School of Chemistry
Faculty of Sciences
University of the Punjab, Lahore
Course Outline
Semester-VIII

Program	**BS Chemistry**	**Course Code**	**Chem-453**	**Credit Hours**	**2**
Course Title	**Electroanalytical Technique-II**		**Course Type**	**Major (Elective)**	

Course Introduction

The course is organized to understand the electroanalytical techniques. The students will learn the details about the theory and applications of advanced electroanalytical techniques including voltammetry, polarography, and amperometry.
Voltammetry: Excitation signals in voltammetry, voltammetric Instrumentation, Hydrodynamic Voltammetry, Cyclic Voltammetry, Stripping methods, voltammetric with ultra-micro-electrodes.
Polarography: Introduction and principle of polarography, basic instrumentation, working and advantages of DME (dropping mercury electrode); limiting and residual current; half-wave potential; qualitative and quantitative aspects of polarographic analysis.
Amperometry: Principle of Amperometry, types of amperometry and amperometric titrations, amperometric titrations with one micro-electrode, amperometric titration with twin microelectrodes, applications of amperometry.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Deal with electroanalytical techniques.
2. learn the details about the theory and applications of advanced electroanalytical techniques including voltammetry, polarography, and amperometry.
3. Understand the mechanisms involved in these techniques.
4. Apply these techniques for multi-elemental analysis.

Course Content		**Assignments/Readings**
Week 1	Voltammetry, Excitation signals in voltammetry, Voltammetric Instrumentation	Class based Learning/Test
Week 2	Hydrodynamic Voltammetry	Class based Learning/Test
Week 3	Cyclic Voltammetry, Stripping methods	Class based Learning/Test
Week 4	Voltammetric with ultra-micro-electrodes	Class based Learning/Test
Week 5	**Polarography,** Introduction and principle of polarography	Class based Learning/Test
Week 6	Basic instrumentation	Class based Learning/Test
Week 7	Working and advantages of DME (dropping mercury electrode)	Class based Learning/Test

Week 8	Mid Term Assessment	
Week 9	Limiting and residual current, half-wave potential.	Class based Learning/Test
Week 10	Qualitative and quantitative aspects of polarographic analysis.	Class based Learning/Test
Week 11	Amperometry, Principle of Amperometry	Class based Learning/Test
Week 12	Types of amperometry and amperometric titrations	Class based Learning/Test
Week 13	Amperometric titrations with one micro electrode	Class based Learning/Test
Week 14	Amperometric titration with twin microelectrodes	Class based Learning/Test
Week 15	Applications of amperometry	Class based Learning/Test
Week 16	Submission of assignments. If required, then discuss the whole chapter for final term exams preparation	

Textbooks and Reading Material

Recommended Books:

1. Oladiji, A. T., Oladele, J. O., & Ajayi, E. I. (Eds.). (2024). Nutrition and Diet in Health: Principles and Applications.
2. Bohnert, K. (2024). Optical Fiber Current and Voltage Sensors.
3. Canty, M. J. (2019). Image analysis, classification and change detection in remote sensing: with algorithms for Python.
4. Bard, A. J., Faulkner, L. R., & White, H. S. (2022). Electrochemical methods: fundamentals and applications. John Wiley & Sons.
5. J. Mendham, R.C. Denney, J.D. Barnes, & M. Thomas. (2000). Vogel's textbook of quantitative chemical analysis. prentice hall.
6. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (1996). Fundamentals of analytical chemistry (Vol. 33, pp. 53-55). Fort Worth: Saunders College Pub.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation, etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-454**	**Credit Hours**	**1**
Course Title	**Electroanalytical Techniques-2 (Lab)**	**Course Type**	**Major (Elective)**		

Course Introduction

The course is organized to provide in-hand use of electroanalytical techniques like voltammetry in quantitative analysis of various acids and bases.
Reduction of ferricyanide ion using Pt electrode
Oxidation of acetaminophen using glassy carbon electrode
Preparation of carbon paste electrode
Determination of electrode surface area using cyclic voltammetry using potassium ferricyanide solution
Effect of scan rate on the electrode properties using potassium ferricyanide solution
Determination of half-wave potential for various analytes
Determination of metal ions using anodic stripping voltammetry by carbon paste electrode
Determination of various organic molecules using voltammetric studies

Learning Outcomes

On the completion of the course, the students will be able to:

1. Learn the in-hand use of electroanalytical techniques like voltammetry in quantitative analysis of various acids and bases.
2. Obtain relevant information from voltammetric analyses.
3. Interpret the results of analysis.

	Course Content	**Assignments/Readings**
Week 1	Reduction of ferricyanide ion using Pt electrode	Lab based Performance/Lab reports
Week 2	Oxidation of acetaminophen using glassy carbon electrode	Lab based Performance/Lab reports
Week 3	Oxidation of acetaminophen using glassy carbon electrode	Lab based Performance/Lab reports
Week 4	Preparation of carbon paste electrode	Lab based Performance/Lab reports
Week 5	Preparation of carbon paste electrode	Lab based Performance/Lab reports
Week 6	Determination of Electrode surface area using cyclic voltammetry using potassium ferricyanide solution	Lab based Performance/Lab reports
Week 7	Determination of Electrode surface area using cyclic voltammetry using potassium ferricyanide solution	Lab based Performance/Lab reports
Week 8	MID TERM EXAMS	

Week 9	Effect of scan rate on the electrode properties using potassium ferricyanide solution	Lab based Performance/Lab reports
Week 10	Effect of scan rate on the electrode properties using potassium ferricyanide solution	Lab based Performance/Lab reports
Week 11	Determination of half-wave potential for various analytes	Lab based Performance/Lab reports
Week 12	Determination of half-wave potential for various analytes	Lab based Performance/Lab reports
Week 13	Determination of metal ions using anodic stripping voltammetry by carbon paste electrode	Lab based Performance/Lab reports
Week 14	Determination of metal ions using anodic stripping voltammetry by carbon paste electrode	Lab based Performance/Lab reports
Week 15	Determination of various organic molecules using voltammetric studies	Lab based Performance/Lab reports
Week 16	FINAL TERM EXAMS	

Textbooks and Reading Material

Recommended Books:

1. Oladiji, A. T., Oladele, J. O., & Ajayi, E. I. (Eds.). (2024). Nutrition and Diet in Health: Principles and Applications.
2. Bohnert, K. (2024). Optical Fiber Current and Voltage Sensors.
3. Canty, M. J. (2019). Image analysis, classification and change detection in remote sensing: with algorithms for Python.
4. Bard, A. J., Faulkner, L. R., & White, H. S. (2022). Electrochemical methods: fundamentals and applications. John Wiley & Sons.
5. J. Mendham, R.C. Denney, J.D. Barnes, & M. Thomas. (2000). Vogel's textbook of quantitative chemical analysis. prentice hall.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
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- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials
- Laboratory performance

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-455**	**Credit Hours**	**2**
Course Title	**Thermoanalytical Techniques**	**Course Type**	**Major (Elective)**		

Course Introduction

The course is organized to understand the importance of thermal methods of analysis.
Thermal Methods of Analysis: General Principle, instrumentation, Application, Limitations of these techniques, TGA (thermogravimetric analysis), DTA (differential thermal analysis), DSC (differential scanning calorimetry), TT (thermometric titrations) and EGD (evolved gas detection)

Learning Outcomes

On the completion of the course, the students will be able to:

1. To learn the importance of thermal methods of analysis.
2. Understand the features related with various types of thermal methods including thermogravimetry, DTA and DSC.
3. Comprehend the effects of temperature on stability of materials.
4. Interpret the thermograms.

	Course Content	**Assignments/Readings**
Week 1	Thermal Methods of Analysis, General Principle	Class based Learning/Test
Week 2	Instrumentation	Class based Learning/Test
Week 3	Instrumentation	Class based Learning/Test
Week 4	Application	Class based Learning/Test
Week 5	Limitations of these techniques	Class based Learning/Test
Week 6	TGA (thermogravimetric analysis)	Class based Learning/Test
Week 7	TGA (thermogravimetric analysis)	Class based Learning/Test
Week 8	Mid Term Assessment	
Week 9	DTA (differential thermal analysis)	Class based Learning/Test
Week 10	DTA (differential thermal analysis)	Class based Learning/Test
Week 11	DSC (differential scanning calorimetry)	Class based Learning/Test
Week 12	DSC (differential scanning calorimetry)	Class based Learning/Test

Week 13	TT (thermometric titrations)	Class based Learning/Test
Week 14	TT (thermometric titrations)	Class based Learning/Test
Week 15	EGD (evolved gas detection)	Class based Learning/Test
Week 16	Final Term Assessment	

Textbooks and Reading Material

Recommended Books:

1. Sepe, M. P. (1997). Thermal analysis of polymers (Vol. 95). Smithers Rapra Publishing.
2. Wright, A. S., Coleman, D., & Kaiser, D. (2023). Theoretical physics in your face: selected correspondence of Sidney Coleman.
3. Lane, G. A., & Lane, G. A. (Eds.). (1983). Solar heat storage: latent heat materials (Vol. 1). Boca Raton, FL, USA.
4. Šesták, J., Hubík, P., Mareš, J. J., & Holba, P. (2013). History of thermal analysis and ICTAC and CALCON societies. Journal of Thermal Analysis and Calorimetry, 12, 2848-7.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2007). Instrumental analysis (Vol. 47). Belmont: Brooks/Cole, Cengage Learning.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-456**	**Credit Hours**	**1**
Course Title	**Thermoanalytical Techniques (Lab)**	**Course Type**	**Major (Elective)**		

Course Introduction

The course is designed to analyze various samples by Thermal analysis methods.

- Thermogravimetric analysis of calcium oxalate
- TG and DTG analysis of polymer gels
- TG and DTG analysis of polythene
- Determination of thermal stability of a given compound
- Determination of carbon black content in epoxy sample
- DTA analysis of biomass/plant materials
- Determination of purity/melting point of benzoic acid/oxalic acid/naphthalene using DTA

Learning Outcomes

On the completion of the course, the students will be able to:

1. Perform thermogravimetric analyses of samples.
2. Interpret thermograms of various samples.
3. Understand the effect of temperature on stability of materials.

Course Content		Assignments/Readings
Week 1	Thermogravimetric analysis of calcium oxalate	Lab based Performance/Lab reports
Week 2	Thermogravimetric analysis of calcium oxalate	Lab based Performance/Lab reports
Week 3	TG and DTG analysis of polymer gels	Lab based Performance/Lab reports
Week 4	TG and DTG analysis of polymer gels	Lab based Performance/Lab reports
Week 5	Determination of thermal stability of a given compound	Lab based Performance/Lab reports
Week 6	Determination of thermal stability of a given compound	Lab based Performance/Lab reports
Week 7	Determination of thermal stability of a given compound	Lab based Performance/Lab reports
Week 8	MID TERM ASSESSMENT	
Week 9	Determination of carbon black content in epoxy sample	Lab based Performance/Lab reports

Week 10	Determination of carbon black content in epoxy sample	Lab based Performance/Lab reports
Week 11	DTA analysis of biomass/plant materials	Lab based Performance/Lab reports
Week 12	DTA analysis of biomass/plant materials	Lab based Performance/Lab reports
Week 13	Determination of purity/melting point of benzoic acid/oxalic acid/naphthalene using DTA	Lab based Performance/Lab reports
Week 14	Determination of purity/melting point of benzoic acid/oxalic acid/naphthalene using DTA	Lab based Performance/Lab reports
Week 15	Determination of purity/melting point of benzoic acid/oxalic acid/naphthalene using DTA	Lab based Performance/Lab reports
Week 16	**FINAL TERM ASSESSMENT**	

Textbooks and Reading Material

Recommended Books:

1. Sepe, M. P. (1997). Thermal analysis of polymers (Vol. 95). Smithers Rapra Publishing.
2. Wright, A. S., Coleman, D., & Kaiser, D. (2023). Theoretical physics in your face: selected correspondence of Sidney Coleman.
3. Lane, G. A., & Lane, G. A. (Eds.). (1983). Solar heat storage: latent heat materials (Vol. 1). Boca Raton, FL, USA.
4. Šesták, J., Hubík, P., Mareš, J. J., & Holba, P. (2013). History of thermal analysis and ICTAC and CALCON societies. Journal of Thermal Analysis and Calorimetry, 12, 2848-7.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2007). Instrumental analysis (Vol. 47). Belmont: Brooks/Cole, Cengage Learning.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials
- Laboratory performance

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-457**	**Credit Hours**	**2**
Course Title	**Environmental Chemistry**	**Course Type**	**Major (Elective)**		

Course Introduction

The course is organized to understand the significance of environmental degradation and impact of modern life.

Analytical Techniques for pollutant Analysis: Techniques for the analysis of emerging pollutants in aqueous system like PCB, PAH, THM, HAA, Guidelines, Parameters, MCL and threshold values by US-EPA, ASTM, Pak-EPA.

Environmental Pollution: Environmental pollution in the world and in Pakistan, Oxygen and ozone chemistry: Ozone depletion and its biochemical effect, Greenhouse effect, Air Pollutants (Sulfur dioxide, nitrogen oxide, chlorofluorocarbons etc.,): sources/discharge and hazardous effects, losses of methane and ammonia from paddyland production system, global sources of methane, or sinks of methane. Atmospheric changes and sources of ammonia. Water contamination and hazardous effects of pesticides, herbicides and insecticides. Effects of nitrogen, Sulphur and Phosphorus based fertilizers on environment. Composition of fertilizer plant effluent discharges, effect and fate of nitrogen, Sulphur and Phosphorus based fertilizers on environment, suggestion for controlling adverse effects of fertilizer plant effluent and conservation of soil, leaching of fertilizers into soil, factors affecting nitrate, sulphate and phosphate accumulation. Public awareness: Improper disposal/dumping of hazardous waste of landfills, and prevention.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Learn the significance of environmental degradation
2. Know the impact of modern life on environmental degradation.
3. Comprehend the industrial and textile analysis.

	Course Content	Assignments/Readings
Week 1	Analytical Techniques for pollutant Analysis, Techniques for the analysis of emerging pollutants in aqueous system like PCB, PAH, THM, HAA	Class based Learning/Test
Week 2	Guidelines, Parameters, MCL and threshold values by US-EPA, ASTM, Pak-EPA	Class based Learning/Test
Week 3	Environmental Pollution, Environmental pollution in the world and in Pakistan	Class based Learning/Test
Week 4	Oxygen and ozone chemistry: Ozone depletion and its biochemical effect	Class based Learning/Test
Week 5	Greenhouse effect, Air Pollutants (Sulfur dioxide, nitrogen oxide, chlorofluorocarbons etc.,), sources/discharge and hazardous effects	Class based Learning/Test
Week 6	losses of methane and ammonia from paddyland production system, global sources of methane, or sinks of methane	Class based Learning/Test
Week 7	Atmospheric changes and sources of ammonia	Class based Learning/Test

Week 8	Mid Term Assessment	
Week 9	Water contamination and hazardous effects of pesticides, herbicides and insecticides	Class based Learning/Test
Week 10	Effects of nitrogen, Sulphur and Phosphorus based fertilizers on environment	Class based Learning/Test
Week 11	Composition of fertilizer plant effluent discharges, effect and fate of nitrogen	Class based Learning/Test
Week 12	Sulphur and Phosphorus based fertilizers on environment	Class based Learning/Test
Week 13	Suggestions for controlling adverse effects of fertilizer plant effluent and conservation of soil, leaching of fertilizers into soil	Class based Learning/Test
Week 14	Factors affecting nitrate, sulphate and phosphate accumulation	Class based Learning/Test
Week 15	Public awareness: Improper disposal/dumping of hazardous waste of landfills, and prevention	Class based Learning/Test
Week 16	Final Term Assessment	

Textbooks and Reading Material

Recommended Books:

1. Harrison, R. M. (2007). Biogeochemical cycling of chemicals. Principles of environmental chemistry,
2. De Anil, K. (2003). Environmental chemistry. New Age International.
3. Moore, J. (2012). Environmental chemistry.
4. Manahan, S. E. (2022). Environmental chemistry.
5. Radojevic, M., & Bashkin, V. N. (1999). Practical environmental analysis.
6. Sparks, D. L., Singh, B., & Siebecker, M. G. (2022). Environmental soil chemistry.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
- Written Assignments/presentations/ Task related to assigned topics
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Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-458**	**Credit Hours**	**1**
Course Title	**Environmental Analysis (Lab)**	**Course Type**	**Major (Elective)**		

Course Introduction

The course is designed to understand the significance of environmental analysis.
Determination of chlorides in aqueous solution
Determination of chemical oxygen demand (COD) of wastewater sample
Determination of biochemical oxygen demand (BOD) of wastewater sample
Determination of Total suspended solids, Total dissolved salts and conductance of the wastewater sample
Determination of nitrogen by Kjeldahl method
Determination of chromium in wastewater samples
Determination of sulphates in wastewater samples
Determination of polyaromatic hydrocarbons (PAHs)

Learning Outcomes

On the completion of the course, the students will be able to:

1. Learn the significance of environmental analysis.
2. Have hands-on experience on certain environmental analyses with emphasis to aqueous systems.

Course Content		Assignments/Readings
Week 1	Determination of chlorides in aqueous solution.	Lab based Performance/Lab reports
Week 2	Determination of chlorides in aqueous solution.	Lab based Performance/Lab reports
Week 3	Determination of chemical oxygen demand (COD) of wastewater sample	Lab based Performance/Lab reports
Week 4	Determination of chemical oxygen demand (COD) of wastewater sample	Lab based Performance/Lab reports
Week 5	Determination of biochemical oxygen demand (BOD) of wastewater sample	Lab based Performance/Lab reports
Week 6	Determination of biochemical oxygen demand (BOD) of wastewater sample	Lab based Performance/Lab reports
Week 7	Determination of Total suspended solids, Total dissolved salts and conductance of the wastewater sample	Lab based Performance/Lab reports
Week 8	MID TERM ASSESSMENT	
Week 9	Determination of nitrogen by Kjeldahl method	Lab based Performance/Lab reports

Week 10	Determination of nitrogen by Kjeldahl method	Lab based Performance/Lab reports
Week 11	Determination of chromium in wastewater samples	Lab based Performance/Lab reports
Week 12	Determination of chromium in wastewater samples	Lab based Performance/Lab reports
Week 13	Determination of sulphates in wastewater samples	Lab based Performance/Lab reports
Week 14	Determination of sulphates in wastewater samples	Lab based Performance/Lab reports
Week 15	Determination of polyaromatic hydrocarbons (PAHs)	Lab based Performance/Lab reports
Week 16	FINAL TERM ASSESSMENT	

Textbooks and Reading Material

Recommended Books:

1. De Anil, K. (2003). Environmental chemistry. New Age International.
2. Manahan, S. E. (2011). Fundamentals of environmental chemistry.
3. Manahan, S. E. (2022). Environmental chemistry.
4. Radojevic, M., & Bashkin, V. N. (1999). Practical environmental analysis.
5. Sparks, D. L., Singh, B., & Siebecker, M. G. (2022). Environmental soil chemistry.

Teaching Learning Strategies

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- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials
- Laboratory performance

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment			
Sr. No.	**Elements**	**Weightage**	**Details**
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Semester-VIII					
Program	**BS Chemistry**	**Course Code**	**Chem-459**	**Credit Hours**	**3**
Course Title	**Compound and Molecular Specific Analysis-II**	**Course Type**	**Major (Elective)**		

Course Introduction

This course in about the advanced spectroscopic techniques, advanced structural elucidation techniques.

Nuclear Magnetic Resonance Spectroscopy: Basic principles; properties of nuclei, Chemical shifts; Spin-Spin coupling; Pulsed Fourier Transform NMR Spectrometry; Identification of structural features; Use of NMR imaging in medicine; Analytical applications of NMR spectroscopy.

Mass Spectrometry: Principle, sample for mass spectrometer, sample introduction system, ionization source, mass analyzers, detections system, qualitative analysis, quantitative analysis, applications, confirmation of synthesis products, isotopes incorporation, structure elucidation, hyphenated mass-spectrometric techniques.

Learning Outcomes

On the completion of the course, the students will be able to:

1. Have knowledge about the advanced spectroscopic techniques.
2. Learn the advanced structural elucidation techniques.
3. Determine the structure of various molecules on the basis of their NMR and mass spectrometric data.
4. Use the laser spectroscopy for the purpose of analysis will also be studied in this course.

Course Content		Assignments/Readings
Week 1	**Nuclear Magnetic Resonance Spectroscopy,** Basic principles	Class based Learning/Test
Week 2	Properties of nuclei	Class based Learning/Test
Week 3	Chemical shifts; Spin-Spin coupling	Class based Learning/Test
Week 4	Pulsed Fourier Transform NMR Spectrometry	Class based Learning/Test
Week 5	Identification of structural features	Class based Learning/Test
Week 6	Use of NMR imaging in medicine	Class based Learning/Test
Week 7	Analytical applications of NMR spectroscopy	Class based Learning/Test
Week 8	Mid Term Assessment	
Week 9	**Mass Spectrometry,** Principle, sample for mass spectrometer,	Class based Learning/Test
Week 10	Sample introduction system, ionization source	Class based Learning/Test
Week 11	Mass analyzers, Detections system	Class based Learning/Test

Week 12	Qualitative analysis, quantitative analysis, applications	Class based Learning/Test
Week 13	Confirmation of synthesis products	Class based Learning/Test
Week 14	Isotopes incorporation	Class based Learning/Test
Week 15	Structure elucidation, hyphenated mass-spectrometric techniques	Class based Learning/Test
Week 16	Final Term Assessment	

Textbooks and Reading Material

1. Yong, J. (2024). Optimising NMR spectroscopy through method and software development. Springer Nature.
2. Hosur, R. V., & Kakita, V. M. R. (2022). A Graduate Course in NMR Spectroscopy. Springer.
3. Rule, G. S., & Hitchens, T. K. (2001). Protein NMR spectroscopy. Mod. Protein Chem. Pract.
4. Cole, L. M., & Cole. (2017). Imaging mass spectrometry.
5. Lee, Y. J. (Ed.). (2022). Mass Spectrometry Imaging of Small Molecules. Humana Press.
6. Gross, J. H. (2006). Mass spectrometry: a textbook. Springer Science & Business Media.

Teaching Learning Strategies

- Lecturing using white/black board/Multimedia
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- Class activities and Discussion
- Quiz about last lecture
- Class Presentations Audio/visual Aids/ Tutorials

Assignments: Types and Number with Calendar

Assignments, quiz, Tasks, Presentation etc.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.