Montgomery County Community College

ESC 214
Lithography for Nanofabrication
3-2-2

COURSE DESCRIPTION

This specific course will cover all aspects of lithography from design and mask fabrication to pattern transfer and inspection. This course is divided into three major sections. The first section describes the lithographic process from substrate preparation to exposure. Most of the emphasis will be on understanding the nature and behavior of photoresist materials. The second section examines the process from development through inspection (both before and after pattern transfer.) This section will introduce optical masks, aligners, steppers and scanners. In addition, critical dimension (CD) control and profile control of photoresists will be investigated. The last section will discuss advanced optical lithographic techniques such as phase shifting masks and illumination schemes as well as e-beam, x-ray, EUV, and ion beam lithography.

This course is designed to be one of six capstone courses (Esc 2II, 212,213,214, 215, 216) for the Penn State Semiconductor Manufacturing Technology (SMT) program. The course is lab intensive, leveraging the Nanofabrication Facility on the University Park campus. All lectures will be given in a technology classroom, Suite 114 Lubert bldg., Manufacturing Technology and thus has a wide variety of very specialized, "hands-on" materials and facilities continually available to students. The course grade evaluation will use a mixture of tests, presentations, reports, and project assignments. Teaming and tem problem solving will be stressed.

REQUISITES

Previous Course Requirements

- ESC 213 Materials in Nanotechnology

Concurrent Course Requirements

None

LEARNING OUTCOMES Upon successful completion of this course, the student will be able to:	LEARNING ACTIVITIES	EVALUATION METHOD
1. Obtain a better understanding of the interfacing of the various stages of the nanofabrication process	Lecture Group and individual skills training activities	Exams Projects Presentations Laboratory Activities

through identification of those stages and their respective functions.		
2. Apply skills in various disciplines of lithography.	Lecture Group and individual skills training activities	Exams Projects Presentations Laboratory Activities
3. Identify the appropriate lithographic application to meet the task.	Lecture Group and individual skills training activities	Exams Projects Presentations Laboratory Activities
4. Safely and effectively operate lithographic equipment.	Lecture Group and individual skills training activities	Exams Projects Presentations Laboratory Activities

At the conclusion of each semester/session, assessment of the learning outcomes will be completed by course faculty using the listed evaluation method(s). Aggregated results will be submitted to the Associate Vice President of Academic Affairs. The benchmark for each learning outcome is that *70% of students will meet or exceed outcome criteria.*

SEQUENCE OF TOPICS

Topic 1	Lecture Lab	Optics and Photo process overview
Topic 2	Lecture Lab	Photoresist properties Substrate preparation, spin application of photoresist
Topic 3	Lecture Lab	Optical lithography: contact aligner Levell exposure on MA-6
Topic 4	Lecture Lab	Mask layout and fabrication L-EDIT demo
Topic 5	Lecture Lab	Photoresist processing issues Exposure matrix on MA-6
Topic 6	Lecture Lab	Optical lithography: projection systems Stepper demonstration

Topic 7	Lecture Lab	Alignment issues Level 2 on MA-6
Topic 8	Lecture Lab	CD control and measurement Level 2 on MA-6
Topic 9	Lecture Lab	Advanced Optical lithography Deep UV,EUV
Topic 10	Lecture Lab	X-ray and Ion Beam Lithography
Topic 11	Lecture Lab	E-beam lithography Pattern fracturing and writing demonstration

LEARNING MATERIALS
Textbook: Identified by Penn State
Instructor handouts and guest speakers

Other learning materials may be required and made available directly to the student and/or via the College's Libraries and/or course management system.

COURSE APPROVAL
Prepared by: William Brownlowe Date: 4/11/2000
VPAA/Provost or designee Compliance Verification:
Bradley Gottfried Date: 4/20/2000

Revised by: William H. Brownlowe Date: 9/24/2013
VPAA/Provost or designee Compliance Verification:
Victoria Bastecki-Perez, Ed. D. Date: 09/30/2013

Revised by: Chengyang Wang Date: 1/10/2018
VPAA/Provost or designee Compliance Verification: Date: 1/12/2018

This course is consistent with Montgomery County Community College's mission. It was developed, approved and will be delivered in full compliance with the policies and procedures established by the College.