

## **CHEM 2423, QUANTITATIVE ANALYSIS**

*Fall Semester, 2014*

Chemistry Department, Dr. Treacy Woods, Department Chair

### **COURSE DESCRIPTION**

This course is a continuation and extension of CHEM 2415 and 2416 into the study of the basic principles of analytical chemistry, which include stoichiometry, and homogeneous and heterogeneous equilibria. This course includes one semester hour credit for laboratory work that includes both volumetric and gravimetric analysis as well as an introduction to instrumental analysis.

### **COURSE SEQUENCE IN CURRICULUM**

This is one of the required courses for a major in Chemistry and is a prerequisite for CHEM 3443, Modern Analytical Techniques, and CHEM 4292-Warren, Senior Seminar Laboratory Research Project in Analytical Chemistry.

### **PRE-REQUISITE INFORMATION**

CHEM 2416.

### **INSTRUCTOR INFORMATION**

Name: Dr. Eric VanCaemelbecke  
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Office Phone: 281-649-3479  
Office Location: S210C  
Office Hours: by e-mail appointment  
Web Page Address, Web Board, ListServ: Blackboard

### **LEARNING RESOURCES**

Course Text: Exploring Chemical Analysis, 3<sup>rd</sup> edition, by Daniel C. Harris, W.H. Freeman Publisher, New York, 2005.  
Laboratory Text: Whaley, Brenda, Quantitative Analysis Laboratory Manual. HBU, Houston, TX, Spring, 1998.  
Supplementary Text: None  
Other Required Materials: Non-programmable calculator.

### **COURSE OBJECTIVES**

#### Purpose of the course:

To provide students with a basic understanding of the theory, principles and practice of inorganic quantitative analysis. Fundamental principles, chemical reactions, applications, techniques, limitations, sources of error and calculations are emphasized.

#### Aims for the course:

The class and laboratory should prepare students to perform laboratory procedures in the university research and industrial environment.

#### On completion of this course, students should be able to:

Lecture section:

1. recognize the basic steps common in any chemical analysis.
2. be able to statistically evaluate analytical data.
3. understand the basic principles and calculations associated with gravimetric methods of analysis.
4. understand the basic principles and calculations associated with titrimetric methods of analysis.
5. be able to solve general problems involving chemical equilibrium.
6. understand the theory and be able to solve mathematical problems in acid-base equilibria.
7. understand the application of acid-base titrations.
8. be familiar with the theory, applications and calculations of precipitate-formation titrations.
9. be familiar with the theory, applications, and calculations of complexes and complex formation titrations.
10. understand the theory of oxidation-reduction reactions, applications, and calculations of oxidation-reduction titrations.
11. understand basic applications of potentiometric and visible spectrophotometry.

Laboratory section:

1. develop good laboratory practices including technique, patience, self-reliance, and self-discipline.
2. accurately measure mass with the analytical balance.
3. accurately measure volume with a buret or pipette.
4. prepare exact solutions volumetrically.
5. determine exact concentrations of solutions by titration.
6. quantitatively transfer materials.
7. learn to properly use the pH meter and spectrophotometer.
8. prepare an appropriate laboratory report and oral presentation

**LITERATURE PRESENTATION:** As an introduction to the chemical literature, I'm asking that each of you select one *research* article (no A-pages, Correspondences, or Technical Notes) from a 2000 -2005 issue of the journal *Analytical Chemistry* which deals in some way with a topic we have covered or will cover. (We have full on-line access to this journal!) You will make a PowerPoint presentation to your lab section over the contents of this article. It is important that you select an article that you understand *thoroughly*. You are responsible for learning PowerPoint. Your presentation should last 12-14 minutes, then there will time for questions at the end. *I must OK the article you want to use*, since I don't want two people reviewing the same article. When submitting an article for approval, you must give me a copy of the abstract. Prior to your presentation you must also provide me with a copy of your PowerPoint slides, preferably in the "Handouts" format from the Print menu.

### **RELATION TO DEPARTMENTAL GOALS AND PURPOSES**

The chemistry department prepares students to respond to their call to share in the wise stewardship of the matter that makes up all of creation in their chosen career. The chemistry department provides a program for students that gives them:

"A thorough and practical knowledge of the intricate nature of matter;"

"The ability to explore and discover the depths of the beauty of matter;"

"The ability to analyze problems, formulate solutions to problems, and be creative in response to challenges related to the wise use of matter;"

"The ability to respect the matter in creation through preparation for excellent and ethical practice of chemistry in their chosen career."

“The opportunity to complete a major that is comparable in curriculum to those at institutions with chemistry majors certified by the American Chemical Society (ACS.)”

### **RELATION TO COLLEGE GOALS AND PURPOSES**

“...to prepare students for careers and further education in the natural sciences and mathematics in a nurturing Christian environment. The College will also serve the HBU community by providing science and mathematics classes that empower HBU students to meet the goals and requirements of their field of study and enrich their liberal arts education.”

### **RELATION TO THE PURPOSE STATEMENT OF THE UNIVERSITY**

University mission and purpose statement from the Houston Baptist University Catalog, 2009-2010: “...to provide a learning experience that instills in students a passion for academic, spiritual, and professional excellence as a result of our central confession, “Jesus Christ is Lord”

“...Committed to providing a responsible and intellectually stimulating environment that:

- fosters spiritual maturity, strength of character, and moral virtue as the foundation for successful living
- develops professional behaviors and personal characteristics for life-long learning and service to God and to the community
- meets the changing needs of the community and society
- remains faithful to the ‘**Nature of the Institution**’ statement”

“...Promotes learning, scholarship, creative endeavor, and service”.

### **ATTENDANCE**

Please see the official Attendance Policy in the HBU Classroom Policy on Blackboard. Students missing more than 25% of the class will be given a failing grade.

### **ACADEMIC ACCOMODATIONS**

Students needing learning accommodations should inform the professor immediately and consult the Academic Accommodations section of the HBU Classroom Policy posted on Blackboard.

### **COURSE REQUIREMENTS & GRADE SCALE**

#### Course requirements:

The student will be given three essay exams during the course. Types of exam questions and other information will be discussed prior to each examination. A comprehensive final exam will be given. A comprehensive make-up exam will be given near the end of the quarter for students who miss one of the first three exams. Only one exam may be missed; for any others, a zero will be recorded. A medical or other appropriate excuse is required. The average of the exam grades comprise sixty percent of the grade in the course. The numerical results of all laboratory experiments, as presented by the student via a written report, are averaged and represent forty percent of the final grade

Relevant material such as answers to problems will be on reserve in the library. You may feel free to copy these materials.

Problems assigned are due during the class period of the problem session. Each student must at least look at each assigned problem prior to the session. If you do not try the problems before I or your colleagues explain them, then you learn little or nothing during the problem session and both of us are wasting time and energy. These sessions will be conducted in a cooperative learning format.

Grading standards:

The grading scale is as follows:

A = 100-90; B = 89-80; C = 79-70; D = 69-60; F = 59-0.

**PROFICIENCIES:**

Technology component:

An introduction to statistical treatment of data is an important part of this course, as well as graphical analysis of data. Computer statistical and graphical software packages such as Excel and InStat are utilized multiple times during the lecture and laboratory.

Designated essay/writing component:

Students must write multiple laboratory reports. These reports must be written according to best practices of technical writing as used in chemical industry.

Reading component:

The student must utilize the textbook. The student learns to organize and critically evaluate scientific information.

Oral communication component:

Students must participate in classroom activities on a rotating basis by responding to questions concerning the material. Students must orally communicate and share knowledge during the cooperative learning sessions for solving mathematical problems, which are components of the course.

Mathematics component:

Approximately one-fourth of the students' time in the course is involving the statistical treatment of numerical data. Mathematical problem-solving (stoichiometric calculations) is an integral part of the course.

Critical thinking component:

Scenarios of real laboratory analysis situations will be examined. Applications of this type of problem solving will be applied to new cases.

**LATE WORK & TEST POLICY**

Late work:

**HOMEWORK:** All lab reports are due at the beginning of the assigned class period. If it is turned in later that same day, 5% of the total possible points will be deducted. If

turned in after the assigned day, 10% of the total possible points will be deducted for each day the assignment is late. Ten points will be deducted for each day a lab report is late.

#### Missed tests:

It is impossible to easily give an equivalent make-up for an exam, which you miss. I prefer to discuss the reason for missing the exam and the mechanism for “make-up” with students on an individual basis. You need to contact me **immediately** about a missed exam. I require that a comprehensive make-up be taken. Only one exam may be missed. A student is required to take the comprehensive final exam.

Missed laboratories must be made up during the regularly scheduled Quantitative Analysis laboratory times. Additional labs scheduled to aid a student in obtaining a good lab grade are not replacements for a regularly scheduled laboratory session.

### **EVALUATION**

#### Method of student appraisal of faculty:

Students will be given an opportunity to appraise the professor by completing the IDEA Faculty Evaluation Questionnaire, and/or the COSM course evaluation at the end of the semester. The instructor, the department chairman and dean will review the responses of the students after the completion of the course.

#### Method of evaluating student response to course:

Students will be given an opportunity to describe their response to the course by completing the IDEA Faculty Evaluation Questionnaire and/or the COSM course Evaluation at the end of the course. The instructor, the department chairman and dean will review the responses of the students after the completion of the course.

### **LABORATORY DRESS CODE**

Students may be asked in advance to wear closed-toed shoes and long pants during certain experimental procedures.

### **LABORATORY CONDUCT AND SAFETY**

**IMPORTANT INFORMATION FOR THIS COURSE:** IF A STUDENT IS PREGNANT OR NURSING, SHE WILL NOT BE ALLOWED TO ATTEND THE LABORATORY SESSIONS BECAUSE SOME OF THE CHEMICALS, WHICH ARE NORMALLY INNOCUOUS, USED IN THESE LABORATORY EXPERIMENTS, MAY BE HARMFUL TO A DEVELOPING FETUS. IF A STUDENT BECOMES PREGNANT DURING THE COURSE, SHE MUST STOP ATTENDING THE LABORATORY SESSIONS IMMEDIATELY AND SHE IS TO NOTIFY HER PROFESSOR. THE PROFESSOR WILL DISCUSS OPTIONS THAT THE STUDENT WILL HAVE TO ENABLE HER TO COMPLETE THE COURSE REQUIREMENTS.

### **TOPICAL OUTLINE - *include table, calendar, or topical outline with dates***

#### Lecture Section:

- Introduction to Analytical Chemistry
- Statistics (part I)
- Statistics (part II)
- Statistics (part III)

- **Exam 1**
- Gravimetric Methods of Analysis
- Titrimetric Methods of Analysis
- **Exam 2**
- Aqueous Solution Chemistry / Equilibrium Constants
- Ph Calculations (monoprotic species)
- Titration Curves (monoprotic species)
- **Exam 3**
- Ph Calculations (polyprotic species)
- Titration Curves (polyprotic species)
- Precipitation Titration Curves
- **Exam 4**
- Complexometric Titration Curves
- Redox titration Curves
- UV-visible Spectroscopy
- **Final Exam**

Laboratory Section:

Lab Check in / Labs Write-up

Experiment 1: Calibration of Buret

Experiment 2: Standardization of NaOH and determination of total acidity (KHP) (2 weeks)

Experiment 3: Standardization of HCl and analysis of Na<sub>2</sub>CO<sub>3</sub>

Experiment 4: Complexometric Determination of Calcium

Experiment 5: Gravimetric determination of Nickel (2 weeks)

Experiment 6: Redox titration of Iron (2 weeks)

Experiment 7: Spectrophotometric determination of Red dye #40

Experiment 8: Titration of unknown organic acid

Experiment 9 Literature Presentation / lab check out

The content of this outline and the attached schedule are subject to change at the discretion of the professor.

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Student Signature – I have read and understand the syllabus for this class. I understand that the content of this syllabus and the topical outline are subject to change at the discretion of the professor. I have read and understand the HBU Classroom Policy posted on Black Board. **I promise to uphold the Code of Academic Integrity at Houston Baptist University and will not tolerate its violation by others.**