ISE 789-002
Advanced Nanoscale Manufacturing
Fall 2012

INSTRUCTORS:

Instructor: Dr. Jingyan Dong
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919-515-7196
Office hours: 3 – 4 pm, Tu, Th, and by appt.

WEBPAGE: https://wolfware.ncsu.edu/?term=current&type=complex&what=ISE%20789

SCHEDULE:

Lectures: 1:30 – 2:45 pm, Tu, Th at Daniels Hall 222

TEXT: None assigned, but there is plenty of reading material available on the course website.

OBJECTIVES

The goal of this course is to introduce students to patterning and fabrication techniques that are useful for nanomanufacturing. The main focus of the course is on the fabrication and manufacturing of one dimensional nanostructure, two dimensional nanopatterns, and three dimensional nanostructures, and the techniques and tools used to fabricate and characterize them. The course includes photolithography, unconventional nanoscale lithography, growth of nanomaterials, such as nanowires and nanotubes, scaling, actuators, and sensors.

GRADING:

Homework assignments: 20%
Class discussion: 30%
Project Reports: 20%
Final exam: 30%

HOMEWORK:

Homework problems will be assigned weekly, if any, emailed by Thursday, due before the *beginning* of lecture the following Thursday. Late Homework: -5% if handed in by the end of Thursday lecture (e.g. if you are late to lecture), -20% before 5 pm Friday (to my office). After that, homework will not be accepted for credit.

PRESENTATION:

The class will include several discussion sessions on recent trends and developments relevant to the course. Each student will pick one topic for one of the discussion sessions and will prepare a 15-minute presentation on the problem and current state of the art in the field. You can use the material prepared for the discussion sessions for the course project.

PARTICIPATION:

You are expected to attend and participate in all class activities. Your participation will count toward your grade at the instructor's discretion. University attendance policy: *www.ncsu.edu/provost/academic_regulations/attend/reg.htm*.

POLICY ON ABSENCES:

Missed exams need to be justified by the student with a written corroboration (Doctor's note or similar). In that case, he/she can choose to retake the exam at a late date, or choose to attribute the grade for the missed exam to the Final Exam (e.g. a student missed the midterm, then the final exam will count 50% of the overall grade. Non-justified missed exams will be assigned a grade of ZERO.

ACADEMIC INTEGRITY STATEMENT:

Exams are to be solved individually including the take-home ones (if any), without any help other than that provided directly by the Instructor. Any attempt at cheating will result in a ZERO grade for that exam, and possibly further action. You may discuss over home work questions and project. But the submitted documents have to be done by yourself. Duplicated homework and reports will result in a ZERO grade.

For more details, see: http://www.ncsu.edu/student_affairs/osc/AIpage/acaintegrity.html. The following Honor Pledge will be in effect at all times: ***"I have neither given nor received unauthorized aid on this test or assignment"***

TOPICS TO BE COVERED

History and Fundamentals of Micro/Nanotechnology

Micro/Nano World, length scales
Devices, Sensors and Actuators
Topical applications

Scaling, Actuators and Power in micro/nano scale Systems

Scaling rates for common physical characteristics
Actuation and sensing

Physics at Nanometer Scale

Mechanics at nanoscale
Quantum size effect
Nanoscale energy transport

Visualization and Characterization of the Nanometer Scale

Enhanced Optical Microscopy
Electron Microscopy
- Scanning Electron Microscopy
- Transmission Electron Microscopy

Scanning probe microscope:
- Scanning Tunneling Microscopy
- Atomic Force Microscopy

X-ray scattering
X-ray photoelectron spectroscopy
Infrared (IR) spectrometry

PhotoLithography

Fundamentals and definitions
Photolithography: types, profiles, resolution calculations, side profiles, etc.

Additive (deposition) and Subtractive (Etching) Processes

Physical vapor deposition and chemical vapor deposition
Doping and Oxidation
Dry Plasma etching
Wet chemical etching

X-ray lithography and LIGA

X-ray source, masks, alignment, resists, exposure, and development

E-beam lithography

Electron source, e-beam resists, optics, exposure, proximity effect and resolution, and development

EUV lithography

EUV source, optics, mask, exposure, and resolution

Nano Imprint lithography

Thermal NIL and UV-curable NIL
NIL mold and resist
Alignment

Soft lithography

PDMS and mold preparation
Micro contact printing
Micro transfer molding

Tip based lithography

Dip-pen lithography
Field oxidation
Mechanical machining
Thermal writing

Synthesis of 1D and 2D nanomaterials

Nanotubes
Nanowires