Course Number and Title: CHM 251 Analytical Chemistry II

Campus Location:
Stanton

Effective Date:
2021-51

Prerequisite:
CHM 250

Co-Requisites:
None

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
4.00 lab hours/week

Course Description:
This course is the second of a two-semester sequence covering quantitative analysis. Analysis via classical, spectrometric, electrochemical, chromatographic, electrophoretic, and kinetic methods are examined. Laboratory experiments are used to illustrate theory.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Discuss the application of classical methods in the analysis of solids and solutions. (CCC 1, 2, 5, 6; PGC CHM 1, 7, 8, 10 CEM 1, 7, 8, 10)
2. Describe electrochemical techniques for the analysis of solutions. (CCC 1, 2, 5, 6; PGC CHM 1, 7, 8, 10)
3. Discuss the use of spectrometric methods to analyze solids and solutions. (CCC 1, 2, 5, 6; PGC CHM 1, 7, 8, 10 CEM 1, 7, 8, 10)
4. Describe and compare separation methods used in the analysis of a sample. (CCC 1, 2, 5, 6; PGC CHM 1, 7, 8, 10 CEM 1, 7, 8, 10)
5. Discuss the analysis of samples using kinetic techniques. (CCC 1, 2, 5, 6, 7; PGC 1, 7, 8 ,10)
6. Discuss and compare the methods of chemical analysis used with biological samples.(CCC 1, 2, 5, 6; PGC CHM 1, 7, 8, 10 CEM 1, 7, 8, 10)
7. Apply laboratory techniques and instrumentation in the analysis of samples by classical, electrochemical, spectrophotometric, separation, kinetic, and chemical analyses. (CCC 1, 2, 3, 4, 5, 6; PGC CHM 1, 7 ,8, 10 CEM 1, 7, 8, 10)
8. Document laboratory observations and data in accordance with accepted professional standards. (CCC 1, 2, 3, 4, 5; PGC CHM 1, 7, 8, 10 CEM 1, 7, 8, 10)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Discuss the application of classical methods in the analysis of solids and solutions.
    1. Describe the unit operations in gravimetric analysis.
    2. Define *thermogravimetry* and *precipitation gravimetry.*
    3. Discuss precipitating agents and applications of precipitation techniques.
    4. Select conditions to maximize the suitability of a precipitate for gravimetric analysis.
    5. Discuss the drying and ignition of precipitates.
    6. Perform gravimetric calculations.
    7. State the general requirements for titrimetric analysis.
    8. Describe the unit operations in titrimetric analysis.
    9. Compare direct versus back titration.
    10. Identify primary standards used in titrimetry.
    11. Describe strong acid versus strong base, weak acid versus strong base and weak base versus strong acid titration curves.
    12. Discuss the choice and use of indicators in titrations.
    13. Identify common acid-base indicators.
    14. Compare titration curves of polyprotic acids, mixtures of acids or bases, and amino acids.
    15. Describe complexometric titration, and discuss the use of ethylenediaminetetraacetic acid (EDTA) as a titrant.
    16. Describe precipitation titration, and select conditions to maximize the suitability of a precipitate for titrimetric analysis.

17. Describe redox titration, and identify common oxidizing and reducing titrants.
18. Perform titration calculations.
19. Select the proper titrimetric method for analyzing a given substance.
20. Compare classical and instrumental methods.

2. Describe electrochemical techniques for the analysis of solutions.
    1. Write overall and half-reactions for redox system.
    2. Draw an electrochemical cell, and write the cell in standard cell notation.
    3. Write Nernst expressions based on overall reactions, half-reactions, or standard cell notation.
    4. Distinguish standard versus formal electrode potentials.
    5. Name and describe reference half-cells.
    6. Compare equilibrium versus non-equilibrium electrochemical analysis.
    7. Recognize and describe potentiometric cells.
    8. Describe the function and use of pH electrodes, including combination electrodes.
    9. Select the correct pH probes for specific samples.
    10. Describe the use of modified electrodes as potentiometric sensors.
    11. Compare and contrast voltammetry, amperometry and coulometry.
    12. Describe the function and use of amperometric sensors.
    13. Describe electrogravimetry.
    14. Discuss the use of modified electrodes as amperometric sensors.
    15. Set up and use calibration curves.
    16. Examine instrument specifications.
3. Discuss the use of spectrometric methods to analyze solids and solutions.
    1. Describe the electromagnetic spectrum, and discuss the interaction of electromagnetic radiation (EMR) with matter.
    2. Compare the processes of absorption and emission.
    3. State and use Beer's Law.
    4. Relate the transitions that occur during absorption of EMR to the energy of the EMR.
    5. Compare and contrast Ultraviolet (UV), Visible (Vis), and infrared (IR) spectrophotometry as qualitative and quantitative analytical techniques.
    6. Discuss fluorimetry.
    7. Define *turbidimetry* and *nephelometry.*
    8. Choose sample cell materials appropriate for a given spectral region.
    9. Choose solvents appropriate for a given spectral region.
    10. Draw block diagrams of and discuss the components of instrumentation for molecular spectrometry.
    11. Compare and contrast single versus double-beam spectrophotometers.
    12. Discuss diode array spectrophotometers and Fourier Transform (FT) spectrophotometers.
    13. Discuss the production and excitation of atoms in a flame. Compare ground versus excited state populations.
    14. Describe and compare atomic emission (AE) and atomic absorption (AA) spectrophotometry.
    15. Draw block diagrams, and discuss the components of instrumentation for atomic spectrophotometry.
    16. Discuss mass spectrometry (MS).
    17. Draw block diagrams of and discuss the components of instrumentation for mass spectrometry.
    18. Set up and use calibration curves.
    19. Examine instrument specifications.
    20. Identify an instrument from its block diagram.
4. Describe and compare separation methods used in the analysis of a sample.
    1. Compare extraction and chromatographic separation.
    2. Classify chromatographic processes.
    3. Define and calculate adjusted retention time, retention factor, separation factor, number of plates, plate height, and resolution for chromatographic separatons..
    4. Describe band-broadening, and list processes contributing to broadening.
    5. State the Van Deempter equation, and relate the constants to the type of band broadening each represents.
    6. Describe gas chromatography (GC).
    7. Discuss GC mobile and stationary phases.
    8. Define *temperature programming*, and discuss its use in GC.
    9. Describe GC sampling and injection.
    10. Draw block diagrams and discuss the components of a GC system.
    11. Describe GC-MS.
    12. Define GC and high performance liquid chromatography (HPLC).
    13. Discuss ion chromatography (IC), size exclusion chromatography (SEC), and supercritical fluid chromatography (SFC).
    14. Describe electrophoresis, gel electrophoresis, and capillary electrophoresis (CE).
    15. Compare chromatographic and electrophoretic separation.
    16. Describe CE sampling and injection.
    17. Draw block diagrams, and discuss the components of a CE system.
    18. Set up and use calibration curves.
    19. Examine instrument specifications.
    20. Identify an instrument from its block diagram.
5. Discuss the analysis of samples using kinetic techniques.
    1. Describe the combination of spectrometry and enzymatic catalysis used in kinetic analysis.
    2. Discuss flow injection analysis (FIA).
    3. Set up and use calibration curves.
    4. Examine instrument specifications.
6. Discuss and compare the methods of chemical analysis used with biological samples.
    1. Describe the role of potentiometric and amperometric sensors in biological and clinical analysis.

2. Describe the role of molecular spectroscopy in biological and clinical analysis.
3. Describe the role of GC, HPLC, and CE in biological and clinical analysis.

7. Apply laboratory techniques and instrumentation in the analysis of samples by classical, electrochemical, spectrophotometric, separation, kinetic, and chemical analyses.
    1. Perform titrimetry or gravimetry to quantitatively analyze solids or solutions.
    2. Calibrate potentiometric instruments.
    3. Use potentiometry for qualitative and quantitative analysis of solution.
    4. Obtain spectra of organic and inorganic compounds.
    5. Calibrate spectrophotomers, and perform quantitative analysis of solids and solutions.
    6. Prepare and calibrate chromatographic instruments.
    7. Perform chromatographic analysis of samples.
    8. Examine instrument capabilities.
    9. Troubleshoot instrumental problems.
8. Document laboratory observations and data in accordance with accepted professional standards.
    1. Keep a laboratory notebook.
    2. Obtain data on the chemical and physical properties of substances using printed and online resources.
    3. Attach instrument printouts, spreadsheet calculations, and graphs to a notebook in accordance with accepted procedures.

Evaluation Criteria/Policies:
The grade will be determined using the Delaware Tech grading system:

90	–	100	=	A
80	–	89	=	B
70	–	79	=	C
0	–	69	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Final Course Grade:
Calculated using the following weighted average

Evaluation Measure	Percentage of final grade
Tests (summative) (equally weighted)	60%
Laboratory (summative) (single lab written reports worth 100 points, double lab written reports worth 200 points, presentation worth 100 points, total 900 points required)	35%
Projects (formative)	5%
TOTAL	100%

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):
Chemistry

1. Apply knowledge of the theories and principles of chemistry.
2. Follow safety procedures.
3. Perform basic laboratory operations and techniques.
4. Keep a laboratory notebook following standard laboratory practices and present data in an organized written format.
5. Prepare common laboratory solutions.
6. Prepare and purify samples using common techniques.
7. Communicate in a professional manner.
8. Analyze samples by common qualitative and quantitative techniques.
9. Use and maintain common laboratory instruments and equipment.
10. Apply mathematical concepts to the solution of scientific problems.

Chemistry Math Concentration

1. Apply knowledge of the theories and principles of chemistry.
2. Follow safety procedures.
3. Perform basic laboratory operations and techniques.
4. Keep a laboratory notebook following standard laboratory practices and present data in an organized written format.
5. Prepare common laboratory solutions.
6. Prepare and purify samples using common techniques.
7. Communicate in a professional manner.
8. Analyze samples by common qualitative and quantitative techniques.
9. Use and maintain common laboratory instruments and equipment.
10. Apply differential and integral calculus in the solution of problems.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.