward-Fieser rules and interpretation of characteristic absorption and resonance patterns.
- To introduce software-assisted drawing and spectral data correlation for simple organic compounds.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Calculate lambda max values of selected conjugated systems using empirical rules.	Apply	PO3, PO4
CO2	Interpret IR spectra for identification of functional groups and compounds.	Analyze	PO4, PO5
CO3	Interpret NMR spectra for structure identification of simple organic compounds.	Analyze	PO4, PO5
CO4	Use software tools such as ChemDraw for drawing structures and correlating structural data.	Apply/Create	PO3, PO6

List of Experiments / Activities

A) Calculation of λ_{\max} by Woodward-Fieser rules for conjugated dienes and enones. Spectral problems based on UV. (10 examples from conjugated dienes and 10 example from enones)

B) Identification of the structure of organic compounds using IR- spectroscopy (IR spectra should be provided).

a) Ethane, b) Ethene, c) Ethyne, d) Benzene, e) 1-Propanol f) Acetone, g) Acetophenone, h) Acetaldehyde, i) Benzaldehyde, j) Benzoic acid, k) Methyl benzoate and l) Phenyl cyanide.

C) Identification of the structure of organic compounds using NMR- spectroscopy (NMR spectra should be provided).

a) Ethyl bromide, b) Ethyl alcohol, c) Acetaldehyde, d) 1,1,2-tribromo ethane, e) Ethyl acetate, f) Toluene, g) Acetophenone h) Phenol, i) Ethyl methyl ether, j) Ethylene glycol

D) Analysis with software like Chem draw. (Draw some structure and find data of that structure)

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
SACHVC1351 - Green Approaches in Practical

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	Green Approaches in Practical SACHVC1351
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	Value Added / Skill Course
Credits	2
Total Hours	60 Hours
Formative Assessment Marks	20
Summative Assessment Marks	30
Total Marks	50

Course Objectives

- To make students aware of sustainable and environmentally benign practical approaches in chemistry.
- To develop skill in selected green laboratory operations and green synthesis experiments.
- To encourage adoption of safer materials, reduced waste generation, and energy-efficient methods.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Explain basic laboratory operations and planning relevant to safe and green practical work.	Understand/ Apply	PO1, PO8
CO2	Perform selected green chemistry experiments using safer reagents and sustainable methods.	Apply	PO3, PO4
CO3	Evaluate conventional and green approaches in terms of waste reduction, safety, and sustainability.	Analyze/ Evaluate	PO4, PO10
CO4	Prepare observations, reports, and interpretations for green practical work.	Apply/Create	PO6, PO7

List of Experiments / Activities

1. Preparation and characterization of biodiesel from vegetable oil.
2. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.
3. Mechanochemical solvent free, solid–solid synthesis of azomethine using *p*-toluidine and *o*-vanillin/*p*-vanillin (various other combinations of primary amine and aldehyde can also be taken)
4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II)
5. Preparation of dibenzalacetone by cross aldol condensation reaction using base catalysed green method
6. Nitration of salicylic acid using green method Ca(NO₃)₂
7. Acetylation Of Primary Amine (Preparation of acetanilide) by Green Procedure
8. Bromination of acetanilide by green procedure
9. Preparation of benzo pinacolone (Pinacol Pinacolone Rearrangement Reaction)-

Swami Ramanand Teerth Marathwada University, Nanded
Faculty of Science & Technology
 SACHOJT1351 - On-Job Training in Analytical Chemistry

Name of the Program	B.Sc. (Analytical Chemistry), Third Year
Title of the Paper/Course	On-Job Training in Analytical Chemistry SACHOJT1351
Year of Implementation	Academic Year 2026-2027
Semester	VI
Paper Type	On-Job Training
Credits	4
Total Hours	120 Hours
Formative Assessment Marks	40
Summative Assessment Marks	60
Total Marks	100

Course Objectives

- To provide hands-on exposure to analytical laboratories, quality control units, testing laboratories, or industrial settings relevant to analytical chemistry.
- To develop professional competence in sample handling, routine analysis, documentation, and laboratory discipline.
- To strengthen communication, reporting, and problem-solving skills in real analytical work environments.

Course Outcomes (COs)

CO No.	Upon completion of this course, students will be able to:	Bloom's Level	PO Mapped
CO1	Describe the workflow, instrumentation, and quality practices of the host laboratory or industry.	Remember/ Understand	PO1, PO2
CO2	Assist in sample collection, preparation, testing, or documentation as per standard procedures.	Apply	PO3, PO6
CO3	Interpret practical observations from on-job training in the context of analytical chemistry.	Analyze	PO4, PO5
CO4	Prepare a certified training diary and final report, and present the learning outcomes effectively.	Apply/Create	PO6, PO7

List of Experiments / Activities

Sr. No.	Title of Experiment / Activity
1	Orientation to host laboratory/industry and safety practices.
2	Observation of sample receipt, coding, and documentation workflow.
3	Exposure to routine wet chemical and/or instrumental analytical procedures.
4	Participation in quality control, calibration, or standardization activities.
5	Maintenance of daily diary/logbook certified by the supervisor.
6	Preparation and presentation of final OJT report.

Reference Books:

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2. Yates, P. (2007) Chemical calculations, CRC Press.
3. Harris, D. C. (2007) Quantitative Chemical Analysis. Freeman, Chapters 3-5.
4. Levie, R. de. (2001) How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press.
5. Organic Chemistry by Morrison and Boyd, Print ice hall.
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8. Fundamental of organic chemistry by Solomon, John willey
9. A Text book of organic chemistry by Bahl and Bahl.
10. A Text book of organic chemistry by P. L. Soni.
11. Synthetic Organic Chemistry, by: G. R. Chatwal.
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32. Green Chemistry J. N. Gurtu and Kusum Sharma.
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35. A text book of organic chemistry by P. L. Soni, H. M. Chawla
36. A text book of organic chemistry by K. S. Tewari, S. N. Mehrotra, N. K. Vishnoi
37. A text book of organic chemistry by Arun Bahl and B. S. Bahl
38. Principles of organic chemistry by M. K. Jain

39. Heterocyclic chemistry synthesis, reactions and mechanism by Raj K. Bansal
40. Reaction mechanism and reagents in organic chemistry by G. R. Chatwal
41. Synthetic organic chemistry by G. R. Chatwal
42. Natural products by O. P. Agarwal (Vol. I & II)
43. Spectroscopy of organic compounds by P. S. Kalsi
44. Elementary organic absorption spectroscopy by Y. R. Sharma
45. Absorption spectroscopy of organic molecules by V. M. Parikh
46. Chemistry of pesticides by K. H. Buchel (T.W.)
47. Instrumental Methods of Chemical Analysis. (1989): Chatwal G and
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