City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A in 2024/25

Part I Course Overview

Course Title:	Reliability Engineering in Electronics Industry
Course Code:	MSE6814
Course Duration:	One Semester
Credit Units:	3
Level:	P6
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	EE6614

Part II Course Details

1. 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.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Recognize the difference between chip technology and packaging technology.		✓		
2.	Identify failure modes and its cause in modern electronic packaging technology.		✓	✓	
3.	Perform failure analysis on electromigration, thermomigration and stress-migration.				✓
4.	Demonstrate independent ability to perform failure analysis as a failure engineer in electronic packaging industry.		✓	✓	
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

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.

3. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

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

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4				
Continuous Assessment: 40 %								
Tests (min.: 2)	✓	✓	✓	✓			30 %	
#Assignments (min.:3)	✓	✓	✓	✓			10 %	
Examination: 60 % (duration: 2 hrs , if applicable)								
Examination	✓	✓	✓	✓			60 %	
** The weightings should add up to 100%.*							100%	

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

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Continuous Assessment	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.	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Examination	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.	High	Significant	Moderate	Basic	Not even reaching marginal level

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Continuous Assessment	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.	High	Moderate	Basic	Not even reaching marginal level
2. Examination	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.	High	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1-5	Awareness on the knowledge and analysis tools as a failure engineer in electronic packaging industry. Applications of learned knowledge and skills for practical cases in modern electronic packaging technology.

Part III Other Information (more details can be provided separately in the teaching plan)

1. 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

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

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

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	Nil