City University of Hong Kong
Course Syllabus

offered by Department of Physics
with effect from Semester B 2017 /18

Part I Course Overview

Course Title:	**Failure Analysis and Case Studies**
Course Code:	**AP8124**
Course Duration:	**One semester**
Credit Units:	**3**
Level:	**R8**
Proposed Area: *(for GE courses only)*	☐ **Arts and Humanities** ☐ **Study of Societies, Social and Business Organisations** ☐ **Science and Technology**
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)*	**AP6305 Failure Analysis and Case Studies** **AP7213 Failure Analysis and Case Studies**

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 failure analysis of engineering components, through the study and practice on actual engineering failure cases.

2. Course Intended Learning Outcomes (CILOs)

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 a failure investigation.		✓	✓	
3.	Innovatively evaluate the choice of instruments and methods of failure 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.		✓	✓	✓
		100%			

** If weighting is assigned to CILOs, they should add up to 100%.*

[#] Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.

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)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
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 failure analysis.	✓	✓	✓		✓		1 hour/week for 3 weeks
Laboratory	Analyse failed engineering components.	✓	✓	✓	✓	✓		3 hours/week for 2 weeks
Case Studies	Simulate the failure analysis process through real life cases.	✓	✓	✓		✓		3 hours/week for 8 weeks
Mini-project	Evaluate failure analysis work carried out by a certain party.	✓	✓	✓		✓		3 hours/week for 2 weeks

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5			
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

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 failure 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 failure 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.

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

N/A

2.2 Additional Readings

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).