City University of Hong Kong
Course Syllabus

offered by Department of Materials Science and Engineering
with effect from Semester A 2022/23

Part I Course Overview

Course Title:	**Forensic Engineering and Case Studies**
Course Code:	**MSE6305**
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)*	**AP6305 Failure Analysis and Case Studies (From the old curriculum)**
Exclusive Courses: *(Course Code and Title)*	**AP8124 Failure Analysis and Case Studies (From the old curriculum)** **AP7213 Failure Analysis and Case Studies (From the old curriculum)**

Part II Course Details

1. Abstract

To provide the students with an understanding of the various failure mechanisms in materials and to develop their ability in performing forensic engineering analysis of engineering components, through the study and practice on actual engineering failure cases.

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 and describe common engineering failure mechanisms.		✓		
2.	Generate the procedures for conducting forensic engineering investigation.		✓	✓	
3.	Innovatively evaluate the choice of instruments and methods of forensic engineering analysis.		✓	✓	
4.	Analyse failed engineering components using instruments.		✓	✓	✓
5.	Create a list of possible failure causes and generate a plan to discover the root cause of failure.		✓	✓	✓
6.	Appreciate the roles of parties and expert witness in criminal prosecution and civil dispute.		✓	✓	
** 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 self-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. Teaching and Learning Activities (TLAs)

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

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5	6	
Lecture	To cover basic concepts between failure mechanisms and causes.	✓	✓	✓		✓	✓	3 hours/week for 4 weeks
Discussion (internet)	Through technical communication, reinforce self-learning of aspects of forensic engineering analysis.	✓	✓	✓		✓		1 hour/week for 3 weeks
Laboratory	Analyse failed engineering	✓	✓	✓	✓	✓		3 hours/week

	components.							for 2 weeks
Case Studies	Simulate the forensic engineering process through real life cases.	✓	✓	✓		✓	✓	3 hours/week for 8 weeks
Mini-project	Evaluate forensic engineering work carried out by a certain party.	✓	✓	✓		✓	✓	3 hours/week for 2 weeks

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	5	6		
Continuous Assessment: 100 %								
Discussion (internet)	✓	✓	✓		✓	✓	10%	
Laboratory	✓	✓	✓	✓	✓		15%	
Case Studies	✓	✓	✓		✓	✓	20%	
Mini-project	✓	✓	✓		✓	✓	25%	
Tests	✓	✓	✓		✓		30%	
Examination: 0%								
** The weightings should add up to 100%.*							100%	

5. Assessment Rubrics

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

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Discussion (internet)	CAPACITY for SELF-DIRECTED LEARNING to research on failure cases and present the associated ideas	High	Moderate	Basic	Not even reaching marginal levels
2. Laboratory	ABILITY to EXPLAIN the fracture or failure, ABILITY to FORMULATE a failure analysis plan, and CAPACITY for SELF-DIRECTED LEARNING to analysis a sample using instruments	High	Moderate	Basic	Not even reaching marginal levels
3. Case Studies	ABILITY to EXPLAIN in DETAIL and with ACCURACY methods and results of failure analysis	High	Moderate	Basic	Not even reaching marginal levels
4. Mini-project	ABILITY to EXPLAIN in DETAIL and with ACCURACY the analysis of an expert report	High	Moderate	Basic	Not even reaching marginal levels
5. Tests	ABILITY to EXPLAIN the technical details of a failure case	High	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Discussion (internet)	CAPACITY for SELF-DIRECTED LEARNING to research on failure cases and present the associated ideas	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Laboratory	ABILITY to EXPLAIN the fracture or failure, ABILITY to FORMULATE a failure analysis plan, and CAPACITY for SELF-DIRECTED LEARNING to analysis a sample using instruments	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Case Studies	ABILITY to EXPLAIN in DETAIL and with ACCURACY methods and results of failure analysis	High	Significant	Moderate	Basic	Not even reaching marginal levels
4. Mini-project	ABILITY to EXPLAIN in DETAIL and with ACCURACY the analysis of an expert report	High	Significant	Moderate	Basic	Not even reaching marginal levels
5. Tests	ABILITY to EXPLAIN the technical details of a failure case	High	Significant	Moderate	Basic	Not even reaching marginal levels

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

1. Keyword Syllabus

Lecture

- General procedures of forensic engineering analysis, classification of failure sources
  Design deficiencies, material deficiencies, processing deficiencies, assembly errors, service conditions, neglect and improper operation.
- Methods and equipment for failure analysis
  Sample selection and treatment, equipment for materials examination, materials analysis equipment for forensic engineering analysis, commonly used NDT methods.
- Failure mechanisms
  Fatigue failures, fractography, effect of variables : part shape, type of loading, stress concentration, metallurgical factors, etc. Wear failures, adhesive, abrasive, erosive, corrosive wear. Corrosion failures, types of corrosion : uniform, pitting, selective leaching, intergranular, crevice, etc. Elevated temperature failures, creep, thermal fatigue, microstructural instability, oxidation.
- Roles of parties and expert witness
  Identification of parties involved in a forensic engineering case. Distinction between factual and expert witness. Criminal trial and civil dispute. Role of expert witness before and during legal proceedings.

Case studies

Examples of case studies : Failure investigation of an exploded gas cylinder. Failure of a chemical reactor. Failure of a high-power electrical cable. Broken rail analysis. Failure of multi-layer ceramic capacitors. Failure of copper-to-rail joint by 'Cadweld' joining. Failure of a passenger hoist. Electronic lead-tin solder joint failures. Failure of a rocker arm. Cargo lift failure.

Laboratory exercise

Examples of laboratory exercises:

SEM examination of a cross-section. SEM examination of a fracture surface.

Mini-project (role play)

Examples of mini-project : Gearbox housing accident. Failure of a laundry machine. Contaminations in LCD. Galvanizing vat accident. Failure of a drive shaft in an air-cargo handling vehicle.

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.)

N/A

2.2 Additional Readings

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

1.	D R H Jones, Engineering Materials 3 – Materials Failure Analysis: Case Studies and Design Implications, 1993. (CityU Lib Cat TA409 .J67 1993)
2.	D R H Jones, Failure analysis case studies: a sourcebook of case studies selected from the pages of Engineering failure analysis 1994-1996, Amsterdam ; New York : Elsevier, 1998. (CityU Lib Cat TA169.5 .F35 1998)
3.	J A Charles and F A A Crane, Selection and use of engineering materials, 2nd edition, Butterworths, 1989. (CityU Library Cat No TA403.C73.1989)
4.	Case histories in failure analysis, American Society of Metals, 1979. (CityU Lib Cat TA460.C33)
5.	C L Briant, Metallurgical aspects of environmental failures, Elsevier Science Pub, 1985. (CityU Library Cat No TA460.B69.1985)
6.	H P Block and F K Geitner, Machinery failure analysis and trouble shooting, Gulf Pub Co, Houston, Texas, 1983. (CityU Library Cat No TS191.B56.1983)
7.	J L McCall and P M French (ed), Metallography in failure analysis, Plenum Press, NY and London, 1977. (CityU Library Cat No TN689.2.S88.1977)
8.	W Brostow and R D Corneliussen, Failure of Plastics, Hanser Publishers. (CityU Lib Cat TP1087.F37)G E Dieter, “Engineering Design - A Materials and Processing Approach” (2nd ed.), McGraw-Hill (1991).