MODERN ANALYTICAL CHEMISTRY
SPRING 2020

Course Description: CHEM 5460 is a proficiency analytical course with primary emphasize on strengthening student’s fundamental knowledge of analytical chemistry. The course will also introduce students to the modern analytical methodology with emphasis on measurements, data analyses and instrumental techniques, including separation methods, electrochemical methods and spectroscopy. This course will provide advanced degrees seeking students with the vital practical skills required for professional chemist active in the chemical measurement science.

Course Objectives:
• Establish a general familiarity with important analytical techniques.
• Bridge any gaps in undergraduate training in chemical analysis.
• Enhance understanding of statistical terminology and its applications.
• Effective utilization of the primary literature in and persuasive presentation.
• Promote a mindset change from graduate student to professional scientist.

Instructor: Dr. Oliver Chyan, 
Voice (940)565-3463 , Chemistry Building, room 156 
E-mail: Chyan@unt.edu


Class Schedule: Tuesday, Thursday 3:30 - 4:50 PM. 
Chemistry, room 253

Office Hours: (Tuesday & Thursday, 1PM -2:30 PM) (or by arrangements if need extra help.)

Exams: Three terms exams will be held on Feb. 6, Mar. 5, & April 2. Please plan accordingly. The average of three exams will be counted as 70% toward final grade. Your lowest term exam score may be dropped provided you take ALL three exams and receive >50% on EVERY exam. Then, the other two higher exam grades will be counted 35 % each toward the final grade. Presentation (20%) and term paper (10%) based on a research project, selected by students and approved by instructor, will account for the rest of 30% grade. Optional final exam
(comprehensive) will be provided to those like to further improve their term grade. More details will be announced later.

**Missing Exam:** Plan your schedule accordingly. If you must miss an exam, permission (with proper documentation) must be obtained in advance. Medical absence requires proper doctor’s statement.

**Homework:** Working the problems is very important to achieve better understanding of materials taught and good grade in the class. A copy of the solution manual ([Check: UNT Willis library service desk](http://vpaa.unt.edu/academic-integrity.htm)) with detailed answers to the problems is reserved in the Willis library. *Note: the solution manual is not errors free.* Extra credit will be given for the completed homework submitted on time, see following section.

**Grading Scale:**

<table>
<thead>
<tr>
<th>Final percent</th>
<th>Average</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 - 100 %</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>80 - 89 %</td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>70 - 79 %</td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>60 - 69 %</td>
<td></td>
<td>D</td>
</tr>
<tr>
<td>Below 60 %</td>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

**Note:**

*I reserve the right to make changes/modifications of the syllabus if needed.*

*The Chemistry Department believes in reasonably accommodating individuals with disabilities and complies with university policy established under Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act (1990) to provide equal access and opportunity. Please communicate with your professor as to your specific needs and/or the office of Disability Accommodation (ODA) (Room 321, Union, 565-4323).*

**Academic Ethics:** A high level of ethical conduct will be maintained in this course. Any evidence of an act of academic dishonesty during the exams will result in an automatic F and expulsion from this course. Please adhere to University policies and the UNT Code of Conduct and Discipline with respect to academic ethics and honesty.

[http://vpaa.unt.edu/academic-integrity.htm](http://vpaa.unt.edu/academic-integrity.htm)
### CHEM 5460 MODERN ANALYTICAL CHEMISTRY

#### Important Dates (Spring 2020)

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic/Exam/Due Items</th>
<th>Note</th>
</tr>
</thead>
</table>
| 1<sup>st</sup> week of Jan 13 | Intro: Analytical Measurements (Ch 0-2)  
Experimental Error (Ch 3)            |                           |
| 2<sup>nd</sup> week     | Experimental Error (Ch 3)  
Statistics (Ch 4)          |                           |
| 3<sup>rd</sup> week     | Quality Assurance & Calibration (Ch 5)  
Chemical Equilibrium (Ch 6)      |                           |
| 4<sup>th</sup> week  
(Feb 6, Th) | Activity & Systematic Treatment (Ch 7)  
(Exam #1)  
Ch. 1, 2, 3, 4, 5, 6       | 23.3% grade                |
| 5<sup>th</sup> weeks    | Monoprotic Acid-Base Equilibria (Ch 8)  
Polyprotic Acid-Base Equilibria (Ch 9) |                           |
| 6<sup>th</sup> week of <Feb 20: seek approval - research project Title>  
Acid-Base Titrations (Ch 10)      |                           |
| 7<sup>th</sup> weeks    | EDTA Titrations (Ch.11)                     |                           |
| 8<sup>th</sup> week  
(Mar 5, Th) | Fundamental of Electrochemistry (Ch.13)  
(Exam #2)  
Ch. 7, 8, 9, 10, 11       | 23.3% grade                |
| 9<sup>th</sup> week     | (Spring Break)                                       |                           |
| 10<sup>th</sup> week    | <Mar 19: Presentation Outline due>  
Electrodes & Potentiometry (Ch.14) |                           |
| 11<sup>th</sup> week    | Redox Titrations (Ch.15)  
Electroanalytical Techniques (Ch.16) |                           |
| 12<sup>th</sup> week  
(April 2, Th) | Fundamental of Spectrophotometry (Ch.17)  
(Exam #3)  
Ch. 13, 14, 15, 16, 17    | 23.3% grade                |
| 13<sup>th</sup> week  
(April 7, 9) | Spectrophotometers, AA (Ch.19-20)  
Research Paper Presentation | 20% grade                  |
| 14<sup>th</sup> week  
(April 14, 16) | Research Paper Presentation |                           |
| 15<sup>th</sup> week    | Industry Application of Analytical Chemistry |                           |
| 16<sup>th</sup> week    | Industry Application of Analytical Chemistry |                           |
| May 1: Term paper due  
May 1 to Chyan@unt.edu | 10% grade                  |
| May 5  
1:30-3:30PM | Final Exam (optional)  
For Grade Improvement |                           |
### MODERN ANALYTICAL CHEMISTRY

**Suggested Homework Problems “Quantitative Chemical Analysis” by D. C. Harris (9th)**

<table>
<thead>
<tr>
<th><strong>•Fundamental Skills</strong></th>
<th><strong>Assigned Problems</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch. 0 The Analytical Process</td>
<td>None</td>
</tr>
<tr>
<td>Ch. 1 Chemical Measurements</td>
<td>3-5 (= 3, 4, 5), 13-15, 18, 20-27, 29-31, 33-37</td>
</tr>
<tr>
<td>Ch. 2 Tools of the Trade</td>
<td>1-7, 9-18, 20-22</td>
</tr>
<tr>
<td>Ch. 3 Experimental Error</td>
<td>1-3, 9, 11-15, 17-24, 26, 31, 35</td>
</tr>
<tr>
<td>Ch. 4 Statistics</td>
<td>1-8, 10, 12, 13, 18, 22, 23, 25, 26, 29, 30</td>
</tr>
<tr>
<td>Ch. 5 QA and Calibration</td>
<td>1-4, 6-8, 10, 14-16, 19-22, 28-30, 33-36, 38, 39, 44-52</td>
</tr>
<tr>
<td>Ch. 6 Chemical Equilibrium</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>•Titrimetric Methods of Analysis</strong></th>
<th><strong>Assigned Problems</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch. 7 Titration Begins</td>
<td>1-8, 10, 11, 13, 17, 19, 22, 26</td>
</tr>
<tr>
<td>Ch. 8 Activity &amp; Systematic Treatment</td>
<td>1, 2, 4, 5, 7, 10, 11, 13, 16-20, 23, 25</td>
</tr>
<tr>
<td>Ch. 9 Monophonic Acid-Base Equilibria</td>
<td>1-3, 5-8, 11-13, 18, 21-23, 26, 29, 30, 32, 34, 36, 39-40, 42, 43</td>
</tr>
<tr>
<td>Ch. 10 Polyprotic Acid-Base Equilibria</td>
<td>3, 4, 6, 12-21, 24, 25, 29, 30, 38, 40, 41</td>
</tr>
<tr>
<td>Ch. 11 Acid-Base Titrations</td>
<td>1-4, 6, 8, 12-14, 18, 19, 23, 25, 27, 29, 31, 36, 37, 42, 45, 49, 50, 58, 60, 62</td>
</tr>
<tr>
<td>Ch. 12 EDTA Titrations</td>
<td>1-3, 6, 7, 14, 16, 23, 24, 27-29, 32-34, 36, 37</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>•Electroanalytical Methods of Analysis</strong></th>
<th><strong>Assigned Problems</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch. 14 Fundamentals of Electrochemistry</td>
<td>5-10, 12, 14-18, 21-23, 28-32, 37, 39, 40, 42, 43, 46, 49</td>
</tr>
<tr>
<td>Ch. 15 Electrodes and Potentiometry</td>
<td>1, 2, 5, 8, 9, 12, 21, 22, 24, 25, 31-35</td>
</tr>
<tr>
<td>Ch. 16 Redox Titrations</td>
<td>1-4, 7-11, 13, 14, 17-19, 22-27, 29, 30, 33</td>
</tr>
</tbody>
</table>
Some Tips for CHEM 5460

Prepare for Exams (70% grade)

1. **Team study** is a proven effective way to do well in this class. Make friends and work together. Start today!

2. **Pre-view** (i.e. read ahead) the chapter(s) before attending the class, especially for new or not so familiar concepts like statistical analysis, etc.

3. **Our lecturing time is rather limited.** Both important concepts and selected examples will be covered in the class. However, *do not expect all questions tested will be covered exactly in the class.*

4. **What will be tested from textbook?** Study *chapter examples*, Do the *Exercises* and verify the answers at the end of the book. Work on *Assigned Problems* and verify with answers from solution manual (UNT library reserved)

5. **What will be tested other than textbook?** Study “practicing quizzes” provided and take notes on Lecture examples.

6. **Practice before exam:** Before the exam, make up a simulated exam (put in some of those marked problems you have difficulty earlier) and give yourself one hour and half on the simulated exam.

Term Paper and Presentation (30% grade)

1. **Start Early** on literature search, seek Dr. Chyan’s approval **early** (confirm topic priority by Email date).

2. **Continue taking Good Notes** (electronic notes with selected Figures/proper citation) on relevant papers (>20 papers) from your own literatures search.

3. **Establish a Central Theme (Objectives)** of the term paper; **seek Dr. Chyan's inputs and approval.** *(due by Feb 24, Research Project Title)*

4. **Construct Presentation Outline** *(due by March 19)* that leads to convincing writing and persuasive presentation to communicate your central theme and objectives.

5. **Prepare Sharp PowerPoint Presentation** with clear messages that attracts audience attention to learn and invites questions. Tips will be provided.

6. **Deliver an Inspiring Persuasive Presentation**, tips/advises will be provided.
Some Suggested Research Frontiers for Term Paper Topic

Analytical Chemistry using Nanoparticles
Single-molecule spectroscopy (SMS)
Single Molecular Detection and Imaging
Surface-Enhanced Raman Spectroscopy
Analytical applications using Microfluidic Systems
Nanoscopic Porous Sensors
Application of High-Resolution Mass Spectrometers in Medical Science
Chemical Sensor based on optical fibers and waveguides
Chemical Sensor based on ion-selective and chemically modified electrodes
Chemical Sensor based on surface acoustical wave devices
Fluorescent-Protein-Based Biosensors
Two-dimensional separation using high-performance liquid chromatography
HPLC–capillary electrophoresis
Recent Advances in Scanning Probe Microscopy
Developing of fast gas chromatography (GC) separations (< 1 minute) Metrology
Microchannel Electrophoresis based on lab-on-chip concepts
Capillary Electrophoresis (CE) in Biological Materials Analysis
Analytical Applications based on DNA hybridization and antibody-antigen binding
Scanning Electrochemical Microscopy (SECM) and its Applications
Desorption Electrospray Ionization (DESI) mass spectrometry and Its Applications
Electroanalytical Application using Miniaturized Electrode (~nm)
Environmental Analytical Chemistry
Analytical Applications Related to Food and Drug Administration Requirements
Analytical Applications Related to Microelectronic Industry
Analytical Applications Related to Pharmaceutical Industry