

# NE 353

## Nano Probing and Lithography

Nanotechnology Engineering  
University of Waterloo  
Fall 2024

**Time and location:** TBD

**Instructor:** Dr. Guo-Xing Miao  
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Office hours: TBD  
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TA: TBD

**Course Objective and Content:**

This course provides an overview of all major lithography technologies capable of creating or duplicating sub-100 nm features. It covers photon and electron based exposure-develop lithography, and direct writing/imprinting types of lithography. In the end, you should have a solid knowledge on how to fabricate nanostructures (and devices).

Topics:

1. Resolution enhancement techniques for photolithography
2. Other types of photon-based lithography
3. Extreme UV lithography
4. X-ray lithography
5. Electron beam lithography
6. Focused ion beam lithography
7. Nanoimprint lithography
8. Scanning probe microscopy and lithography
9. Soft lithography and other patterning techniques
10. Lithography based on self-assembly

**Textbook:**

Zheng Cui, Nanofabrication: Principles, Capabilities and Limits, Springer, 2017 (2<sup>nd</sup> edition, PDF version of this book is available at the Library).

**References:**

Ampere A Tseng (Editor), Nanofabrication: Fundamentals and Applications, World Scientific, 2008 (optional)  
Zheng Cui, Micro-nanofabrication: Technologies and Applications, Springer, 2013 (optional)

**Course Grading Criteria:**

- 4 assignment (weeks 2,4,8,10, due a week after) 40%
- Mid-term exam (date/location TBD) 20%
- Final Exam (date/location TBD) 40%

Assignments are posted in weeks 2,4,8,10, due by the end of Sunday in the following week. Turn in the completed assignments to Learn's dropbox folder (or slide below the office door EIT 4009). **Late homework not accepted.** You should do these by yourself and this will help you a lot for your exams.

The exams will be closed book. Formulas needed, if any, will be provided on the exam paper. You should not need calculators.

### **Additional university policies:**

**Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) for more information.]

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

**Discipline:** A student is expected to know what constitutes academic integrity [check [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/)] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties check Guidelines for the Assessment of Penalties, [www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm).

**Appeals:** A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm).

**Note for Students with Disabilities:** The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

**Turnitin.com:** Plagiarism detection software (Turnitin) will be used to screen assignments in this course. This is being done to verify that use of all material and sources in assignments is documented. In the first week of the term, details will be provided about the arrangements for the use of Turnitin in this course.

Note: students must be given a reasonable option if they do not want to have their assignment screened by Turnitin. See: <http://uwaterloo.ca/academicintegrity/Turnitin/index.html> for more information.

**Fair Contingencies for Emergency Remote Teaching.** To provide contingency for unforeseen circumstances, the instructor reserves the right to modify course topics and/or assessments and/or weight and/or deadlines with due notice to students. In the event of further challenges, the instructor will work with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty.

**Online Academic Integrity for Individual Assessments.** For all graded course assessments, students are expected to work individually and submit their own original work. Under [Policy 71](#), the instructor may have follow-up conversations with individual students to ensure that the work submitted was completed on their own. Any follow up will be conducted remotely (e.g., MS Teams, Skype, phone), as the University of Waterloo has suspended all in-person meetings until further notice. Any permissions for collaboration on assessments (e.g., team project) must be provided by the instructor in writing.

**Compassionate Consideration.** If you are facing challenges that are affecting more than one course, please contact your Associate Chair or Director of your program. They will review your case and coordinate a reasonable and fair plan in consultation with appropriate others (for example: Instructors, Department Undergraduate Studies Committee, Chair, AccessAbility Services, Engineering Counselling services, Registrar's Office).

**Wellness Support and Contact Information.** We all need a support system. We encourage you to seek out mental health supports when they are needed. Please reach out to [Campus Wellness and Counselling Services](#). We understand that these circumstances can be troubling, and you may need to speak with someone for emotional support. [Good2Talk](#) is a post-secondary student helpline based in Ontario, Canada that is available to all students including outside Ontario. [MATES](#) is a one-to-one student peer support program offered by the Waterloo Undergraduate Student Association in consultation with Campus Wellness. MATES provides support to students who are hoping to build social skills, or are experiencing personal or academic concerns or low-level mental health and wellness difficulties.