CHEM 3281 – Instrumental Analysis for Engineers

SYLLABUS – Fall, 2011

Catalog Description: (3-3-4) Provide students with a background to modern analytical chemistry and instrumental methods of analysis with applications to engineering and other areas.

Pre-requisites: PHYS 2212 and CHEM 1315 or CHEM 2311

Textbooks: Skoog, Holler and Crouch: "Principles of Instrumental Analysis" 5th, 6th, or 7th edition, Thomson Brooks/Cole 2007

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***Note**: When emailing me, please set the subject of your message to: **CHEM 3281**. This will help me to answer promptly.*

Office Hours: MWF 1:15-2:00 pm and by appointment

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Course Web Site: https://t-square.gatech.edu/portal

Learning Objectives:

- Provides students with the theoretical underpinnings of modern methods of chemical analysis
- Enhances their understanding of the principles of operation and essential components of analytical instrumentation
- Enables students to gain practical experience in using laboratory instrumentation similar to that employed by practicing clinicians, scientists and engineers in industry or academe
- Provides students with real-world analytical challenges and the tools to solve them
- Promotes a high level understanding of the applications of sampling, statistics, separation, and analysis in determining the composition of complex chemical mixtures

Assessment

The course grade will weight the student's performance in lab and lecture in the following way: Score = 3*lecture + lab. A passing grade in both lab and lecture is required.

Note#1: Midterm exams will be given on ***Sept. 21st***, ***Oct. 26th***, and ***Nov. 30th***

Note #2: In determining the lecture grade, the final exam (Wednesday, Dec. 12th 11:30 am - 2:20 pm) will be equivalent to two midterm exams.

Note #3: In determining the lab grade, each report will be equally weighted.

Final grades will be given based on the following scale:

A (100 – 80%)
B (79 – 70%)
C (69-60%)
D (59-50%)
F (below 50%)

Academic Integrity

Students in this class are expected to abide by the Georgia Tech Honor Code and avoid any instances of academic misconduct, including but not limited to: (a) Possessing, using, or exchanging improperly acquired written or oral information in the preparation of a lab report or exam. (b) Substitution of material that is wholly or substantially identical to that created or published by another individual or individuals. (c) False claims of performance or work that has been submitted by the student.

See the published Honor Code for further information.
http://www.honor.gatech.edu/plugins/content/index.php?id=9

Please note:

- An old exam is posted on the T-square course site for use in preparing for the first exam
- No calculators, cell phones, PDAs, or other personal electronic equipment is allowed during exams
- No formula sheets, texts, notes, or contact with colleagues is allowed during exams
- Collaboration on laboratory reports is permitted but submission of duplicate text is not.
- "Word" should be used with caution since experimental procedures and questions have changed
- Plagiarism is not allowed. Cite your sources!

Topical Outline:

- Introduction to Spectrometric Methods (Chapter 6)
- Essential Components of Optical Spectrometers (Chapter 7)
- Atomic Absorption and Emission Spectroscopy (Chapters 8 & 9)
- Laser Induced Breakdown Spectroscopy (Chapter 10)
- Molecular Spectroscopy in the UV-Vis Range (Chapters 13-15)
- Vibrational Spectroscopy (Chapters 16-18)
- Basic Statistics and Sampling Theory (Appendix A)
- Practical Electronics (Chapters 2-4)
- Signal to Noise Enhancement Techniques (Chapter 5)
- Potentiometry and Voltammetry (Chapters 22, 23, & 25 sections A, B, D, & E)
- Electrophoresis (Chapter 30 sections A-C)
- Fundamentals of Extraction
- Solid Phase Extraction Techniques
- Chromatographic Theory (Chapter 26)
- Gas Chromatographic Instruments (Chapter 27)
- Liquid Chromatographic Instruments (Chapter 28)
- Supercritical Fluid Chromatography (Chapter 29)
- Mass Spectrometry (Chapters 11 & 20)
- Thermal Methods of Analysis (Chapter 31)
- Optical, Electron, and Probe Microscopy (Chapter 21 sections F&G)

List of Experiments to be Conducted in the Laboratory

Rotation	Experiment	Suggested Readings*
1	Flow Injection Analysis	*Ch. 13A, 13B, & 33B*
	Atomic Absorption Spectroscopy (expanded)	*Ch. 9*
	Laser Induced Breakdown Spectroscopy	
	Raman Spectroscopy of a Complex Mixture	*Ch. 18A-C*
	Mixture Analysis by Fluorimetry	*Ch. 15A*
	Flow Injection Analysis	*Ch. 33A&B*
	Bye	
2	Electrophoretic Separation of a Textile Dye Mixture	*Ch. 30A*
	Ion Selective Electrodes	*Ch. 23A,B,C&H*
3	Solid Phase Extraction of Caffeine	*Ch. 20D&E*
	Gas Chromatography of a Phenolic Mixture	*Ch. 27A-D*
4	Liquid Chromatography - Kinetics of Reactive Dyes	*Ch. 28A-D*
	Analysis of Gasoline Formulations using GC/MS	

*****in addition to the handout prior to coming to lab to perform the experiment

General Information and Policies

- Lectures will be devoted to both theoretical and practical aspects of the analytical procedures encountered in the laboratory. Lecture topics, exam dates, and suggested readings are available on the T-square site for this course. Attendance is required of all students.
- Attendance at laboratory is required of all students. Students must be on time for each lab meeting since the laboratories are tightly scheduled and there is very little free time available. The lab will not be open at hours other than those scheduled. Students may not under any circumstances work in the laboratory without supervision.
- Everyone in the laboratory will conform to Georgia Tech Laboratory Personal Protective Equipment and Appropriate Attire Policy (appended to syllabus on T-square site for this course). This includes wearing a lab coat and safety googles at all times. Failure to comply will result in your being asked to leave the laboratory. Make-ups resulting from your failure to comply with this policy will not be permitted. There will be no exceptions.
- Each student is required to keep and maintain the equipment in working order. Instructions for each laboratory experiment are available on-line under T-square.
- Each student is required to maintain a laboratory notebook. The notebook must have a sewn-in binding with the ability to make a carbon copy of each page. A carbon copy of the notes and data you obtained must be turned into the TA at the completion of each lab experiment.
- Excused absences from laboratory will be given provided that the reason for the absence meets the Institute's guidelines. Students will be required to make up the laboratory during the periods reserved for make-ups in the laboratory schedule ("dead week").

Chapter	Topic	Suggested Homework Problems
Appendix A	Evaluation of Analytical Data	a1-1, a1-2, a1-12, a1-21, a1-24
1	Introduction	1-1 through 1-10
2	Electrical Components and Circuits	2-1, 2-14, 2-15, 2-19
3	Operational Amplifiers in Chemical Instrumentation	3-10, 3-11, 3-16
4	Digital Electronics and Microcomputers	4-1, 4-2, 4-8 through 4-12
5	Signals and Noise	5-1, 5-2, 5-8
6	An Introduction to Spectrometric Methods	6-1, 6-14, 6-15, 6-19
7	Components of Optical Instruments	7-8, 7-12, 7-18
8	An Introduction to Optical Atomic Spectrometry	8-4, 8-9
9	Atomic Absorption and Atomic Fluorescence Spectrometry	9-11, 9-12, 9-14, 9-20
10	Atomic Emission Spectrometry	10-1, 10-11
13	An Introduction to Ultraviolet/Visible Molecular Absorption Spectrometry	13-8, 13-11, 13-20, 13-24
14	Applications of Ultraviolet/Visible Molecular Absorption Spectrometry	14-10, 14-18, 14-23
15	Molecular Luminescence Spectrometry	15-2, 15-9, 15-10
16	An Introduction to Infrared Spectrometry	16-2, 16-8, 16-13, 16-15
17	Applications of Infrared Spectrometry	17-4, 17-5, 17-10, 17-11
18	Raman Spectroscopy	18-3, 18-7, 18-9
20	Molecular Mass Spectrometry	20-2, 20-10, 20-13, 20-19
21	Surface Characterization by Spectroscopy and Microscopy	21-12
22	Introduction to Electroanalytical Chemistry	22-5, 22-9, 22-14
23	Potentiometry	23-14, 23-20, 23-26
25	Voltammetry	25-1, 25-3, 25-6, 25-11, 25-13
26	An Introduction to Chromatographic Separations	26-1 through 26-17
27	Gas Chromatography	27-6, 27-18, 27-19, 27-26, 27-27
28	High-Performance Liquid Chromatography	28-7, 28-12, 28-13, 28-21
29	Supercritical Fluid Chromatography and Extraction	29-2, 29-7
30	Capillary Electrophoresis and Capillary Electrochromatography	30-1, 30-6, 30-8
31	Thermal Methods	31-1, 31-2, 31-7, 31-8
33	Automated Methods of Analysis	33-2, 33-3