Western Engineering

Department of Chemical & Biochemical Engineering

CBE 9180 – INSTRUMENTAL METHODS OF ANALYSIS FOR ENGINEERS
COURSE OUTLINE FOR 2013-2014

Description

This course is aimed specifically at Engineers who need a broad base introduction to analytical instrumentation tools for the measurement of different chemical properties and processes (composition, structure, etc). The course covers fundamentals of modern analytical instrumentation, providing general background theory and principles of operation. The lectures introduce the chemical or physical principles exploited during analytical measurement, a description of how the instrument carries the measurement and some of the techniques used to increase accuracy, precision and sensitivity. The course does not aim to be comprehensive nor provides exhaustive information on specific analytical techniques. The course however will discuss specific applications in Chemical and Environmental Engineering. Some of the topics will be tailored to the specific interests and needs of the students enrolled. The course has a laboratory project component which will provide hands on experience in the use of gas chromatography.

Prerequisite

Students must have taken a first or second year undergraduate course in General Chemistry to enroll in this class.

Corequisite

None.

Antirequisite

None.

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Program. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours/Location

Tuesday 8:30-10:30 (UCC 59), Wednesday 9:30-10:30 (UCC 58)

Course Instructor
Dr. J. Herrera (TEB 463) Telephone: 519-661-2111 ext: 81262 email: jherrer3@uwo.ca

Graduate Coordinator
TEB 477, Telephone: 519-661-2111 ext: 88352 email: cbegrad@uwo.ca

Required Text
None.

Reference Text
Skoog, D.A., Holler, F.J., Crouch, S.R. Principles of Instrumental Analysis, Brooks Cole, 6th ed.

Please notice that the textbook is not mandatory but strongly recommended, there are not enough copies in the library and practice problems will be assigned from the book.

Course Notes
Course notes will be available at the course website.

Laboratory Project
The course has a group project with a laboratory component on gas chromatography; this will provide hands on experience in the use of analytical instrumentation. Specific guidelines and expectations for the project report will be posted during the first two weeks of the term.
A laboratory report will be required as part of the project. During the laboratory work required for the project students must abide by the University's safety regulations and procedures. For more information:
http://www.uwo.ca/humanresources/docandform/docs/ohs1/manuals/uwo_lab_hs_safety_manual.pdf

Units
SI units will be the primary units used in lectures and examinations.

Specific Learning Objectives.

First part: Analytical Separations

I. Gas chromatography (GC) (Assigned reading-Laboratory project)
   -Partition equilibrium
   -The gas chromatograph
   -Choosing a stationary phase (GC column)
   -Detectors used in gas chromatography (FID, TCD, ECD, NPD)
   -How to choose a successful column/detector combination.
   -Quantification methods in GC analysis

-Variables used to improve separation efficiency.

II. Liquid chromatography (HPLC) (Assigned reading)
-The HPLC instrument
-Choosing a mobile and stationary phase
-Detectors used in HPLC
-Overview of ion exchange chromatography
-Overview of gel permeation chromatography
-Quantification using the HPLC
-Variables used to improve separation efficiency.

Second part: Spectroscopy

III. General introduction to spectroscopy. (6 hours)
-Light and matter
-Atomic structure
-The electromagnetic spectrum
-Interactions of light with matter.
-General instrumentation used to measure the interaction of light with matter.
- Beer's law.

IV. Introduction to Atomic Spectroscopy methods of analysis (AA and ICP). (4 hours)
- Origin of the atomic spectra. Emission vs. Absorption
-Atomization and Excitation: Fundamentals and instrumentation.
-Emission and Absorption: Fundamentals and instrumentation.
-Qualitative and quantitative information obtained by atomic spectroscopy measurements.

V. Introduction to Optical Absorption Spectroscopy methods of analysis (UV-Vis) (8 hours)
-Overview of molecular bond theory
-Definition of chromophores
-Conjugation in organic molecules and UV light absorption.
-Ligands in transition metal ions and UV-Vis light absorption.
-Instrumentation used to acquire optical absorption spectra.
-Dispersive vs. Multiplex instruments
-Qualitative and quantitative information obtained by UV-Vis.
-What to look for in a UV-Vis spectrum: A practical guide.

VI. Introduction to Vibrational Spectroscopy methods of analysis (FTIR and Raman). (8 hours)
-Vibrations in molecules.
-Bond properties and infrared absorption trends.
-Light scattering and the Raman process

-The Infrared spectrometer: Fourier transform instruments.
-The Raman spectrometer.
-Infrared vs. Raman spectroscopy

VII. Introduction to Mass Spectrometry. (MS) (4hours)
-Molecular formulas
-General overview of fragmentation patterns
-The mass spectrometer.
-Ionization modes.
-Simple uses of mass spectra
-The ICP-MS
-The CG-MS

Evaluation

The final mark will be calculated as follows:

Mid-Term Examination	35%
Final Examination	35%
Laboratory Project	30%

Examinations will be 2 hours and will be LIMITED OPEN BOOK: only handheld non-programmable calculators and notes available on the class website may be brought to the examinations. Textbooks and other reference materials will not be allowed.

Notes

1) Students must present a laboratory project report to pass this course. Students who fail to present a project report will be assigned the aggregate mark, as determined above or 48%, whichever is less.

2) Laboratory project is based on gas chromatography. The project report is due on Friday Feb. 28th, 2014 at 4:00pm.

Repeating All Components of the Course

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.

Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without

grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance

Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Associate Chair (Graduate), after due warning has been given. On the recommendation of the Department concerned, and with permission of the Associate Chair, appropriate action will be taken, with the possibility of course failure.

Cheating

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

Plagiarism

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

Sickness and Other Problems

Students should immediately consult with the instructor or Associate Chair (Graduate) if they have problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

Notice

Students are responsible for regularly checking their Western email and notices posted on their Instructor's door. Course cancellations will also be sent out via Twitter.

Consultation

Office hours will be arranged for the students to see the instructor. Other individual

consultation can be arranged by appointment.

December 19, 2013/jh