GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL of ELECTRICAL & COMPUTER ENGINEERING

ECE3803- Semiconductors: From sand to electronic systems driving the present and future.

GTE - Syllabus & Schedule

Instructor: Dr. Suresh Sundaram

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Office: GTE 213

Office Hours:

Monday 3.00 -4.30 pm, Walk-ins, or by appointment – specific hour TBA latter

Class Details:

Lecture: Tuesday and Wednesday 15.55- 17.50

Pre-requisites: CHEM 1310 or CHEM 1211

Course Websites:

http://canvas.gatech.edu/

We will use Canvas for course organization and classwide communication. Lecture slides and recordings will appear in Canvas, as well as all assignments.

Course Materials:

optional Textbook(s):

There is no required course textbook. We anticipate using journal and conference papers for the all the modules of the courses.

Attendance Policy:

The majority of classes will be lecture-based and will occur in-person. Attendance is mandatory.

Course Overview:

Virtually all products and systems in today's market incorporate electronic components based on semiconductor technologies. The semiconductor industry is evolving rapidly to meet future technological demands, driven by advances in materials, growth techniques, device processing, and packaging architectures.

This course provides a comprehensive foundation in modern semiconductor technologies for students interested in careers or research in the semiconductor industry, as well as for those seeking broader knowledge of semiconductor materials, processing, and advanced packaging. The course examines three core modules related to semiconductor component manufacturing:

- Semiconductor Materials: growth, characterization, and processing
- Systems: advanced packaging and heterogeneous integration
- Applications: finished products and enabling technologies

To provide early context and motivation, the course begins with a system-level and application-driven perspective, before progressing to semiconductor materials and device technologies. The course concludes with advanced packaging and integration concepts that enable next-generation electronic systems.

By the end of this course, students will understand the fundamental principles underlying semiconductor technologies, their role in modern electronic systems, and emerging trends shaping the future of the semiconductor industry.

Structure:

Week 1 – Applications: Role of semiconductors and advanced packaging in enabling revolutionary changes in our daily lives: Examples include AI, smartphones, and medical devices which will include industry expert talk

Week 2 – From Sand to Silicon: Comprehensive process overview from raw materials to packaged devices, discussion of major players in silicon including key foundries and industry leaders.

Weeks 3–5 – Materials and Devices for advanced semiconductor systems: Fundamental concepts in semiconductor materials, Epitaxial growth, characterization, device physics and fabrication processes in realization of advanced semiconductor systems will be dealt.

Week 6 – Lab visits

Weeks 7–10 – Advanced Packaging and Systems Design: System-level integration, thermal

management, interconnect challenges, and advanced packaging and bonding technologies

Week 11- Project presentations and final exam.

Topical Outline

This course is mainly divided into three parts:

1. Introduction/Review of applications of semiconductors
    - Historic perspective of semiconductor technology.
    - The role of semiconductors and advanced packaging in ubiquitous technologies/applications such as AI, smart phones and other devices.
    - Overview of process involved in mass producing semiconductor chips.
    - Different semiconductor technologies
    - Major players involved in the semiconductor industry.
2. Semiconductor materials, growth and fabrication of devices.
    - Silicon gigascale integration
    - SiGe & III-V's
    - Solar cells
    - III-nitrides
    - Power electronics
    - Sensors

    Semiconductor device structure, design, growth, characterizations and device fabrication of the above applications will be dealt.

3. Advanced packaging and system design:
    - System-level integration,
    - Thermal management: modeling and technologies
    - Advanced packaging technologies (2.5D and 3D) and design considerations
    - Assembly and bonding
    - Thermal-electrical co-design considerations

Course Objectives:

The objectives of this course are:

- To highlight the importance and impact of semiconductor technologies in enabling modern electronic systems and applications.
- To provide essential knowledge of semiconductor materials, their properties, and their applications in electronic systems.

- To introduce evolving semiconductor growth, characterization, and fabrication techniques, ranging from epitaxial growth to van der Waals materials and device realization or prototype development.
- To develop an understanding of recent engineering advances in semiconductor packaging and system-level design.

Learning Outcomes:

At the completion of the course, the students should be able to

- Explain the situations that call for advanced semiconductor materials in the modern semiconductor industry.
- Describe the structure and operating principles of semiconductor devices.
- Explain semiconductor material growth methods
- Analyze and interpret results from common semiconductor characterization techniques
- Describe and demonstrate key semiconductor fabrication steps and processes.
- Explain advanced semiconductor packaging architectures and their impact on device performance.
- Prepare technical reports and documentation that conform to standard scientific and engineering writing conventions.
- Identify industry players and career pathways.

Grade Policy:

20% – Homework
10% - Reports
20% – Mini Project / Oral presentation
25% – Quiz I
25% – Final exam

Final Exam:

The final exam for this course will be held during the exam period assigned for the class.

Grading Scale:

The course will not be graded on a curve. Your final grade will be assigned as a letter grade according to the following scales:
A 90-100%
B 80-89%
C 70-79%
D 60-69%
F 0-59%

Course Expectations & Guidelines

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit
http://www.catalog.gatech.edu/policies/honor-code/ Or
http://www.catalog.gatech.edu/rules/18/.

Any student suspected of cheating or plagiarizing on an assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Attendance and/or Participation

Mandatory attendance for lectures. Quizzes and project presentations must be during the allotted time period. You may need to miss a portion of the course for valid reasons (e.g., sick, onsite interviews). For illnesses or personal emergencies, contact the Office of Student Life, as described in the policies at
http://www.catalog.gatech.edu/policies/student-absence-regulations/.
For Institute Approved Absences, we adhere to the Institute policies at
https://registrar.gatech.edu/info/institute-approved-absence-form-for-students.

Collaboration & Group Work

Homework submissions should be written and submitted separately by each student, but discussion with other students is allowed and encouraged within reason (e.g., students should still independently complete the work).
Quizzes must be done individually. Any collaboration on quizzes will be considered cheating (see the Academic Integrity section).
Semester projects will be done in groups of 3 people. Students are able to choose their own groups, and for those without a full group, I will randomly assign students together.

Extensions & Late Assignments

Assignments are due at the time listed in the schedule. There are no undocumented exceptions. If you have an emergency situation or a school sanctioned exception, please contact me before the due date so we can adjust your assignment deadlines (some documentation may be needed).

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect,

acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.