IC/Sensor/MEMS Fabrication

PLACE/TIME:  1202 EB, 03:00 - 03:50 p.m., M W
INSTRUCTOR AVAILABILITY:  3211EB
   Tuesdays:   2:00 – 3:00 p.m.
   Wednesdays: 4:15 – 5:00 p.m.
Phone: 353-6329; aslam@msu.edu; www.egr.msu.edu/~aslam

COURSE INFORMATION:
♦ Grading procedures:

<table>
<thead>
<tr>
<th>Evaluat. Method</th>
<th>Points</th>
<th>Schedule</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>10</td>
<td>Due Every Monday, 3:00 p.m.</td>
<td>Questions: Conceptual, problems and multiple-choice</td>
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<tr>
<td>Open-book Quizzes¹</td>
<td>30</td>
<td>Every Other Wednesday, in class</td>
<td>Questions: Conceptual, problems and multiple-choice</td>
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<tr>
<td>Examples, Demos</td>
<td></td>
<td>Discussed in class (designed to enhance understanding of material used in lab and lectures). Demos are Lego-based and innovative.</td>
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<tr>
<td>Lab Report: Graded by the lab instructor</td>
<td>60</td>
<td>See Lab Report in the next column for details</td>
<td>Weekly group lab report (each student is individually responsible for lab notes but only one report per group is required) is due before 5:00 p.m. on Tuesdays. Lab report must contain lab notes (write clearly or type) taken during the experiment. Add the following to lab report: • Records and explanations of data, problems and issues related to lab; 35 points • List of safety precautions; 10 points • Conclusions and suggestions; 15 points</td>
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<tr>
<td>Final Exam</td>
<td></td>
<td>There will be no final exam but the class will meet for a general discussion on course/grades on the scheduled exam day (see MSU final exam schedule)</td>
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<tr>
<td>Class Ethics</td>
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<td>The class ethics include honesty in exams, projects, experiments, and class attendance.</td>
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♦ Latest course-related information will be posted on instructor’s website:

¹ No make-up quizzes please.
http://www.egr.msu.edu/~aslam/teaching.htm

♦ Copies of lecture presentations will be supplied in pdf format.

♦ To access the files from the above website use the following information: Username; ece477 and Password; wims477

PRE-REQUISITES:
ECE 474 or equivalent.

TEXT:

ADDITIONAL READING:
• Microchip Manufacturing, S. Wolf, LATTICE PRESS (SUNSET BEACH, CA), 2004.
• SILICON PROCESSING - for the VLSI Era, S. WOLF and R.N. TAUBER.
• THIS WEB SITE HAS INFORMATION ON FABRICATION: HTTP://JAS2.ENG.BUFFALO.EDU/APPLETS/INDEX.HTML

LECTURE DISCUSSIONS: *Closely related to labs*
• It is very important to take part in lecture discussions, which will include a number of examples not included in lecture transparencies or textbooks.
• These examples are very important for understanding the underlying concepts. Most quiz questions will be based on class discussions.

SYLLABUS OUTLINES:
Lectures/Experiment 1: *FIELD OXIDATION*
Wafer cleaning (RCA-clean), wet oxidation, N₂ anneal,
Lectures/Experiment 2: **LITHOGRAPHY** (mask 1): *p-diffusion areas*
Oxide thickness measurement, spin photoresist (PR), expose (mask 1) and develop to generate pattern, etch window in oxide, remove PR

Lectures/Experiment 3: **DIFFUSION** (pre-deposition)
RCA clean, boron diffusion (pre-deposition), remove borosilicate glass,

Lectures/Experiment 4: **DIFFUSION** (drive-in)
Measure resistivity in test areas, RCA clean, drive-in diffusion

Lectures/Experiment 5: **LITHOGRAPHY** (mask 2): *gate oxide areas*
Spin PR, expose (mask 2), generate pattern, etch window, remove PR

Lectures/Experiment 6: **GATE OXIDATION**
RCA clean, gate oxidation, N$_2$ anneal

Lectures/Experiment 7: **LITHOGRAPHY** (mask 3): *contact holes*
Measure oxide thickness, spin PR and generate pattern (mask 3), open contact holes (oxide etch), Al evaporation

Lectures/Experiment 8: **LITHOGRAPHY** (mask 4): *metal patterning*
Spin PR, generate pattern (mask 4), etch Al, low temperature anneal

Lectures/Experiment 9: **DIODE TEST**
Measure diode characteristics and resistance

Lectures/Experiment 10: **C-V TEST**
Find flatband voltage and oxide charge

Lectures/Experiment 11: **MOSFET TEST**
MOSFET characteristics, find $g_m$, voltage gain

Lectures/Experiment 12: **SENSOR/MEMS TEST**
Resistor and diode as a temperature sensor, testing of diamond MEMS chip (will be fabricated WIMS grad students)

Lectures/Experiment 13: **Additional Testing**