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SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

# COURSE OUTLINE

**COURSE TITLE:** ANALYTICAL CHEMISTRY - INSTRUMENTAL I

**CODE NO.:** CHM 221-4 **SEMESTER:** V

**PROGRAM:** WATER RESOURCES/ENVIRONMENTAL ENGINEERING TECHNOLOGY

**AUTHOR:** D. HEGGART

**DATE:** MAY 1993 **PREVIOUS OUTLINE DATED:** AUG. 1992

**APPROVED:** _____ May 25/93
DEAN, SCHOOL OF SCIENCES & NATURAL RESOURCES — DATE

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**TOTAL CREDIT HOURS:** 64

**PREREQUISITE(S):** CHM 230

## I. PHILOSOPHY/GOALS:

The course is designed to give the student an understanding of the role Instrumentation has in Analytical Chemistry. The course involves theory and laboratory which will serve as a basis and is a prerequisite for CHM 231 which is taught in Semester 6.

## II. STUDENT PERFORMANCE OBJECTIVES:

### Unit 1. Instrumental Quantitative Analyses. Chapter 7, Braun.

Upon successful completion of this course the student should be able to:

1. Determine the concentration of a sample using graphic methods by plotting the working curve for both linear and non-linear plots.
2. Determine the concentration of a sample using statistical methods (Regression Analysis). The equation will be developed for analyses involving a blank as well as those not using a blank.
3. Determine the Regression Equation and the concentration of a sample for non-linear plots using transformations as an example for %T vs. concentration.
4. Determine the concentration of a sample using methods of standard additions.
5. Complete Experiment #1 - Determination of Iron in Water.
6. Complete Assignment #1.

### Unit 2. Molecular Spectroscopy - Chapter 8, Braun

Upon successful completion of this course the student should be able to:

1. Develop the Beer-Lambert Law from first principles and make calculations for C or $\epsilon$.
2. Make calculations involving the Beer-Lambert Law for solutions containing more than one absorbing species.

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3. Compare instruments operations in the various regions of EMR (UV, visible + infra-red) as to operation, λ, detector, cell, etc.

4. Use the concept of absorbance to determine the end point of a titration.

5. Calculate pKa using absorbance measurements.

6. Complete Experiment #2 - Determination of Iron in Water.

7. Complete Assignment #2.

**Unit 3 Atomic Spectroscopy - Chapter 9, Braun**

Upon successful completion of this course the student should be able to:

1. Compare AAS, AFS, FES and AES.

2. Describe how atomic absorbance occurs and how it is used to determine concentration.

3. Compare the block diagram of an AA with a typical spectrophotometer operating in visible region.

4. Describe the components of an AA, explain how the HCL functions as the source, the types of burners, detectors etc.

5. Discuss the advantages and limitations of AA.

6. Use the concepts developed in Unit 1 to calculate the concentration of samples.

7. Complete Assignment #3.

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**Unit 4 Chromatography - Chapter 12 and 13, Brown**

1. Describe the different types of chromatographic techniques - LC, IC, GC, column, paper TLC etc.
2. Describe the various components of a typical gas or liquid chromatograph - column, detector, mobile phase, etc.
3. Make calculations for retention time, efficiency, HETP, resolution.
4. Describe the various columns and detectors used.
5. Complete Assignment #4.

**Unit 5. Laboratory Work**

The student will complete <u>five</u> experiments from the following:

1. Determination of t- Fe as $Fe^{3+}$ by Spectrophotometry.
2. Determination of t- Fe as $Fe^{2+}$ by Spectrophotometry.
3. Determination of $Ca^{+2}$ and $Mg^{+2}$ by AAS.
4. Analysis of wastewater for organic solvents by GC.
5. Analysis of water for anions by LC.
6. Determining of TC, TOC and TIC by carbon analysis.
7. Analysis of drinking water for $F^-$ by specific ion electrode.
8. Analysis of wastewater for $NO_3^-$ by specific ion electrode.
9. Determination of acidity in water by potentiometry.

Each experiment will involve the analyses of a known plus several unknowns. Spiking and diluting the unknowns may be required. Each experiment is graded out of 65 marks [Analysis 50,Report 15].

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**III. TOPICS TO BE COVERED:** — **Approximate Time Frames**

| TOPIC NO. | TOPIC DESCRIPTION |
|---|---|
| 1 | Instrumental Qualitative Analysis - 20% of total time<br>Working Curves & Standards<br><br>- non-linear<br>- linear<br>- method of standard additions<br>- curve fitting - least squares fit<br>- Assignment #1<br>- Quiz #1 |
| 2 | Molecular Spectroscopy - 20%<br><br>- review of atomic physics as it relates to EMR<br>- development of Beer-Lambert Law<br>- criteria for selection of for an Absorption measurement<br>- analysis based on light scattering - turbidimetry<br>- nephlometry<br>- end point detection using Absorption measurement<br>- determination of Ka using Absorption measurement<br>- Assignments #2 and #3<br>- Quiz #2<br>- Mid-Term |
| 3 | Atomic Absorption - 30%<br><br>- comparison of AAS, AFS, FES, AES<br>- double beam vs. single beam<br>- application<br>- advantages and limitations<br>- interferences<br>- monochromators, detectors<br>- Assignment #4 |

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**III. TOPICS TO BE COVERED: (Cont'd)** — **APPROXIMATE TIME FRAMES:**

| TOPIC NO. | TOPIC DESCRIPTION | |
|---|---|---|
| 4 | Chromatography | - 30% |
| | - types of chromatography | - HPLC, GC<br>- Column, Paper<br>- TLC, Ion-exchange<br>- electrophoresis |
| | - stationary Phase, Mobile Phase, Carrier Gas | |
| | - Detectors | |
| | - Qualitative and Quantitative aspects of G.C. | |
| | - retention time and retention volume | |
| | - efficiency, HETP, n | |
| | - resolution, symmetry | |
| | - Column Types | |
| | - Assignment #5 | |

**IV. EVALUATION METHODS:**

| | |
|---|---|
| - Assignments and Quizzes - termwork | 20% |
| - Mid-term test | 30% |
| - Final test | 50% |

The theory mark is the sum of all tests, assignments, mid-term and final examinations.

| | |
|---|---|
| Term Test/Quizzes/Assignments/Final Exam | 50 marks |
| Lab Work | 50 marks |
| | --------- |
| | 100 marks |

Late labs will be marked but will be downgraded 10% per week while late assignments will not be accepted.

| | | |
|---|---|---|
| Grades: | 90% > - A+ | 80% > - A |
| | 70% > - B | 60% > - C |

The final grade is arrived at by totalling the theory marks (50%) and the lab marks (50%).

The lab mark is the sum of all marks awarded for the analysis plus the written report for each of the five experiments. The analysis is graded on accuracy and precision. The report is graded on format, content, and neatness.

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**IV. EVALUATION METHODS: (Cont'd)**

Assignments are due on the date specified. Late assignments will not be accepted so it is critical that you submit as much of the assignment as possible on the due date. Lab reports are due one week from completion of the lab. Late labs will be downgraded 10% per week.

ATTENDANCE:

Your grade will be greatly affected by attendance at scheduled classes and labs. 85% is required at all theory classes while 100% is needed for all labs. Serious illness (doctor's care) is the only valid excuse.

EXEMPTION:

The theory grade is the sum of all test and assignments. Tests will include all work up to the time of each test. Should a student miss any test, he/she will not be eligible for the exemption. All students having 70% or more on term work and mid-term exam are exempt from the final exam which will cover the whole course and counts 50% of the theory grade.
The final exam will be held during the exam week at the end of the semester.

**V. REQUIRED STUDENT RESOURCES:**

Introduction of Chemical Analysis - Braun, McGraw-Hill, 1982
(available from D. Heggart)
Lab Experiments for CHM 221/231

**VI. ADDITIONAL RESOURCE MATERIAL:** (available in College Library)

Undergraduate Instrumental Analysis - 4th Edition, Robinson, Dekker, 1987.
Analytical Chemistry, Skoog & West, 4th ed., Saunders, 1986.
Analytical Chemistry, Christian, 4th ed., Wiley, 1986.

**VII. SPECIAL NOTES:**

Students with special needs (e.g. physical limitations, visual impairments, hearing impairments, learning disabilities) are encouraged to discuss required accommodations confidentially with the instructor.

Your instructor reserves the right to modify the course as he/she deems necessary to meet the needs of students.