MSE6814: RELIABILITY ENGINEERING IN ELECTRONICS INDUSTRY

Effective Term
Semester B 2024/25

Part I Course Overview

Course Title
Reliability Engineering in Electronics Industry

Subject Code
MSE - Materials Science and Engineering
Course Number
6814

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
EE6614

Part II Course Details

Abstract

The course aims to let students acquire a fundamental understanding of the basic technology and applications of modern electronic packaging in consumer electronic products. The trend of packaging, starting from wire-bonding, taping-automatic bonding, flip chip solder joints, micro solder-bumps, and Cu-to-Cu direct bonding, as well as hybrid bonding, will be covered.
The course is designed so that the students can learn the basic concepts in circuit design of 3D IC in electronic packaging technology. Especially, the materials integration in printed circuit board, multilayered interconnections in back-end-of-line, redistribution layer, Si interposer, through-Si-vias will be covered. Device reliability issues such as electromigration, thermomigration, and stress-migration will be explained clearly. Because Joule heating is the most serious cause of yield and reliability in modern consumer electronic products, the so-called low power device means low entropy or low waste heat production device. For device lifetime prediction, the Mean-Time-To-Failure equations will be derived based on entropy production in irreversible processes. The ways to measure the parameters in the equations will be discussed.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize the difference between chip technology and packaging technology.		x		
2	Identify failure modes and its cause in modern electronic packaging technology.		x	x	
3	Perform failure analysis on electromigration, thermomigration and stress-migration.				x
4	Demonstrate independent ability to perform failure analysis as a failure engineer in electronic packaging industry.		x	x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will engage in formal lectures which follows the chapters in the textbook to gain knowledge about reliability engineering in electronics industry.	1, 2, 3, 4	3hrs/wk (for 11 wks)
2	Presentation and Tests	Students will give presentations on topics related to the course. Tests will also be conducted.	1, 2, 3, 4	3hrs/wk (for 2 wks)

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4	30	
2	#Assignments (min.:3)	1, 2, 3, 4	10	

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

Remark:
To pass the course, students are required to achieve at least 30% in continuous assessment and 30% in the examination.
may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task

Continuous Assessment (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Ability to analyze problems in advanced electronic packaging technology.
2. Ability to achieve failure analysis on electromigration, thermomigration and stress-migration in 3D IC technology.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal level

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

1. Ability to analyze the challenges of advanced packaging technology in details, from chip design to device fabrication to chip applications.
2. Ability to explain the engineering modern electronic packaging technology in 3D IC system.

Excellent

(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Continuous Assessment (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
1. Ability to analyze problems in advanced electronic packaging technology.
2. Ability to achieve failure analysis on electromigration, thermomigration and stress-migration in 3D IC technology.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal level

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
1. Ability to analyze the challenges of advanced packaging technology in details, from chip design to device fabrication to chip applications.
2. Ability to explain the engineering modern electronic packaging technology in 3D IC system.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal level

Part III Other Information

Keyword Syllabus

- Cu-to-Cu and Other Bonding Technologies in Electronic Packaging
- Randomly Oriented and (111) Uni-directionally Oriented Nanotwin Copper
- Solid-Liquid Interfacial Diffusion Reactions (SLID) between Copper and Solder
- Solid State Reactions between Solder and Copper
- Essence of Integrated Circuits and Packaging Design
- Performance, Power, Thermal and Reliability
- 2.5D/3D System-in-Packaging Integration
- Irreversible Processes in Electronic Packaging Technology
- Electromigration
- Thermomigration
- Stress-Migration
- Failure Analysis
- Artificial Intelligence on Electronic Packaging Reliability

Reading List

Compulsory Readings

	Title
1	Electronic Packaging Science and Technology by King-Ning Tu, ISBN: 9781119418313, John Wiely & Sons, Inc., 2021

Additional Readings

	Title
1	Nil