# CHM-411/511: Modern Instrumental Methods
# Spring 2016
# Course Syllabus

**Lecture Instructor:** **Dr. Rosalynn Quiñones**
**Science Building, Room 496**
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**Times**
**Lecture Meeting:** Science Building 405, 12:30 – 1:45pm Tuesday and Thursday
**Laboratory:** Science Building 492, 1:00 – 3:45pm Monday
**Course Credits:** 4
**Office Hours:** Tuesdays and Thursdays 2:30 pm – 4:00 pm located at Residence Hall TTW – Lobby, or by appointment. I welcome drop-in visits, but cannot guarantee that I will be available to help you during non-office hours. Simple questions can be answered via email.
**Prerequisites:** C or better in CHM 307 or CHM 357

**Course Overview**

"Modern Instrumental Methods" is a course that satisfies one of the upper level elective requirements for the Chemistry Major. In this course, the students will be introduced to the principles behind and the techniques associated with chemical measurements that utilize scientific instrumentation such as spectroscopy, chromatography methods, surface analytical methods, thermal, and electrochemistry analysis. The purpose of this course is providing the necessary background to choose the most appropriate instrumental method to solve qualitative and quantitative chemical problems efficiently. Chemical measurements are designed to provide the most accurate and precise information possible and, to acquire information to this level, chemical techniques must be understood in terms of detection limit, sensitivity, and/or spectral resolution. Chemical information obtainable from various techniques will be presented and discussed. Error analysis and data processing techniques that reduce or filter instrument noise and provide signal enhancement will be introduced. Applications presented in this course will focus on chemical systems of modern interest such as polymers, nanostructures, surface and material chemistry. The goal is to understand the advantages and limitations of various instrumental techniques and how chemical information, which is obtained by a specific instrument, can be processed to explain chemistry and solve scientific problems.

One of the main objectives of this course is to promote active learning that will be accomplished by having students report on and design concept maps from literature studies to further develop their previous knowledge and to draw a parallel of the topics discussed in the lecture. This will be built-in by class lectures and active discussion, homework, and exams. Problem solving skills and critical thinking will be improved by analyzing experimental data during class time and having group discussions led by the instructor. To this end, the class will engage in individual and group problem solving activities in lecture, and learn to search and read the chemical literature in order to address problems associated with chemical measurements. These educational skills will be useful in future science classes but also in analyzing issues in other classes and areas of study.

**Course Student Learning Outcomes**

Students will:

1. Apply the scientific method to analytical and instrumentation problems, in order to explain chemical realities.
2. Acquire problem solving skills during different assessments; in groups and individually.
3. Mathematical assess qualitative and quantitative data obtained by various tools
4. Relate how the electromagnetic waves with atomic and molecular species interact.
5. Discuss the uses of spectrometry for structural determination of molecular species.
6. Review the theory and practical applications of the electromagnetic spectrum.

7. Discuss surface and material chemistry for future advanced chemistry courses.
8. Deliberate electroanalytical methods to obtain qualitative and quantitative data based on electrical properties.
9. Apply chromatography method to separate, identify and determine components in a mixture.
10. Analyze how a physical property or reaction product is measured as a function of temperature.
11. Apply research experience into the applicability by analyzing data obtained by various instruments.
12. Apply presentation skills, oral skills, critical thinking, ability to handle questions, and audience engagement by oral presentations.

***Materials***
*Book:* "Principles of Instrumental Analysis" by Douglas A. Skoog, 6th edition;
*Lab:* Scientific Calculator; Lab Notebook, Lab Notes (notebook)

**Attendance Policy**
Attendance for lecture is optional, but strongly encouraged. You are responsible for all announcements and material given during class. A tentative lecture schedule of topics is attached. Absences from exams can only be made-up if the absence falls within one of the categories outlined in the undergraduate catalog. To make-up an exam, you will need to follow the process for securing an excused absence. All excused absences must be obtained as soon as possible.
Lab attendance **is mandatory** and will be monitored by Instructor. There are no make-up lab times scheduled for this course.

***Web Site***
Information relevant to this course will be posted on MU online. MU online is highly utilized in this class. Please check MU online site regularly. Your homework, useful websites, grades and announcements will be posted there. You must submit your homework, lab reports and papers in MU online. Moreover, some exercises assigned in class will be deeply discussed, and answered.

**Course Policy**

**Course Assessments**
*Exams*: There are Four (4) exams which 3 exams will be given during lecture period and one exam during final exam period. The exams will consist of multiple choices, essay questions, and problem solving in which all steps leading to the solution must be shown. Exam dates are approximate. You will be given 1 week prior notice before all exams.
Make-up exams will be given only to students whose absence has been approved by the Dean of Student Affairs (for policy, see link on next page of syllabus) and must be arranged in advance (if possible).
Re-grades will be considered within one day of the exam being returned. If you request a re-grade, the entire assignment will be reviewed. This may result in either the loss or gain of points.

*Homework* is very important and useful to enhance the comprehension of the material. Homework will be assigned with each chapter. Some homework will be discussed by the student during the lecture to promote active learning. It will be very difficult to do well in this class without doing the homework. Doing practice problems is the best way to learn the material. The students can use any resources to build up the case: books, internet, and scientific journals. However, at least two (2) scientific references are expected.

- You will require to complete a case study in where students will prepare and present a lecture on an assigned case study. The case studies will be assigned by the faculty and are listed on the MU online. You will discuss the purpose for the work, the design of the instrumental method used and its operational principles, the data presented and the conclusions reached
    - Plan the presentation for about 25 – 30 minutes with 8 – 10 minutes for questions. This means about 25 slides. The presentation should be organized as follows:
        1. Describe the chemical problem, why the analysis is needed and the motivation for the work,

2. Present details of the measurement method (how everything is fit together and how it works)
3. Indicate any theoretical principles that relate the instrument/method response to an analyte concentration
4. Present and discuss the measurements made and the data presented
5. Review the conclusions from the paper and
6. Offer your perspectives about what the future holds for the measurement method and what chemical or biochemical problems it could be used to help solve.

- As you read through the paper, it may be necessary for you to obtain other literature in order to understand and explain the work presented. Also, note that when you find the article on the journal website, there is very often is supplemental information that you should access and use in your presentation. At the end of your presentation, list the citations you used. Your textbook or another textbook could be one of these citations. This case study will count as 50 points of the course assessment.

- Concept maps will be assigned to each student. There will be 12 topics to select from. The students will prepare one concept map for two different topics during the semester. Each concept map will count as 25 points of the course assessment.

**Laboratory**

The lab is on Mondays from 1:00 – 4:00 pm. The experimental information for each lab will be posted online at least one week prior to performing the experiment. Quantitative reports will be due, collected and graded during the semester. These quantitative lab reports will count for 150-180 points (30 points per report) as part of the lab course assessment. Lab work will constitute the 30% lab component grade of the course. A handout on how to write a lab report is posted in MU online. Each lab report will be due one week after the completion of the lab (Tuesday of the following week).

- All lab reports must be uploaded at MU online **in a Word document and/or Excel (if applicable).** The lab reports will be graded and posted them in MU online. A laboratory report format is posted in MU Online.
- Lab experiments will be performed individual otherwise noted. Every lab data or observations must be collected in the lab notebook. Lab notebook will count 50 points towards lab assessment. A Laboratory notebook format is posted in MU Online. *Please, follow those instructions!*
- Lab responsibilities will be counted towards 50 points of lab course assessment. This responsibilities will be as followed but not limited to these:
    1. Check-in/out drawers
    2. Clean up benches, balances and instrumentation area
    3. Preparation standards/ solutions and safe them in proper place
    4. Chemicals back in place
    5. Signup sheet
    6. Clean glassware and safe them in proper place
    7. Turn on/off instruments
    8. Waste
    9. Safety
    10. Respond in a timely fashion (typically 1-2 days) to emails, and in-class announcements
    11. Check regularly MU Online
    12. Update individual data in Excel spreadsheets
    13. Upload lab reports in a timely manner at MU Online website
- The students will work on a final paper written according to ACS publications guidelines: http://pubs.acs.org/page/jacsat/submission/authors.html. A final paper format is posted in MU Online. *This project will be written using all data collected by the students through the semester in just one (1) Module project emphasizing statistics, discussion, and conclusion.* This final paper will count 100 points as part of the course assessment. Final paper will be due on **Thursday April 28, 2016 by 11pm.**

- A Presentation of this paper will be required and will count an additional 50 points of the course assessment. *This oral project will evaluate presentation skills, oral skills, critical thinking, ability to handle questions, and audience engagement.* Final oral presentations will be held during lab section on **Monday April 25, 2016.**
  **Late work:** Late work will be penalized 5 points per day. No assignments will be accepted more than one week late.

**Grading Policy**

| Course Point Allocation | |
|---|---|
| 4- exams (100 points each) | **50%** |
| 3- Homework (100 points) | **10%** |
| Lab | **30%** |
| Final paper/ Presentation | **10%** |
| **Total** | **100 %** |

***Grade Scale***

| Grade Chart | |
|---|---|
| 100-90 | A |
| 89-80 | B |
| 79-70 | C |
| 69-60 | D |
| 59-0 | F |

***Miscellaneous policies***

*I have an Open Communication Policy:* If you are having trouble with a problem, concept, or anything class related please do not hesitate to email me or come by my office. Please silence cell phone ringers during class, laboratory, and exams. The instructor reserves the right to answer any ringing cell phones during lecture, or to dismiss the offending student. Use of cellphones / PDAs / MP3 players and similar devices during tests and exams will be considered academic dishonesty. Recording of lectures without the instructor's permission is prohibited. Laptops should not be used during class without permission. The content of this course will adhere closely to the information contained in the textbook. You may use other resources (alternate texts, notes from other professors, etc.). If you find information that contradicts something written in the textbook or said in the lecture, please consult Dr. Quiñones.

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**University Policies**

A link to all Marshall Policies is attached (http://www.marshall.edu/academic-affairs/policies/).

***Academic Honesty***

The university policy will be enforced. See page 71 of the 2015 – 2016 undergraduate catalog. Some examples of academic dishonesty include (but are not limited to) copying another student's assignment, lying about being ill on the day of a test, using a cell phone or other communication device during a test, quoting an author's writing (including material found on the internet) without giving due credit.
http://www.marshall.edu/catalog/files/UG_15-16_final_published.pdf

***Incomplete Coursework***

The university policy will be enforced. See page 94 of the 2015 – 2016 undergraduate catalog.
http://www.marshall.edu/catalog/files/UG_15-16_final_published.pdf

*D/F Repeat Rule*
See page 89 of the 2015 – 2016 undergraduate catalog.
http://www.marshall.edu/catalog/files/UG_15-16_final_published.pdf

***Accommodations for Disabilities***
Students with disabilities must contact the Office of Disabled Student Services in Prichard Hall 117, phone 696-2271 to provide documentation of their disability to ensure proper accommodation. Please visit http://www.marshall.edu/disabled for additional information.

***Tentative Course Schedule***

| Weeks | Lecture |
|---|---|
| Jan. 11 – 15 | Measurement Basics<br>(Chapter 1, 5, Appendix 1) |
| Jan. 18 | *Martin Luther King, Jr.- No classes* |
| Jan. 18 – 22 | An Introduction to Spectrometric Methods<br>(Chapter 6) |
| Jan. 25 – 29 | Atomic Spectroscopy (Chapter 6, 9A-9D)<br>Atomic Spectroscopy (Chapter 10) |
| Feb. 1 – 5 | Atomic and Molecular Spectroscopy: MS<br>(Chapter 11A, 11B, 11C, 20) |
| Feb. 8 –12 | **Exam 1**<br>Molecular Spectroscopy: UV-Vis<br>(Chapter 13, 14A, 14B)<br>Molecular Spectroscopy: Luminescence<br>(Chapter 15) |
| Feb. 15 – 19 | Molecular Spectroscopy: IR, Raman<br>(Chapter 16, 17A, 17B, 18) |
| Feb. 22 – 26 | Molecular Spectroscopy: IR, Raman<br>(Chapter 16, 17A, 17B, 18) |
| Feb. 29 – Mar. 4 | **Exam 2**<br>Nuclear Magnetic Resonance Spectroscopy<br>(Chapter 20) |
| Mar. 7 – 11 | Surface Characterization (Chapter 21) |
| Mar. 14 – 18 | Surface Characterization (Chapter 21) |
| Mar. 21 – 25 | *Spring Break – No Classes* |
| Mar. 28 – Apr. 1 | **Exam 3** |
| Apr. 4 – 8 | Chromatography (Chapter 26) |
| Apr. 11 – 15 | GC Chromatography (Chapter 27) |
| Apr. 18– 22 | HPLC Chromatography (Chapter 28) |
| Apr. 25 – 29 | Electroanalytical Chemistry<br>(Chapter 22, 23A, 23B, 24A, 24B, 25A, 25B, 25D) |
| May 2 – 6 | **Exam 4- Final exam week-TBA** |

**** This schedule is subject to change. Changes, if necessary, will be announced in class****