CHEM 220 - Fundamentals of Analytical Chemistry Lecture (Spring 2020)

Co-requisite: CHEM 220L  Pre-requisites: CHEM 112, 112L, MATH 111 or equivalents

Instructor: Dr. Jay G. Forsythe
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Office Hours: Mon 9-11 AM; Tues 9:30-10:30 AM; also by appt

Lecture Time and Location: Tues / Thurs, 8:00 – 9:15 AM, SSMB 127

Final Exam Time and Location: Saturday, April 25th, 12:00-3:00 PM, SSMB 127

Student Learning Outcomes:

- To carry out concentration, titrimetric, equilibrium, and statistical calculations.
- To explain and apply the theory behind quantitative methods and modern instrumentation.
- To assess the quality of laboratory data and identify any sources of error.
- To construct and apply calibration curves used in chemical analysis.
- To explain chemical equilibria and its applications and perform appropriate calculations.
- To select the most appropriate method for a given chemical analysis.
- To demonstrate problem-solving abilities in the area of chemical analysis.

Attendance and Participation: Due to the problem-heavy nature of this course, the majority of lecture material will be written on the board or document camera. Therefore, it is highly recommended students attend all lectures, and it is the student’s responsibility to follow up on missed notes. While in class, it is expected that students will actively participate. Please refrain from texting, online games, social media, etc.

Communication: Major class announcements and handouts will be discussed in class and sent via e-mail. Writing assignments will be edited, uploaded, and graded through the OAKS Dropbox. Grades for individual assignments and tests will be uploaded to OAKS.

Required Materials:

- *Exploring Chemical Analysis*, 5th Edition, Daniel C. Harris (print or digital is fine, older versions too)
- ALEKS online course preparation (free)
- Scientific calculator with log and exponential functions

Optional Materials:


Disability Services: Students with a documented disability who will require accommodations in this course must provide the proper documentation in the form of a Professor Notification Letter (PNL) **by Tuesday, January 14th**. If you are approved for extra time on tests, this will need to be arranged with the SNAP office so that you can take it there. I will need the envelope at least one day before the test so I can have it delivered to the SNAP office in time for you to take it there. This applies to the final as well.

Honor Code: Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when suspected, will be investigated. Each incident will be examined to determine the degree of deception involved.

Incidents where the instructor determines the student’s actions are related more to a misunderstanding will be handled by the instructor. A written intervention designed to help prevent the student from repeating the
error will be given to the student. The intervention, submitted by form and signed both by the instructor and the student, will be forwarded to the Dean of Students and placed in the student’s file.

Cases of suspected academic dishonesty will be reported directly by the instructor and/or others having knowledge of the incident to the Dean of Students. A student found responsible by the Honor Board for academic dishonesty will receive a XXF in the course, indicating failure of the course due to academic dishonesty. This status indicator will appear on the student’s transcript for two years after which the student may petition for the XX to be expunged. The F is permanent. Students should be aware that unauthorized collaboration—working together without permission— is a form of cheating. Research conducted and/or papers written for other classes cannot be used in whole or in part for any assignment in this class without obtaining prior permission from the instructor.

Students can find the complete Honor Code and all related processes in the Student Handbook at http://studentaffairs.cofc.edu/honor-system/studenthandbook/index.php

Course Evaluation: Course evaluations will be completed on the last day of class. The instructor will leave the room early so you can fill out the electronic forms objectively. Please take them seriously.

Recommended Study Practices: Working (and re-working) book / OAKS problems and going over class notes are the best ways to prepare for exams. Book and OAKS problems will not be collected or graded, but are essential in preparing for exams and should be done throughout the course. In particular, OAKS problems should be useful as they are written similar to test questions. It is much more efficient to work a few problems a day than to work them all right before the exam. Also, the Student Learning Center (SLC) is a good resource and has science-specific assistance (http://csl.cofc.edu/).

ALEKS Course Prep (FREE): An online prep assignment was designed to ensure students from different educational backgrounds are ready to start the course. ALEKS goes at the pace of each individual student – if you are a little rusty in chemistry, it may take a while. If you are not, it should not take long. You will take an initial assessment and then go from there. NOTE: the degree to which you complete ALEKS prep will be considered when assigning plus/minus to your final grade (see Grading). Sign up for ALEKS using the below instructions, and please let me know immediately if you have any issues accessing it:

2. If you have used ALEKS before, login. If you have not, on the left-hand side there is a yellow box that says “New Student? Sign up now.” Click on it.
3. The course code is: 3PAQQ-FKDPC. When you type it in, you will be able to start your initial assessment. After the initial assessment is complete, then you can work on completing your pie.

Course Outline:

Unit I: Fundamentals of Quantitative Analysis
- Chapter 1 sections 1.3 and 1.4 (Chemical Concentrations and Preparing Solutions)
  - Recommended problems: 1-9, 1-10, 1-11, 1-12, 1-13, 1-14, 1-15, 1-17, 1-20
- Chapters 3 and 4 thru section 4.5 (Math Toolkit and Statistics: skip section 4-6)
  - Recommended problems: 3-1, 3-2, 3-3, 3-4, 3-5, 3-9, 3-11, 3-12, 3-13, 3-14, 3-15, 3-16, 3-20, 4-1, 4-2, 4-4, 4-5, 4-6, 4-7, 4-8, 4-9, 4-11, 4-12, 4-13, 4-14, 4-15
- Chapter 4 sections 4.6 - 4.7 and Chapter 5 (Calibration Curves)
  - Recommended problems: 4-19 (use Excel), 5-4, 5-14, 5-18, 5-22
- Chapter 6 (Titrations: incorporate section 1-5 with 6-4; skip sections 6-5 and 6-6)
  - Recommended problems: 1-27, 1-28, 1-29, 1-31, 6-1, 6-5, 6-6, 6-12, 6-14, 6-15, 6-17, 6-18, 6-20
**Unit II: Acid and Base Chemistry**
- Chapter 8 (Acids/Bases)
  - Recommended problems: 8-1, 8-3, 8-4, 8-9, 8-11, 8-13, 8-14, 8-15, 8-16, 8-17, 8-18, 8-19, 8-21, 8-22, 8-23, 8-28, 8-32
- Chapter 9 (Buffers)
  - Recommended problems: 9-1, 9-2, 9-4, 9-6, 9-7, 9-8, 9-9, 9-12, 9-13, 9-14, 9-15, 9-16, 9-20, 9-22
- Chapter 10 (Acid and Base Titrations: skip derivatives in 10-4, skip section 10-6)
  - Recommended problems: 10-1, 10-2, 10-3, 10-6, 10-7, 10-8, 10-9, 10-11, 10-12, 10-13, 10-14, 10-15, 10-16, 10-17, 10-20, 10-23, 10-27
- Chapter 11 (Polyprotic Acids)
  - Recommended problems: 11-2, 11-3, 11-7, 11-9, 11-10, 11-12, 11-13, 11-17, 11-19, 11-20, 11-25, 11-26

**Unit III: Equilibrium and Electrochemistry**
- Chapter 12 (Equilibrium: skip problems using Debye-Huckel eqn in 12-2)
  - Recommended problems: 12-1, 12-2, 12-6, 12-7, 12-8, 12-9, 12-11, 12-16, 12-18, 12-22, 12-23, 12-24, 12-26, 12-29, 12-36, 12-37, 12-38
- Chapters 14 and 15 (Electrochemistry: skip section 15-5)
  - Recommended problems: 14-1, 14-2, 14-3, 14-4, 14-8, 14-9, 14-10, 14-11, 14-12, 14-14, 14-16, 14-17, 14-20, 14-23, 14-24, 14-25, 15-1, 15-2, 15-11

**Unit IV: Spectroscopy and Chromatography**
- Chapters 18 – 20 (Spectroscopy: skip sections 19-1 thru 19-3, 20-2, and 20-4 thru 20-6)
  - Recommended problems: 18-1, 18-2, 18-3, 18-4, 18-5, 18-7, 18-12, 18-14, 18-15, 18-19
- Chapters 21 and 22 (Chromatography: skip sections 21-5, 22-2, and 22-4)
  - Recommended problems: 21-1, 21-2, 21-3, 21-4, 21-7, 21-11, 22-2, 22-5

**Key Dates:** Test dates are unlikely to change, but the material covered may change depending on lecture pace. Writing assignments will be due at the beginning of class (8:00 AM) and those dates are subject to change depending on weather and/or unforeseen events which may arise.

**Unit I:**
- Writing 1 (optional first draft) by Tuesday, 1/21 at 8:00 AM
- ALEKS Prep due Thursday, 1/23 at 8:00 AM
- **EXAM 1:** Thursday, 1/30 at 8:00 AM (in class)

**Unit II:**
- Writing 1 (final submission) due Tuesday, 2/4
- **EXAM 2:** Thursday, 2/27 at 8:00 AM (in class)
- Writing 2: due Tuesday, 3/10 at 8:00 AM

**Unit III:**
- **EXAM 3:** Thursday, 3/26 at 8:00 AM (in class)
- Writing 3: due Tuesday, 3/31 at 8:00 AM

**Unit IV:**
- **EXAM 4:** Thursday, 4/9 at 8:00 AM (in class)
- Reassessment Day (can retake one exam of your choice): Friday, 4/17 btwn 12:00-5:00 PM
- Writing 4: due Tuesday, 4/21 at 8:00 AM
**Grading:** Semester exams will be graded on a 10-pt scale (A = 100-90%, B = 89-80%, C = 79-70%, D = 69-60%, F = 59% and below) but this scale may be adjusted by the instructor if needed. Overall course grades will be earned using the below rubric. *Plus/minus adjustments at the end of the semester are at the instructor’s discretion and the following criteria will be considered: class attendance and participation, completion of ALEKS prep assignment, and proximity to grade cutoffs.*

**To receive an A in this course, a student must:**

- Obtain an A on at least two semester exams, average a B or higher for all four semester exams, pass all four writing assignments, and score at least a 34 (raw score) on the ACS final.

OR

- Obtain an A on at least three semester exams, average a B or higher for all four semester exams, pass all four writing assignments, and score at least a 29 (raw score) on the ACS final.

**To receive a B in this course, a student must:**

- Obtain a B or higher on at least two semester exams, average a C or higher for all four semester exams, pass all four writing assignments, and score at least a 29 (raw score) on the ACS final.

OR

- Obtain a B or higher on at least three semester exams, average a C or higher for all four semester exams, pass all four writing assignments, and score at least a 24 (raw score) on the ACS final.

**To receive a C in this course, a student must:**

- Obtain a C or higher on at least two semester exams, average a D or higher for all four semester exams, pass at least three of four writing assignments, and score at least a 24 (raw score) on the ACS final.

OR

- Obtain a C or higher on at least three semester exams, average a D or higher for all four semester exams, pass at least three of four writing assignments, and score at least an 20 (raw score) on the ACS final.

**To receive a D in this course, a student must:**

- Obtain a D or higher on at least two semester exams, average a 55% or higher for all four semester exams, pass at least two of four writing assignments, and score at least an 15 (raw score) on the ACS final.

OR

- Obtain a D or higher at least three semester exams, average a 55% or higher for all four semester exams, pass at least two of four writing assignments, and score at least a 15 (raw score) on the ACS final.

**A student will receive an F if they do not satisfy all minimum requirements for a D.**
Reassessment Day (Friday, April 17th; normal length of time somewhere between 12:00-5:00 PM):
One semester exam may be retaken on “Reassessment Day,” and the new score will replace the previous score if it increases. Reassessments will cover the same material but with different questions than before. If a student’s score decreases, then the initial test score will remain with no penalty. Students must notify the instructor of the exam they wish to retake and their desired time slot by 5:00 PM on Tues, April 14th.

Writing Assignments:

Documents should be 1 page or less, single spaced. These will be graded pass/fail, but require accurate content, professional style and grammar, and a citation of the article/paper used. Examples will be provided on OAKS and all assignments will be uploaded to OAKS also – no paper copies are needed. Please see http://library.williams.edu/citing/styles/acs.php for assistance with citations in ACS format.

**Assignment 1**: Find a news article in the popular press (newspaper, magazine, internet) that involves analytical or environmental chemistry. Do NOT use a technical journal. Your first assignment can be edited by Dr. Forsythe without penalty and then you may re-submit the final version to be graded by the 2/4 due date. This will only occur for the first writing assignment – the purpose of this process is to learn how to write clearly and effectively.

1. Summarize the article in one paragraph.
2. Make three lists of terms and concepts:
   a. terms you understand well
   b. terms that you are reasonably sure about
   c. terms that you don’t understand
3. Write a list of questions, technical or otherwise, that the article raises in your mind.
4. Critique the article by addressing the validity of the data/arguments that the other uses. Be sure to include a proper bibliographic citation of your article.

**Assignment 2**: Find an article in Chemical and Engineering News (https://cen.acs.org/) of interest to you that involves analytical or environmental chemistry (examples: a new innovation, a real-world problem to be solved, employment opportunities, or government regulations). Discuss why you selected the article, and include a proper bibliographic citation. NOTE: You will likely need to be on the campus internet to access some of these articles. Dr. Forsythe also has hard copies which you can borrow.

1. Briefly summarize the article.
2. What new chemistry concepts did you learn, or if you did not learn new chemistry what was reinforced for you?
3. Do you agree or disagree with any statements made by the author and why?

**Assignment 3**: You will be given a scientific article by Dr. Forsythe and will address the following:

1. Summarize the article, as with previous ones.
2. Find and discuss terms and concepts in the paper that we have gone over in class this semester.
3. Discuss strengths and weaknesses of research described in the paper.

**Assignment 4**: Find an article in one of these two journals that uses spectroscopy or chromatography: Analytical Chemistry or Environmental Science and Technology. NOTE: You will likely need to be on the campus internet to access these journals. Be sure to include a proper bibliographic citation.

1. Summarize the method used and the results of the research.
2. Describe how well you understood the article (or not). What was confusing, if anything?
3. What would you do as an analytical chemist to improve the procedure?

*Anal. Chem. link: [http://pubs.acs.org/journal/ancham](http://pubs.acs.org/journal/ancham)*
*Environ. Sci. & Tech. link: [http://pubs.acs.org/journal/esthag](http://pubs.acs.org/journal/esthag)*
Class: 220_PREP_SPR2020  
Class Code: 3PAQG-FKDPC  
Subject: General Chemistry (Second Semester)  
Instructor: Dr. Forsythe  
Class Dates: 01/06/2020 - 01/23/2020  
Class Content: 16 topics  
Textbook: ALEKS Curriculum

## Objectives Covered

<table>
<thead>
<tr>
<th>Objectives Covered</th>
<th>Progress Level</th>
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</thead>
<tbody>
<tr>
<td>1. Prerequisite Review Topic (7 topics)</td>
<td>100%</td>
</tr>
<tr>
<td>2. Acid-Base Chemistry (4 topics)</td>
<td>100%</td>
</tr>
<tr>
<td>3. Redox and Electrochemistry (2 topics)</td>
<td>100%</td>
</tr>
<tr>
<td>4. Spectroscopy (1 topic)</td>
<td>100%</td>
</tr>
<tr>
<td>5. Concentration Units (2 topics)</td>
<td>100%</td>
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</tbody>
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### Prerequisite Review Topic (7 Topics)
- Applying the quadratic formula: Decimal answers
- Finding the slope and y-intercept of a line given its equation in the form $Ax + By = C$
- Evaluating a logarithmic expression
- Solving an equation of the form $\log_{a} b = c$
- Basic properties of logarithms
- Writing the net equation for a sequence of reactions
- Identifying the limiting reactant in a drawing of a mixture

### Acid-Base Chemistry (4 Topics)
- Recognizing common acids and bases
- Interconverting pH and hydronium ion concentration
- Calculating the pH of a strong acid solution
- Calculating the pH of a strong base solution

### Redox and Electrochemistry (2 Topics)
- Recognizing reduction and oxidation
- Identifying oxidizing and reducing agents

### Spectroscopy (1 Topic)
- Interconverting wavelength, frequency and photon energy

### Concentration Units (2 Topics)
- Calculating mass percent composition
- Calculating mole fraction