Syllabus – Microelectronics Manufacturing and the Environment

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Department of Chemical & Environmental Engineering

CHEE, MSE & ECE 415 & 515

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Course Description

- This course will focus on the presentation of basic semiconductor fabrication unit operations as they relate to:
  - Theory of operation
  - Materials
  - Equipment
  - Fabrication processes
  - Key environmental impacts and challenges

- Prerequisites:
  - None
Instructor Information

- **Instructor:**
  - Name: Ara Philipossian
  - Office: Electrical & Computer Engineering Building, Room 223
  - Phone: 520 621 6101
  - E-Mail: ara@engr.arizona.edu

- **Office Hours:**
  - Wednesdays 2 to 4 PM (No office hours this week).
  - There will be no TA for this course
  - Other times by appointment only (send me an e-mail please)
  - Office hours are subject to change
Method of Instruction

• Class location: McClelland Hall – No. 133 – Mondays 3:30 to 5:50 PM

• Course will be delivered in the form of traditional lectures as well as instructional videos:
  – Prof. Ara Philipossian  UA – Lectures
  – Prof. Farhang Shadman  UA – Video
  – Dr. Michael Goldstein  Intel – Video
  – Prof. Srini Raghavan  UA – Video
  – Dr. Robert Meagley  Intel – Video
  – Dr. Larry Larsen  Sematech – Video

• Self-discipline will be paramount in order to keep up with the pace and the volume (and format) of information delivered
Method of Instruction (continued)

- Homework:
  - Ten or so assignments

- Exams:
  - Mid-Term No. 1
  - Mid-Term No. 2

- Group Project Proposal (Written and Oral):
  - Please see the next 5 slides
Project Proposal

• ORAL PRESENTATION AND SUBMISSION DEADLINE
  – Monday May 2, 2016
  – Deliver a hardcopy to Ara Philipossian in the class
  – Present to the entire class (no more than 10 minutes and 9 PPT slides)

• WRITTEN PROPOSAL LENGTH
  – No more than 14 pages including figures and list of references
  – Keep it crisp and to the point
  – Font size: 11
  – Spacing: Double
MAXIMUM OF 5 STUDENTS PER GROUP

FOCUS AREAS
- Process consumables replacement
- Process consumables reduction
- Process consumables re-use

TOPICS TO CHOOSE FROM
- Electroplating of copper
- CMP of copper or dielectrics
- CMP of Shallow Trench Isolation
- Thermal oxidation
- LPCVD of dielectrics
- LPCVD of tungsten
- Wet cleaning and surface preparation
- Dry cleaning & surface preparation
- Rinsing
- Drying
- Post-CMP cleaning
• TOPICS TO CHOOSE FROM (CONTINUED)
  – Wet etching of silicon nitride or silicon dioxide
  – Dry etching of silicon dioxide
  – PVD of copper
  – Plasma etching
  – Lithography

• RESEARCH OBJECTIVE
  – What problem are you solving?
  – What opportunities are you suggesting to be exploited?
  – What technology or usage issues motivate this problem?
  – What has been done in this area in the past?
  – How does your proposed work differ from what’s already been done by other researchers?
  – What is your research hypothesis?
  – How will you verify that hypothesis?
  – What is the potential impact on industry practice if the hypothesis is verified?
Project Proposal (continued)

• RELATIONSHIP TO OTHER RESEARCH OR PRACTICE
  – What similar research to this proposal is being conducted by other universities?
  – How does this proposal differ from that research

• RESEARCH POTENTIAL IMPACT
  – What concrete results are expected?
  – How could those results be put into practice?
  – How could an IC manufacturer benefit from the completion of this work?
  – What technological advances must happen for that benefit to be realized?

• RESEARCH PLAN (ASSUME A 2-YEAR DURATION)
  – Deliverables
  – Timeline
  – Technical tradeoffs that may have to be made
  – Risks in this research and how they will be managed
Project Proposal (continued)

• BIBLIOGRAPHY
  – Roughly 10 publications relating to state-of-the-art and your proposed work
  – Attach hardcopies of all referenced publications and submit it with your report (note that these pages are in addition to the 14 pages containing your report)

• GRADING
  – Your grade will be based on the following:
    • Creativity
    • Originality
    • Aesthetics & professionalism of the report
    • Impact to industry
    • Completeness & relevance of previous work cited in the bibliography and your ability to structure your proposal recognizing what’s been done before by other researchers
    • Likelihood of success of your proposal
YOUR Final Grade

- Homework: ZERO – I will not be collecting or grading any of the HWs. I will post all solutions on D2L. Exams will be based on HW.

- Mid-Term Exam 1: 30%
- Mid-Term Exam 2: 40%
- Proposal: 30%
Facts About This Course

• Total of 166 students have taken this course under Prof. Philipossian:
  - A = 45 %
  - B = 25 %
  - C = 20 %
  - D, E and DROP = 10 %

• Evaluation of the Instructor and the course over the past 7 years:
  - Instructor’s teaching effectiveness = 4.55 / 5.00
  - Overall rating of course = 4.25 / 5.00
  - How much learned = 4.15 / 5.00
  - Usefulness of lectures & discussions = 4.50 / 5.00
  - Usefulness of homework = 4.10 / 5.00
  - Treated with respect = 4.80 / 5.00
  - Difficulty level = 4.00 / 5.00
Books

• **Required Textbook:**
  

• **Recommended Books:**
  
  
  
  
  
Groundrules

• There will be no make-up exams whatsoever

• Turn off all mobile devices in the classroom

• **Lectures start promptly at 3:30 PM and end at 5:50 PM**
  
  – Please be on time
  
  – Students arriving after 3:35 PM are requested to wait outside the classroom. Late students will be admitted into the classroom when there is a natural break in the lecture (usually around 4:45 PM).
  
  – There is an exception for 2 students due to class overlap!
  
  – Being 5 minutes late means:
    • (5 minutes) x (26 students + 1 instructor)
    • More than 2 hours of other people’s time wasted
  
  – If you miss a lecture, please do not ask me for a tutorial on the subjects covered during the lecture

• Complete your reading assignment prior to each lecture
Groundrules (continued)

• Do not seek the instructors’ help in solving homework problems if you have not given the problem your best shot.

• You must show the instructor in writing your logic and deductive reasoning in attempting to solve a problem before the instructor proceeds to help you
Course Structure (subject to change)

- Lecture No. 1 by Ara Philipossian ... January 25
  - Review of the Syllabus
  - Introduction to Device Fabrication
  - Introduction to Design for the Environment
  - Silicon Wafer Manufacturing – Part 1
  - Silicon Wafer Manufacturing – Part 2 (Please watch video on D2L ASAP)
Course Structure

- Lecture No. 2 by Ara Philipossian … February 1
  - Impurity Diffusion
  - Thermal Oxidation

- Lecture No. 3 by Ara Philipossian … February 8
  - Thermal oxidation (continued)
  - Dielectric Deposition

- Note: There will be NO CLASS on February 15th due to a school holiday – Please watch the videos mentioned in the section re: Lecture No.4 (next page)!
Course Structure

- Lecture No. 4 by Ara Philipossian, Srini Raghavan and Larry Larsen … February 22
  - Low k Dielectrics
  - Wet Etching, Cleaning and Surface Preparation
  - Drying (by Srini Raghavan – Please watch video on D2L ASAP)
  - Ion Implantation (by Larry Larson – Please watch video on D2L ASAP)
  - You need to download SRIM in order to solve the Implantation HW problems.

- Review Lecture (No. 5) by Ara Philipossian… February 29

- Review Lecture (No. 6) by Ara Philipossian … March 7

  Mid-Term Exam 1 … March 21 (Duration = 2 Hours)
Course Structure

• Lecture No. 7 by Ara Philipossian … March 28
  – Chemical Mechanical Planarization - Part 1

• Lecture No. 8 by Ara Philipossian … April 4
  – Chemical Mechanical Planarization - Part 2

• Lecture No. 9 by Farhang Shadman, Michael Goldstein and Robert Meagley … April 11 (Watch Video on D2L – No Class)
  – Ultra-Pure Water Production, Use and Re-Use
  – Rinsing
  – Photolithography
  – Metallization
Course Structure

- Review Lecture (No. 10) by Ara Philipossian … April 18
- Review Lecture (No. 11) by Ara Philipossian … April 25
- Proposal Presentations … May 2

Mid-Term Exam 2 … May 9 at 3:30 PM (Duration = 2 Hours)