



## Course Number and Title: CHM 250 Analytical Chemistry I

**Campus Location:**

Georgetown, Dover, Stanton, Wilmington

**Effective Date:**

2018-51

**Prerequisite:**

CHM 151

**Co-Requisites:**

None

**Course Credits and Hours:**

5.00 credits

4.00 lecture hours/week

4.00 lab hours/week

**Course Description:**

This course is the first of a two-semester sequence covering quantitative analysis. Analytical processes and procedures, good laboratory practices, statistics, sampling, chemical equilibria, and high performance liquid chromatography (HPLC) analysis 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](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. Apply the analytical process to chemical analysis (CCC 2, 4, 5, 6; PGC 1, 7, 8, 10)
2. Employ applicable methods of data reduction and statistical analysis. (CCC 1, 2, 6; PGC 1, 7, 10)
3. Prepare laboratory solutions appropriate for chemical analysis. (CCC 2, 4, 6; PGC 1, 5, 7, 10)
4. Perform stoichiometric calculations. (CCC 2, 5, 6; PGC 1, 7, 10)
5. Apply equilibrium concepts in chemical analysis. (CCC 2, 5, 6; PGC 1, 7, 10)
6. Compare the analysis of samples using HPLC. (CCC 1, 2, 5, 6; PGC 1, 7, 8, 10)
7. Perform laboratory procedures required for chemical analysis. (CCC 1, 2, 3, 4, 5, 6; PGC 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
8. Document laboratory observations and data in accordance with accepted professional standards. (CCC 1, 2, 3, 4, 5; PGC 3, 4, 7)

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. Apply the analytical process to chemical analysis.
  1. Describe the analytical process.
  2. Define terms associated with chemical analysis.
  3. Discuss the differences between qualitative and quantitative analysis.
  4. Classify analytical techniques based on method and/or scale of operation.
  5. Define and distinguish Good Laboratory Practices (GLP), current Good Manufacturing Practices (cGMP), and Good Clinical Practices (GCP).
  6. List regulatory agencies and industry organizations that govern GLP.
  7. Define and distinguish quality assurance and quality control.
  8. Compare and contrast voluntary versus regulated compliance.
  9. Describe documentation for GLP.
  10. Describe regulations for laboratory notebooks and their particular application in the analytical laboratory.
  11. Discuss safety procedures and equipment as related to chemical and biological labs.

12. List and define common figures of merit for analytical methods.
  13. Discuss factors considered in selection of an analytical method.
  14. Discuss calibration and validation of analytical methods.
  15. Discuss obtaining a representative sample.
  16. List factors considered when obtaining a sample.
  17. Discuss sample preservation.
  18. Examine the sample dissolution process.
  19. Discuss sample pretreatment.
  20. Describe liquid-liquid extraction.
  21. Define *partition ratio* and *distribution ratio*, and calculate fraction and concentration extracted.
  22. Compare single versus multiple extractions.
  23. Predict how competing equilibria affect the distribution ratio.
  24. Discuss solid-phase extraction.
  25. Discuss collection and preservation of biological samples.
  26. Describe the use of an internal standard.
  27. Use a standard operating procedure (SOP).
2. Employ applicable methods of data reduction and statistical analysis.
    1. Review scientific notation and significant figures
    2. Identify the types and sources of errors in laboratory measurements.
    3. Define and distinguish accuracy and precision.
    4. Define *populations* and *samples*, and describe the distributions of each.
    5. Calculate and apply measures of central tendency and variability of samples: mean, median, deviation, range, standard deviation, and relative standard deviation/coefficient of variation.
    6. Calculate confidence limits and confidence intervals for replicate data.
    7. Perform statistical evaluation of experimental data using Microsoft Excel.
    8. Identify outliers and apply tests for rejection of outliers.
    9. Apply basic graphing procedures, and use Microsoft Excel to graph data.
    10. Discuss linear regression and goodness of fit.
    11. Recognize when application of linear regression to analytical data is appropriate.
    12. Relate a regression equation to a theoretical model.
    13. Calculate analysis results from linear regression of calibration data.
    14. Use Microsoft Excel for statistical calculations.
  3. Prepare laboratory solutions appropriate for chemical analysis.
    1. Select the best balance for weighing a given sample.
    2. Discuss sources of error in weighing.
    3. Describe the role and use of weighing bottles and desiccators in the weighing process.
    4. Explain weighing by difference.
    5. Describe the uses and applications of volumetric apparatus, including volumetric flasks, burets, pipets, and micropipettes.
    6. Discuss cleaning and marking of laboratory glassware, including volumetric glassware.
    7. Describe calibration/validation of volumetric glassware.
    8. Describe the preparation of standard solutions.
    9. Discuss selection of reagents and other chemicals.
    10. Define *primary standards*, and discuss their use in analysis.
    11. Compare the purity of different classes of reagents, and state when using each is appropriate.
    12. Perform dilution calculations.
    13. Discuss mixing.
    14. Discuss filtration.
    15. Compare the properties of precipitates and precipitating reagents.
    16. Select conditions to maximize the suitability of a precipitate for an analysis.
  4. Perform stoichiometric calculation.
    1. Perform concentration calculations.
    2. Perform gravimetric calculations.
    3. Perform titrimetric calculations.
  5. Apply equilibrium concepts in analysis.
    1. Classify equilibria used in analysis.
    2. Distinguish homogeneous versus heterogeneous equilibria.
    3. Compare activity and concentration.
    4. Calculate ionic strength.
    5. Explain how ionic strength variation affects analyses.
    6. Review Le Chatelier's principle.
    7. Write stepwise and overall equilibrium constants.
    8. Distinguish analytical versus equilibrium concentrations.
    9. Write and simplify mass- and charge-balance expressions.
    10. Write equilibrium expressions, and calculate equilibrium concentrations.
    11. Describe the common ion effect.
    12. Compare and contrast the three major acid-base theories.
    13. Identify conjugate acid-base pairs.

14. Discuss acid–base equilibria in water and the pH scale.
15. Review and perform pH calculations involving strong acids, strong bases, weak acids, and salts of weak acids, weak bases and salts of weak bases, buffers, polyprotic acids, and salts of polyprotic acids.
16. Use fraction of species plots (alpha fraction plots).
17. State and perform buffer calculations both as equilibrium expressions and using the Henderson-Hasselbalch equation.
18. Define *buffering capacity*.
19. Discuss the effect of dilution and temperature on buffers.
6. Compare the analysis of samples using HPLC.
  1. Compare extraction and chromatographic separation.
  2. Describe HPLC.
  3. Compare the major modes of HPLC separation.
  4. Draw block diagrams, and discuss the components of an HPLC system.
  5. Describe and differentiate HPLC mobile and stationary phases.
  6. Define *gradient elution*, and discuss its use in HPLC.
  7. Describe HPLC sample preparation.
  8. Compare HPLC detection methods.
  9. Describe HPLC-Mass Spectrometry (HPLC-MS), and differentiate total ion current (TIC) and selective ion monitoring (SIM).
7. Perform laboratory procedures required for chemical analysis.
  1. Demonstrate appropriate use and care of digital balances.
  2. Validate the performance of laboratory equipment.
  3. Prepare stock solutions.
  4. Perform dilutions.
  5. Compare the accuracy and use of general versus volumetric glassware.
  6. Calibrate laboratory equipment according to manual criteria.
  7. Prepare and check pH of buffers.
  8. Apply statistical analysis to laboratory data.
  9. Standardize solutions.
  10. Prepare samples for analysis.
  11. Perform HPLC analysis.
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:**

Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	-	100	=	A
83	-	91	=	B
75	-	82	=	C
0	-	74	=	F

Students should refer to the [Student Handbook - https://www.dtcc.edu/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.

**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):**

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.

**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](https://www.dtcc.edu/disabilitysupport) web page or visit the campus Advising Center.