Course Syllabus for Chemistry 4314  
Instrumental Analytical Methods  
Spring Semester, 2006

Class Time: Monday, Wednesday and Friday 11:00 AM - 11:50 AM  
Place: Chemistry, Room 113

Instructor: Professor Carol Korzeniewski (Office: Chemistry Room 328C)  
            Phone: 742-4181; Email: carol.korzeniewski@ttu.edu

Office Hours: M,W 1:00 PM to 2:00 PM, or by appointment


Laboratory: Chemistry 4114.

Course Description: Principles and applications of instrumental chemical analysis methods will be explored. Emphasis will be on problem solving with the aim of developing skills for approaching measurements with analytical instrumentation. The literature of modern analytical chemistry will be introduced and selected journal articles assigned on various subjects throughout the term.

Course Web-page: To locate the course web-page, you can use the web address below to get to the Chemistry Department home page.

http://www.depts.ttu.edu/chemistry/

On the left side of the screen under ‘Information about’ click on ‘Faculty’, then click on my name under ‘Analytical Chemistry’ to get to my homepage. Scroll to the bottom of my page and click on the “Chemistry 4314, Spring 2006” link. Homework assignments, quiz and exam dates, and quizzes will be posted there.

Homework: Homework (not graded) will be assigned from problems at the end of the chapters. Select problems will be reviewed in class and at occasional evening problem sessions. Solutions will be available by login to the course eLearning channel from the Raiderlink Portal accessible at http://www.raiderlink.ttu.edu. Instructions for adding the eLearning channel to your Raiderlink Portal can be downloaded from the course web-page. You will benefit most by keeping pace with the homework.

Quizzes: Quizzes are take-home assignments designed to help students prepare for examinations and keep pace in the course. The quizzes will be based on
homework exercises and material presented in class. Quizzes will be worth 20% of the total points. Quizzes are due at the start of class on the following dates:

- **Quiz 1**: Mon., Jan. 23
- **Quiz 2**: Mon., Feb. 6
- **Quiz 3**: Mon. March 6
- **Quiz 4**: Wed., March 22
- **Quiz 5**: Wed. April 12

### Exams and Grading:

<table>
<thead>
<tr>
<th>Exam</th>
<th>Date</th>
<th>Time</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam 1</td>
<td>Mon., Feb. 13</td>
<td>11:00 AM to 11:50 AM</td>
<td>100 pts.</td>
</tr>
<tr>
<td>Exam 2</td>
<td>Wed., March 29</td>
<td>11:00 AM to 11:50 AM</td>
<td>100 pts.</td>
</tr>
<tr>
<td>Exam 3</td>
<td>Fri., April 21</td>
<td>11:00 AM to 11:50 AM</td>
<td>100 pts.</td>
</tr>
</tbody>
</table>

- **Quizzes**: 5 for a total of 150 pts.
- **Essay and review problems**: Mon. May 1, 5 PM 50 pts

**Total**: 500 pts.

There will be a **Final Exam** held during the scheduled period (Friday, May 5, 7:30 AM to 10:00 AM). The standardized American Chemical Society examination in instrumental analysis will be given. Your score (75 pts possible) will be added to your point total. This exam is good practice for the type of standardized tests required for admission to professional and graduate schools in the sciences and diagnostic exams used in chemistry graduate programs. The exam can be started no later than 30 min past the starting time stated in the TTU schedule of classes. Systematic guessing is not allowed.

### Final grades:
The final letter grade will be based on the final numerical grade as follows:

- > 448 pts. (> 90%) A
- 447 - 397 (89-80 %) B
- 396 - 347 (79-70 %) C
- 346 - 297 (69-60 %) D

### Exam Policy:
Each exam will be a combination of multiple choice and free response questions. You will be responsible for all material presented in lecture and assigned in the text. You are permitted to bring a 4 x 6 inch “crib card” to the two regular hour exams. You will need the following items for each exam: photo identification, pencils, a calculator with extra batteries. A portion of the final exam will be comprehensive.

**Please note**: You must notify me in advance if sickness or another unavoidable circumstance will prevent you from taking an examination at the scheduled time. A message may be left at 2-3067 (department office), if you are unable to reach me. **There will be no make-up exams**. However, an exam may be taken at an earlier time if you present verification of the conflict and make arrangements well in advance of the exam date.
Expected Learning Outcomes: Upon completion of this course, students will be able to:

- Identify and describe general techniques of chemical instrumental analysis
- Describe figures of merit for analytical techniques
- Discuss methods for instrument calibration
- Perform basic circuit analysis calculations, including the use of Ohm’s law, and determination of measurement errors.
- Explain the meaning of signal-to-noise ratio (S/N) and discuss methods for enhancing S/N in analytical measurements
- Identify essential components of optical spectroscopic instruments
- Describe essential components of mass spectrometer systems and differentiate between various types of mass spectrometry methods
- Explain how a pH electrode works and the difference between a potentiometric and an amperometric electrochemical measurement
- Discuss types of analytical separation methods and identify essential components of chromatographic systems
- Describe applications and advantages of Fourier transform techniques in analytical chemistry

Assessment: The expected learning outcomes for the course will be assessed through in class exams, take-home quizzes, non-graded homework assignments, polling the class and related non-graded quiz activities, and discussions in class and at optional evening review sessions. In addition, students will be given an opportunity to take a standardized, nationally normed American Chemical Society examination in analytical chemistry at the conclusion of the course.

Assistance: Please do not delay in seeking help when a problem or concept gives you difficulty. See me during my office hours or make an appointment.

Special Conditions: Any student who, because of a disabling condition, may require some special arrangements in order to meet course requirements should contact the instructor as soon as possible so that the necessary accommodations can be made.
Lecture Topics Outline  
Chemistry 4314 – Spring 2006

I. Introductory Topics  
Classification of analytical methods (Ch. 1A)  
Types of instrumental methods (Ch. 1B)  
Instruments for analysis (Ch. 1C)  
Figures of merit (precision, sensitivity, detection limit, concentration range, sensitivity, Ex 1-1) (Ch. 1D)  
Calibration of instrumental methods (calibration curve, standard addition, internal standard) (Ch. 1E)

II. Measurement Basics  
Ohm’s law, voltage dividers (Ex 2-1) (Ch. 2A)  
DC voltage, current, resistance measurement (Ch 2A)  
Operational amplifiers (input impedance, feedback) (Ch. 3A)  
OpAmp circuits (inverting amplifier, voltage follower, current follower, Ex 3-1) (Ch 3B-D)

Quiz #1 (Due Mon., Jan 23)

AC signals, capacitance, impedance, RC filters (Ch. 2B)  
Analog and digital signals (Ch. 4A)  
DAC and ADC devices (resolution, rate) (Ch. 4C)

III. Signals and Noise  
Signal-to-noise ratio (S/N) (Ch. 5A)  
Noise types (thermal (Johnson), shot, flicker (1/f), environmental) (Ex 5-1) (Ch 5B)  
S/N enhancement techniques: hardware - filtering, modulation, lock-in amplifiers  
software: ensemble averaging, boxcar averaging, digital filtering (Ch 5C)

IV. Optical Spectroscopic Methods - Basics  
EM radiation (wave properties, coherence) (Ch. 6A-6B)  
Quantum properties of light (energy states, spectra) (Ex 6-3) (Ch. 6C)  
Quantitation with light (absorption, emission, scattering) (Ch. 6D)  
Optical instrument layouts (Ch. 7A)

Quiz #2 (Due Mon. Feb 6)

EM radiation sources (Ch. 7B)  
Wavelength selectors (filters, monochromators) (Ex 7-1, 7-2) (Ch. 7C)  
Sampling (Ch. 7D)  
Radiation Detectors (photo tube, PMT, array) (Ch. 7E)

EXAM I (Monday, Feb. 13, 11:00 AM)
V. Optical Spectroscopic Methods - Techniques
Atomic absorption (transitions, sources, instrumentation) (Chs. 8 and 9)
Atomic emission (ICP sources, array detection) (Chs. 9 and 10)
Molecular UV/Vis absorption (Beer’s law apps, Ex 13-1, instrumentation) (Ch. 13)
UV/Vis theory (chromophores, spectra, analysis of mixtures) (Ch. 14A-E)
Molecular luminescence (transitions, instrumentation, emission vs absorption, chemiluminescence) (Ch. 15)
Infrared absorption (vibrational modes, instrumentation, FT IR – Ch 16C, Ch. 7I) (Ch. 16)
Raman spectroscopy (scattering theory, instrumentation) (Ch. 18)

Quiz #3 (Due Mon., March 6)

VI. Non-Optical Spectroscopic Techniques

Nuclear magnetic resonance (theory, instrumentation, FT-NMR, special applications) (Ch 19A, 19C, handout material)

Quiz #4 (Due Wed., March 22)

Mass spectrometry (spectra, ionization sources, mass analyzers, FT-MS) (Ch 11A-C; Ch 20)

EXAM II (Wednesday, March 29, 11:00 AM)

VII. Electroanalytical Chemistry

Electrochemical cells, electrodes and potentials (Ch. 22)
Potentiometry (Ch. 23)
Coulometry (Ex 24-1) (Ch. 24A-B)
Voltammetry (Ch. 25)

Quiz #5 (Due Wed. April 12)

VIII. Separations

Chromatography (theory, general methods) (Ch. 26)
Gas chromatography (Ch. 27)

EXAM III (Friday, April 21, 11:00 AM)

HPLC (Ch. 28)
Electrophoresis and capillary methods (Ch 30)

FINAL EXAM (Friday, May 5, 7:30 AM)