

MSE 582, Fall 2022
Surface Physics

Instructor: Prof. Yingjie Zhang, yjz@illinois.edu

Time: Tu/Th 2-3:30 pm

Location: 1302 Siebel Center for Comp Sci

Note: This course will be in-person only. However, if you have legitimate reasons to miss some lectures (e.g., positive COVID test) and would like to watch the lecture recording, please email the instructor ahead of time. Upon reasonable request, the instructor will do a zoom recording during the in-person class and send you the link afterwards.

Website: canvas

Office hour (virtual): Thursday 3:30 – 4:30 pm

Credit: 4 graduate hours

Course description: Theory and characterization techniques of materials surfaces and interfaces, including: surface and interface structure; thermodynamics of interfaces; electronic structure of surfaces; X-ray spectroscopy and scattering; electrochemical interfaces and catalysis; scanning probe microscopy.

Prerequisite: Basic knowledge of quantum mechanics & solid state physics. MSE 304, or Phys 460, or Phys 485, or Chem 442 (or other equivalent courses)

Textbook (optional):

K. Oura, et al. Surface Science: an Introduction (ebook available online)

Course Topics:

| WEEK | TOPICS |
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| 1 | Introduction to surface science; Surface tension; Nucleation |
| 2 | Wulf's Theorem; Reconstruction; Surface forces, contact angle, wetting |
| 3 | Experimental surface science: vacuum, sample preparation |
| 4 | Surface characterization: AES, XPS, ISS, SIMS |
| 5 | Surface structure, reciprocal lattice and diffraction |
| 6 | Surface diffraction |
| 7 | Electronic structure of surfaces |

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| 8 | Electronic structure and photoemission |
| 9 | X-ray absorption and emission |
| 10 | Adsorption, reactions, catalysis |
| 11 | Scanning Tunneling Microscopy |
| 12 | Atomic Force Microscopy |
| 13 | Functional scanning probe microscopy |
| 14 | Electrochemical interfaces & energy applications |

Grading:

- 1) Homework assignments, 40%
- 2) Final exam (take-home exam), 30%
- 3) Final project that consists of two parts: in-class presentation (10%), and final report (20%).

Note on homework: You are allowed to discuss with each other about homework assignments, but NOT copy each other.

Note on the take-home final exam: You are NOT allowed to discuss with anyone in any form about the final exam questions. If unreasonable level of similarities are found in the answers between any two students, each student will receive zero score on the corresponding questions. If more than half of the results show unreasonable level of similarities, each student will receive zero score for the whole exam.

Late policy:

Homework, final project report, and completed final exams turned in within 24 hours after the deadline will be given 50% score. After 24 hours past the deadline, 0% score will be given.

Policy on conflicts or emergencies:

- (1) For time conflicts with other events (e.g. another scheduled exam), or an official UIUC activity (e.g. varsity athletics, band concert), please show official documentation about the conflict at least **one week** before the homework/report/exam due date. The due date will be extended if the excuses are legitimate.
- (2) If you will not be able to make it to the exam or submit HW on time due to serious illness or other emergent personal crisis (e.g. car accident) that are not described in (1), you must send an email to the instructor (yjz@illinois.edu) at your earliest convenience, and submit a statement from the professionals that are authorized to evaluate your situation (e.g. doctors, police officers). The statement needs to clearly explain that you are not physically capable of submitting the HW/report/exam on time. The due date will be extended if the excuses are legitimate.