

# ECE 449/ ECE 560 (Technology of Integrated Circuits)

**Instructor:** Dr. Shaikh S. Ahmed  
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**Office Hours:** TTH 12:00 p.m. – 2:30 p.m. (or by appointment)

**Lecture:** TTH 10:35 – 11:50 a.m., ENGR A-322

**Total Credit Hours:** 3

**Prerequisite:** ECE 447 (or instructor consent)

**Text Book:** The subject matter for this course will be heavily drawn from the literature and extensive references will be provided in the class notes. A list of useful books is provided in the following:

- 1) *Semiconductor Devices: Physics and Technology* by S. M. Sze and M. K. Lee, John Wiley and Sons, Inc., 3<sup>rd</sup> edition (2012), ISBN 978-0470-53794-7
- 2) *Semiconductor Material and Device Characterization* by Dieter Schroder, Wiley-IEEE Press, 3<sup>rd</sup> edition (January 30, 2006), ISBN-10: 0471739065, ISBN-13: 978-0471739067
- 3) *Introduction to Micro Fabrication* by Sami Franssila, Wiley 2<sup>nd</sup> edition, 2010, ISBN: 978-0-470-74983-8

## *Tentative Topical Outline:*

### **The economic driving forces:**

Moore's law and more-than-Moore; IC industry: organogram and operation

### **Materials for state-of-the-art integrated circuits:**

Semiconductor crystals, tubular and monolayer materials, organic materials, heterostructures, wafers and notations

### **Micro- and nano- fabrication technologies:**

Wafer technology, Basic processing steps in IC fabrication, Selective doping techniques including diffusion and ion implantation, Nanolithography, Etching, Contacts and interconnects, Spontaneous formation and ordering of nanostructures, Methods of nanotube and thin-film growth, Chemical and biological methods for fabrication, Fabrication of electromechanical (MEMS) systems, IC assembly and packaging.

### **Semiconductor device and circuit characterization:**

Electrical Characterization: Wafer mapping using four point probe, Doping and Line width profiling, Measurement of contact resistance, threshold voltage, channel length and width, Oxide charges and interface traps measurements using CV profiling, Defects characterization using DLTS, Carrier lifetime using photoconductance decay; Optical characterization: Microscopy and Spectroscopy, Ellipsometry, Fourier transform infrared spectroscopy (FTIR), Photoluminescence spectroscopy (PL), Raman spectroscopy, Acoustic microscopy; Electron Beam Microscopy (High Resolution Imaging): SEM, EMP, TEM, AES, SPM; Particle Beam Analysis (Dopants and Impurities): Secondary ion mass spectrometry (SIMS), Rutherford backscattering spectrometry (RBS), Neutron activation analysis (NAA), AFM; X-ray Techniques (Contamination and Physical Defects): X-Ray fluorescence (XRF), X-Ray photoelectron spectroscopy (XPS), X-Ray diffraction (XRD)

### **Reliability of devices and ICs:**

ICs in harsh environments, hot carriers, NBTI, electromigration, electrostatic discharge, IC power and hot-spot cooling using thermoelectrics

**Future directions:**

Computing

Communication

Emerging IC technologies: biochips, energy harvesting, sensors, organic ICs

**Date and Time of Final Examination:** Tuesday, December 9, 2013, from 10–11:45 a.m.

**Grading:** HW (25%), Quizzes/Mid-Term Exam (35%), Final examination (25%), Final paper (15%)

**Classroom Policies:**

- A. Syllabus is subject to change at the instructor's discretion. Students are responsible for all announcements made in class and/or posted to D2L.
- B. **Attendance Policy:** Attendance will be taken at random throughout the semester, and it may be counted toward the final grade.
- C. **Late Homework/Missed Exams:** Late homework is not accepted. If an exam is missed for a *legitimate* reason, a grade will be assigned based on the remaining homework/exams.

**Mobile Technology Policy:** N/A

*"We emphasize student achievement and success because achievement and success are essential if we are to shape future leaders and transform lives." <sup>1</sup>*

<http://pvcaa.siu.edu/>

## IMPORTANT DATES \*

<u>Semester Class Begins</u> .....	<b>08/18/2014</b>
<u>Last day to add a class</u> (without instructor permission): .....	<b>08/24/2014</b>
<u>Last day to withdraw completely and receive a 100% refund:</u> .....	<b>08/31/2014</b>
<u>Last day to drop a course using SalukiNet:</u> .....	<b>10/26/2014</b>
<u>Last day to file diploma application</u> (for name to appear in Commencement program): .....	<b>10/31/2014</b>
<u>Final examinations:</u> .....	<b>12/8–12/12/2014</b>

Note: For outreach, internet, and short course drop/add dates, visit

Registrar's Academic webpage <http://registrar.siu.edu/>

## FALL SEMESTER HOLIDAYS

Labor Day 09/01/2014

Fall Break 10/11—10/14/2014

Veterans Day 11/11/2014

Thanksgiving Vacation 11/26—11/30/2014

## WITHDRAWAL POLICY ~ Undergraduate only

Students who officially register for a session may not withdraw merely by the stopping of attendance. An official withdrawal form needs to be initiated by the student and processed by the University. For the proper procedures to follow when dropping courses and when withdrawing from the University, please visit <http://registrar.siu.edu/pdf/ugradcatalog1314.pdf>

## INCOMPLETE POLICY~ Undergraduate only

An INC is assigned when, for reasons beyond their control, students engaged in passing work are unable to complete all class assignments. An INC must be changed to a completed grade within one semester following the term in which the course was taken, or graduation, whichever occurs first. Should the student fail to complete the course within the time period designated, that is, by no later than the end of the semester following the term in which the course was taken, or graduation, whichever occurs first, the incomplete will be converted to a grade of F and the grade will be computed in the student's grade point average. For more information please visit:

<http://registrar.siu.edu/grades/incomplete.html>

## REPEAT POLICY

An undergraduate student may, for the purpose of raising a grade, enroll in a course for credit no more than two times (two total enrollments) unless otherwise noted in the course description. For students receiving a letter grade of A,B,C,D, or F, the course repetition must occur at Southern Illinois University Carbondale. Only the most recent (last) grade will be calculated in the overall GPA and count toward hours earned. See full policy at <http://registrar.siu.edu/pdf/ugradcatalog1314.pdf>

## GRADUATE POLICIES

Graduate policies often vary from Undergraduate policies. To view the applicable policies for graduate students, please visit <http://gradschool.siu.edu/about-us/grad-catalog/index.html>

## DISABILITY POLICY

Disability Support Services provides the required academic and programmatic support services to students with permanent and temporary disabilities. DSS provides centralized coordination and referral services. To utilize DSS services, students must come to the DSS to open cases. The process involves interviews, reviews of student-supplied documentation, and completion of Disability Accommodation Agreements.

<http://disabilityservices.siu.edu/>

## PLAGIARISM CODE

[http://pvcaa.siu.edu/\\_common/documents/Plagiarism/Guide%20to%20Preventing%20Plagiarism.pdf](http://pvcaa.siu.edu/_common/documents/Plagiarism/Guide%20to%20Preventing%20Plagiarism.pdf)

## SALUKI CARES

The purpose of Saluki Cares is to develop, facilitate and coordinate a university-wide program of care and support for students in any type of distress—physical, emotional, financial, or personal. By working closely with faculty, staff, students and their families, SIU will continue to display a culture of care and demonstrate to our students and their families that they are an important part of the community. For Information on Saluki Cares: (618) 453-5714, or [siucares@siu.edu](mailto:siucares@siu.edu),

<http://salukicare.siu.edu/index.html>

## EMERGENCY PROCEDURES

Southern Illinois University Carbondale is committed to providing a safe and healthy environment for study and work. We ask that you become familiar with the **SIU Emergency Response Plan** and **Building Emergency Response Team (BERT)** programs. Emergency response information is available on posters in buildings on campus, available on BERT's website at [www.bert.siu.edu](http://www.bert.siu.edu), Department of Safety's website at [www.dps.siu.edu](http://www.dps.siu.edu) (disaster drop down) and the Emergency Response Guideline pamphlet. Instructors will provide guidance and direction to students in the classroom in the event of an emergency affecting your location. *It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency.*

## INCLUSIVE EXCELLENCE

SIU contains people from all walks of life, from many different cultures and sub-cultures, and representing all strata of society, nationalities, ethnicities, lifestyles, and affiliations. Learning from and working with people who differ is an important part of education as well as an essential preparation for any career. For more information please visit: <http://www.inclusiveexcellence.siu.edu/>

## MORRIS LIBRARY HOURS

<http://www.lib.siu.edu/about>

## LEARNING AND SUPPORT SERVICES

Help is within reach. Learning support services offers free tutoring on campus and math labs. To find more information please visit the Center for Learning and Support Services website:

**Tutoring** : <http://tutoring.siu.edu/>

**Math Labs** [http://tutoring.siu.edu/math\\_tutoring/index.html](http://tutoring.siu.edu/math_tutoring/index.html)

## WRITING CENTER

The Writing Center offers free tutoring services to all SIU students and faculty. To find a Center or Schedule an appointment please visit <http://write.siu.edu/>

## AFFIRMATIVE ACTION & EQUAL OPPORTUNITY

Our office's main focus is to ensure that the university complies with federal and state equity policies and handles reporting and investigating of discrimination cases. For more information visit:

<http://diversity.siu.edu/#>

## Additional Resources Available:

**SALUKINET:** <https://salukinet.siu.edu/cp/home/displaylogin>

**ADVISEMENT:** <http://advisement.siu.edu/>