Course Outline

NANO*3200
Nanolithography
Winter 2016

Course Calendar Description: W, (3-3) [0.50 credit] Lithographic techniques applied at the micrometer and nanometer scale are key to the production of devices for the electronic and related industries. Projection and proximity techniques (XUV, electron, and ion beams) and writing processes (electron beam, ion beam, and scanned probe) will be explored. Emphasis will also be placed on soft lithographic techniques such as stamping and dip-pen nanolithography. Prerequisite NANO*2100.

Instructor: Dan Thomas (SCIE 2504, SCIE 2515) x53961 dfthomas@uoguelph.ca

Lab Co-ordinator: Jay Leitch (SCIE 2110) x56262 leitchj@uoguelph.ca

Lab T.A.: Richard Parg (MACN 537) x52165 rparg@uoguelph.ca

Lectures: Tuesday and Thursday 11:30 - 1:00 in CRSC 403

Laboratory: Wednesday 2:30 - 5:20 in SCIE 2109 and 2110

No textbook is identified for the course. Lecture notes and references or links to external sources will be provided.

Lab instructions will be available in the laboratory.
Labs will begin in the second week (January 18).

Assessment	
Final Examination 11:30 A.M. - 1:30 P.M. Monday, April 11	25%
Oral Presentation	10%
Written Report	10%
Assignments (4)	20%
Laboratory	35%

Lithography is the process of imprinting an image on to a surface. It was originally accomplished by transferring the desired image (or its negative) onto a stone (hence the word “lithos” being found in the name) with an oil-based substance, and then filling an aqueous-based dye into the other parts of the stone. When placed on a page, only the regions with the aqueous dye would leave an image on the page. With many refinements over the years, image transference has ben improved and is at the heart of the semiconductor industry, as well as new fields such as MEMS (microelectromechanical systems). Pattern formation and transfer in the nanoscale regime is the next technological challenge. Some processes are simply extensions of the existing technologies while others are quite unique to the nanoscale. This class will examine a variety of technologies and explore their range of applications. Students will be able to recognize a range of lithographic tools that can be used for pattern formation

and transfer. They will appreciate the capabilities and limitations of each process. They will be able to evaluate different processes for the application to solve specific nanoscale problems.

Oral and Written Report: You will be assigned a current researcher in the field of nanoscience who have performed studies in the area of lithography. Your assignment will be to highlight and summarize the work they have done in this area. It will generally take on a chronological presentation, but may also describe the key pathways of development they may have followed. The written report will be 2000 - 2500 words. You will also make an oral report to the class and prepare a 15 minute presentation to describe their work.

Books Used in Developing Course

W. Schanbel, "Polymers and Light", Wiley (2007). QD 381.9 .O66 S36 2007

V. Bakshi, "EUV Lithography" Wiley (2009). QC 459.E98 2009

M. Ohtsu, "Nanophotonics and Nanofabrication", Wiley (2009) TA 1530 .N36 2009

N.S. Allen, "Photochemistry and Photophysics of Polymer Materials", Wiley (2010) QD 381.9 .O66 .H36 2010

UNIVERSITY POLICIES

a) **E-mail Communication** – As per university regulations, all students are required to check their uoguelph.ca e-mail account regularly: e-mail is the official route of communication between the University and its students.

b) **Accessibility** – The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/

c) **Academic Misconduct Policy** –The University of Guelph is committed to upholding the highest standards of academic integrity and enjoins all members of the University community to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor. The Academic Misconduct Policy is detailed in the Undergraduate Calendar: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

d) **Recording of Materials** – Presentations which are made in relation to course work – including lectures – cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

e) **Resources** – Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:

http://www.uoguelph.ca/registrar/calendars/index.cfm?index

i. **Drop Date**: The last date to drop one-semester courses, without academic penalty, is March 11. For regulations and procedures for dropping courses, see the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

ii. **Schedule of Dates**:www.uoguelph.ca/registrar/calendars/undergraduate/current/c03/index.shtml