ECE4460 Course Syllabus

ECE4460

Introduction to Electronic Systems Packaging (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Swaminathan,Madhavan

Prerequisites
ECE 3030 [min C] or ECE 3040 [min C] or ECE 3710

Corequisites
None

Catalog Description
Introduction to packaging technologies, technology drivers, electrical performance, thermal management, materials, optoelectronics, RF integration, reliability, system issues, assembly, and testing.

Textbook(s)
Swaminathan & Engin, *Power Integrity Modeling and Design for Semiconductors and Systems*, Prentice Hall, 2007. ISBN 0136152066 (required)

Bakoglu, *Circuits, Interconnections and Packaging of VLSI*, Addison Wessley.(optional)

Tummala, *Fundamentals of Microsystems Packaging*, 2001.(optional)

Swaminathan and Han, *Design and Modeling for 3D ICs and Interposters*, World Scientific Publishing Company, 2013. ISBN 9789814508599(optional)

Oh & Yuan, *High Speed Signaling: Jitter Modeling, Analysis and Budgeting*, Prentice Hall, 2012.(optional)

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

1. Explain the difference between ICs and Packaging.
2. Calculate the impact of scaling on MOS Transistors and interconnects.
3. Calculate the capacitance, resistance and RC delays of interconnects.
4. Explain the fundamentals of packaging and different packaging technologies.
5. Design and model transmission lines in package substrates (PCB).
6. Design H-Tree clock distribution networks.

7. Explain the importance of power delivery networks for high speed signaling.
8. Design and model power delivery networks on PCB.
9. Explain the role of thermal management in high speed systems.
10. Calculate thermal resistances for a system and resulting junction temperature for transistors.
11. Design a PCB with ICs for high speed signaling that includes power delivery and make signaling and power supply noise measurements.

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (LN) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

Introduction
ICs and Electronic Packaging
Microsystems Integration
Basics of High Speed Signaling
Logic to Memory Communication
Chip to Chip Communication
Devices & Interconnects
Device and Interconnect Scaling
Interconnect Capacitance
Interconnect Resistance & RC Delays
Packaging & Signal Transmission
Fundamentals of Packaging
Signal Transmission
Transmission Lines and Matching
Clock Distribution Basics
Clock Distribution Design
Crosstalk
Channel Modeling & Design
Eye Diagrams & Jitter
Power Delivery

Power Delivery Engineering
Power Distribution Basics and Simple Relationships
Concept of Target Impedance
Power Distribution Components: Switching Regulators
Power Distribution Components: Capacitors
Power Distribution Components: Planes
Power Distribution Components: Low Drop-Out Regulator
Impedance calculations
Impedance and Simultaneous Switching Noise
Signaling and Power Supply Noise
Current Flow Paths & Simultaneous Switching Noise
Thermal Management
Conduction, Convection & Radiation
Thermal Materials
Thermal Calculations
Emerging Technologies