Course Syllabus

CH 5660/MY5660– Surface Science and Spectroscopy
College of Science and Arts/College of Engineering
Fall 2017

Instructor Information

Instructor:	Dr. Kathryn A. Perrine, Assistant Professor
Office Location:	704 Chemical Sciences and Engineering Building
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Office Hours:	M, Th, F 2-3pm or by appointment

Course Identification

Course Number:	CH5660 or MY5660
Course Name:	Surface Science and Spectroscopy
Course Location:	Fisher Hall 125
Class Times:	MWF 1:05-1:55pm
Prerequisites:	applies to undergraduates only: must be a junior, senior student Highly *recommended* prerequisites for undergraduate and graduate students: Thermodynamics, Kinetics, and Quantum Mechanics or Electron Microscopy

Course Description/Overview

This course covers the physical and chemical properties that govern surface science processes in addition to appropriate analysis techniques used to characterize and analyze interfaces and surface chemical reactions. This course will provide an overview of physical chemistry and materials science principles for understanding modern surface science. Included is an overview of the analysis techniques needed to understand surface chemistry, including vibrational spectroscopy, electron spectroscopy and atomic level microscopic techniques with lab demonstrations. The course will highlight the basics and analysis that have many applications for research in chemistry, materials science, and engineering.

Course Learning Objectives

By the end of this course student will be able to:

1. Understand and measure physical and chemical processes on a surface
2. Distinguish differences between surface science techniques and their respective capabilities
3. Analyze and interpret example data from surface science demonstrations
4. Recognize, review and critique surface science literature
5. Design and propose a project and choose a surface science technique that would solve a proposed hypothesis

Course Climate

Please note the class is diverse and others may interpret or respond to ideas differently. I encourage responses and discussions from fellow students in the classroom and on the web. Please respect the ideas or questions brought about by all in the class. All ideas are open for discussion!

Course Resources

Course Website(s)

- Canvas http://www.courses.mtu.edu
- Notebook discussions https://nb.it.mtu.edu/login
    - About notebook, online video https://nb.it.mtu.edu/about/

Required Course Text

- Surface Analysis: The Principle Techniques; 2nd edition. John Vickerman and Ian Gilmore, John Wiley & Sons, Inc. Publishing, 2009, ISBN 0-471-97292 4

Supporting Texts

- Principles of Adsorption and Reaction on solid surfaces; Richard I. Masel, John Wiley & Sons, Inc. Publishing, 1996, ISBN 0-147-30392-5
- An Introduction to Surface Physical Chemistry; Klaus Christmann, Springer-Verlag Berlin Heidelburg, 1991, ISBN 978-3-7985-0858-3
- Physical Chemistry of Surfaces; 6th edition. Arthur Adamson and Alice Gast. John Wiley & Sons, Inc. Publishing, 1997, ISBN 0-471-14873-3

Basic texts:

- Physical Chemistry: Thermodynamics, Structure and Change, 10th edition, Peter Atkins and Julio de Paula; W. H. Freeman; 2014, ISBN-13: 978-1429290197
- Physical Chemistry: A Molecular Approach, Donald A. McQuarrie and John D. Simon; University Science Books; 1997, ISBN-13: 978-0935702996

Grading Scheme

Grading System

Letter Grade	*Percentage*	*Grade points/credit*	*Rating*
A	93% & above	4.00	Excellent
AB	87% – 92%	3.50	Very good
B	82% – 86%	3.00	Good
BC	76% – 81%	2.50	Above average
C	70% – 75%	2.00	Average
CD	65% – 69%	1.50	Below average
D	60% - 64%	1.00	Inferior
F	59% and below	0.00	Failure
I	Incomplete; given only when a student is unable to complete a segment of the course because of circumstances beyond the student's control.		
X	Conditional, with no grade points per credit; given only when the student is at fault in failing to complete a minor segment of a course, but in the judgment of the instructor does not need to repeat the course. It must be made up by the close of the next semester or the grade becomes a failure (F). A (X) grade is computed into the grade point average as a (F) grade.		

No curving will be applied.

Grading Policy

Grades will be based on the following:

Homework & Participation	20%
Journal discussions	30%
Exams (2 exams, 100 points each)	25%
Proposal & Presentation	25%
Total Percentage	**100%**

Late Assignments

Late homework will be accepted up to 1 week with a valid excuse from extenuating circumstances (see http://www.mtu.edu/deanofstudents/academic-policies/attendance/).

After 1 week, homework will be late and a zero will be recorded. No late excuses will be allowed for presentations unless it is medical emergency-related. If there is an event scheduled, please schedule with me in advance.

Midterm and Final Exams will be given on designated days. Only valid excuses according to the academic policy (see http://www.mtu.edu/ctl/instructional-resources/syllabus/syllabus_policies.html) will be allowed for an adjustment of the exam days.

Course Policies

Your grade will be based on:

- Homework sets (includes textbook problems and assignments from instrument demonstrations)
- Journal discussions
- Participation in lab/instrument demonstrations and in-class discussions
- 1 Midterm Exam
- 1 Final Exam
- 1 Proposal and project presentation

The **homework sets** will be collected on the due date. No late homework will be accepted. A grade of a 0 will be given, unless documented explanation is given (see "Excused Absence").

Assigned **journal article assignments** will be posted on canvas. Out of class discussions on Notebook and in class participation will count for your grade.

In class pop quizzes will be used to assess your knowledge of course content. Quiz scores will count as *bonus points* on the homework.

The **Midterm and Final Exams** will be based upon homework and class material. In both cases you will be asked both to show the development of your reasoning skills and your knowledge in solving surface chemical problems. Students who fail to show up for Midterm and Final Exams without a satisfactory and documented explanation will receive a grade of 0 (see "Excused Absence").

Exam schedule:

Exam	date
Midterm	TBA, 1 hour
Final Exam	TBA-set by administration, 2 hours

Laptops are allowed and encouraged in class. Cell phones, Blackberries, iPods, PDAs, or any other electronic devices **are not to be used** in the classroom or in exams, unless instructed by the professor. **Please make sure to bring a calculator with you to class and exams.** Calculators on other devices are prohibited. Information exchanges on these devices during class and exams are also prohibited and violate the Academic Integrity Code of Michigan Tech. (http://www.mtu.edu/conduct/integrity-center/students/)

Attendance is vital for success of the course collaboration and discussion. Please come to class with having read the assigned readings/journal articles and have notes ready for discussion. For additional requirements see (http://www.mtu.edu/deanofstudents/academic-policies/attendance/)
During the lab demonstrations, please wear proper eye protection and follow the instructor's directions. Do not attempt to operate equipment without training or instruction.

All assignments are considered independent work. However students may help each other on homework assignments outside of the classroom. All work, online discussions and projects will be turned in and graded for an individual grade.

Tentative Course Schedule

Week	Topics
1	Defining a surface & the need for vacuum technology
2	Light interactions at the microscopic level
3	Quantum Mechanics and solid state review
4	Crystallography of metal and inorganic surfaces
5	Diffraction techniques LEED, EXAFS
6	Electron spectroscopy XPS, AES
7	Electron spectroscopy: XPS and ambient pressure-XPS
8	Surface interactions: adsorption and desorption
9	Isotherms and Reactions
10	Vibrational spectroscopy, FTIR, HREELS
11	Vibrational spectroscopy, RAMAN, SFG
12	*Thanksgiving recess*
13	Kinetic techniques, TPD/R, calorimetry
14	Atomic structure techniques, STM and AFM
15	Wrap up – project presentations

Throughout the course, I will provide specific information about where to find, in the textbook, the topics covered in class. Supporting information and announcements will be posted on canvas.

Information about Homework, Journal discussions, Midterm and Final Exams

Homework is given to help students understand the fundamentals of what was discussed in lecture. These are write-in and solving questions. They either involve explaining key terms and definitions, drawing and explaining how an instrument works or working through data analysis from the lab demonstrations. The style of homework problems are reflected in the midterm exam.

Learning objectives:

- to test understanding of key terms from lectures about Surface Science techniques and analysis
- to practice basic data analysis from lab demos and selected spectroscopies
- to apply principles to examples from literature

Homework can be solved with the support of books, notes and/or calculators. Students may work in groups. Keep in mind the exams are performed individually. Homework will be assigned from the required textbook. Supplement materials will be provided for sections not in book.

Lab Demonstrations are given to demonstrate the operation of a technique and how the data is collected. As part of their homework, students are asked to analyze data collected from that technique from a simple experiment they performed.

Learning objectives:

- To understand and visualize how technique is applied to an experiment
- To apply knowledge from lectures
- To practice basic data analysis
- To use the scientific method to analyze the data

Journal paper discussions
Students are asked to read selected papers about a principle Surface Science technique. These papers are chosen to demonstrate the fundamentals of the technique in addition to allow for depth discussion of the data. Each paper's impact applies to a different field of research (i.e. catalysis, semiconductors, environmental studies, etc.). Students will earn participation points for a discussion about the paper using MIT's Notebook interface. (https://nb.it.mtu.edu/about/) Students are expected and encouraged to explain and critique pieces of the literature in their own words and discuss the article in the online discussion.

Learning objectives:

- To apply principles from lectures in understanding "real world" examples
- To learn how to read and interpret modern literature in Surface Science
- To understand and demonstrate how the data is analyzed
- To critique conclusions drawn and asses how the study impacts a research area
- To communicate and discuss literature

Journal paper discussions will be assigned throughout the semester to demonstrate real-world investigations and data interpretation. You will be expected to comment on the articles and participate in class discussions around each article. I will invite you to the Notebook website, developed by MIT at https://nb.it.mtu.edu/login . The free program is designed to read and comment on articles. It enables a group to collectively discuss or ask questions about published works in a common area. I will post the assignment and due date on canvas, but the discussions will take place on Notebook.

Surface Science Proposal & Project
Students will choose a Surface Science technique that is not discussed in class and research the technique. They must address the theory behind how the technique works, limitations of the technique, pros, cons, resolution and sample requirements, etc. They are also expected to provide a few examples from literature that demonstrate each technique.

Part I

Students are expected to design an experiment around their technique of choice to determine how it will solve a hypothesis on a system that they (hypothetically) choose. This problem can be related to research they are involved in or are interested in. It must be an original proposal. This will result in a 2 page mini-proposal about the experiment and how their chosen technique will help answer a problem. This may be related to the student's current research.

Part II

Students are to present their Surface Science technique on the last day of class. They are given a 20 minute time limit (15 minute presentation and 5 minutes for questions) to teach the class about their chosen technique. They are expected to give literature examples of how their technique is demonstrated.

Learning objectives:

- to create an original project using given information (from class/literature)
- to learn to research and write an original (surface science) proposal
- to teach fellow classmates about a given topic and communicate proposal

University Policies

Student work products (exams, essays, projects, etc.) may be used for purposes of university, program, or course assessment. All work used for assessment purposes will not include any individual student identification.

Academic regulations and procedures are governed by University Policy. Academic dishonesty cases will be handled in accordance to University Policies.

If you have a disability that could affect your performance in this class or that requires an accommodation under the Americans with Disabilities Act, please see me as soon as possible so that we can make appropriate arrangements. The Affirmative Action Office has asked that you be made aware of the following:

Michigan Tech has standard policies on academic misconduct and complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. For more information about reasonable accommodation for or equal access to education or services at Michigan Tech, please call the Dean of Students Office, at (906) 487- 2212 or go to http://www.mtu.edu/ctl/instructional-resources/syllabus/syllabus_policies.html

Academic Integrity:
http://www.studentaffairs.mtu.edu/dean/judicial/policies/academic_integrity.html

Affirmative Action:
http://www.admin.mtu.edu/aao/

Disability Services:
http://www.admin.mtu.edu/urel/studenthandbook/student_services.html#disability

Equal Opportunity Statement:
http://www.admin.mtu.edu/admin/boc/policy/ch3/ch3p7.htm

For information on Michigan Tech University policies please paste the link into your browser (http://www.mtu.edu/gradschool/administration/academics/policies-procedures/)

Excused Absences

Events beyond your control may cause you to miss a homework deadline or exam. Whenever possible, contact me **prior to your absence** to arrange to make-up missed work. If you are unable to notify me concerning an absence or if you need to notify several instructors on short notice, contact the Office of Student Affairs for assistance. The Dean of Students will then inform all your instructors that you face a situation that requires that you miss class and you are granted an excused absence. It is then **your responsibility** to contact each of your instructors after you recover from your illness or return to campus.

An absence is excused under the following conditions:

- You participate in off-campus University-sponsored activities such as field trips, fine arts performances, intercollegiate athletics, job fairs, etc. you are granted an excused absence if your activity conflicts with an exam. I consider job-related or research-related trips, job interviews, and professional society meetings as excusable. It is imperative that for an absence of this type, for which a conflict with an exam is known well ahead of time that you arrange with me to take the exam earlier than its normally scheduled time.

- If you encounter circumstances beyond your control such as illness, the funeral of any relative or close friend or other personal emergency, you are granted an excused absence. You must provide verification of the special circumstances that led to your absence. In the event of a missed exam due to an excused absence, it is not possible to make-up the exam. Instead, an excused absence from an exam will receive the score EX. At the end of the semester, exam EX scores will be replaced by a weighted average of all your non-Ex scores on exams (midterms and final exams). If the final exam is missed as a result of an excused absence, you will be awarded the letter grade of I (incomplete) and must the take the final exam at the end of any one of the next semesters that you're in residence. Two or more exams missed as a result of excused absences will be handled on an individual basis.

Please note that if a lab demonstration is missed, **you are still responsible** for the homework and data that is affiliated with that technique. If a homework due date is missed as a result of **an excused absence**, the due date will be extended after you notify me.