Fundamentals of Failure Mechanisms
ECE 8xxx
Course Syllabus

Summary:
Failure mechanisms in reliability engineering will be taught from a basic materials and defects point of view. The methods for predicting the physics of failure of devices, materials, components and systems are reviewed. The main emphasis will be given to degradation mechanisms (diffusion, electro-migration, defects, defect migration) through understanding the physics, and mechanics of such mechanisms. Failure mechanisms observed in electronic devices and electronic packaging will also be presented.

Course Instructor: Dr. Thomas Martin
Office: TBD
Office Hours: TBD
Work Number: 404-407-7490
Email: thomas.martin@gtri.gatech.edu

Credits: 3 lecture hours, letter grade, pass/fail, audit

Prerequisite: graduate standing

Course Texts: "Reliability Physics and Engineering" by J.W. McPherson, Published by Springer. ISBN 978-1-4419-6347 (2010). Edition 1 or 2

Course Notes and Assignments: Posted on Canvas. All solutions as well as the power point presentation of each lecture is presented.

Grading:

Homework	5%
Exam 1	20%
Exam 2	20%
Project	25%
Final Exam	30%

Homework turned in after the deadline will not be accepted
Makeup Exams - may be rescheduled for students having 3 or more Exams in a 24 hour period
Extenuating Circumstances will be handled on a case by case basis
Exams will cover reading assignments, homework, lecture presentations, and in class discussions

Course Objectives

As part of this course, students:

- Apply their knowledge of statistics to analyze device degradation
- Demonstrate their knowledge of microelectronics to identify and characterize failure mechanisms
- Apply knowledge of micro-electronic applications to analyze their failure effects on system performance
- Utilize their acquired knowledge to complete a team based project on evaluating a specific failure mechanism and associated design recommendations

Learning Outcomes

Upon successful completion of this course, students should be able to:

- Interpret accelerated life testing results to estimate device time to failure under normal operating conditions
- Predict microelectronics reliability based on failure mechanisms and associated stresses
- Recommend design/fabrication changes at device and/or system level to improve overall reliability
- Evaluate designs and identify potential reliability enhancements

Office of Disability Statement

https://disabilityservices.gatech.edu/

Academic Honor Code

http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code

Institute Absence Policy

http://www.catalog.gatech.edu/rules/4/

Date	Class Topic	Text Chapters
7-Jan	Introduction	Slides
9-Jan	Reliability vs Quality	Slides
14-Jan	Weibull and Lognormal PDFs	5,6
16-Jan	Failure Rate modeling / Bathtub Curve	7
21-Jan	Holiday	
23-Jan	Materials / Device Degradation	2
28-Jan	Time to Failure based on degradation	3,4
30-Jan	Stress Dependence / Activation Energy	8
4-Feb	Accelerated Degradation / Testing	9,10
6-Feb	Exam 1	
11-Feb	Electro migration	11
13-Feb	Time Dependent Dielectric Breakdown Mobile Ions/Surface Inversion	11
18-Feb	Hot Carrier injection Negative Bias Temperature Instability	11
20-Feb	Electro-Static Discharge Electrical Overstress	Slides
25-Feb	Mechanical Stresses in Materials	12
27-Feb	Creep and Fatigue Induced Failures	12
4-Mar	Stress Migration in Integrated Circuits	11
6-Mar	Corrosion in Integrated Circuits	11,12
11-Mar	Ionizing Radiation (Single Event Upsets)	Slides
13-Mar	Exam 2	
18-Mar	Break	
20-Mar	Break	
25-Mar	System Level Failure Mechanisms I	Slides
27-Mar	System Level Failure Mechanisms II	Slides
1-Apr	Failure Mode Effects & Criticality Analysis	Slides
3-Apr	Design for Reliability Considerations	Slides
8-Apr	Prognostics and Health Management	Slides
10-Apr	System Design Considerations	Slides
15-Apr	Present Projects	
17-Apr	Present Projects	
22-Apr	Summary of Course	Slides
4/25 - 5/2	Final Exam	