Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Dr Alfred Tok Iing Yoong
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Course Title	Failure Analysis of Engineering Materials (Civil and Mechanical)
Course Code	MS6003
Academic Units	1
Contact Hours	13
Research Experience Components	

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

Failure Analysis is a critical aspect in all aspects of practical engineering, and is important in every field of engineering like mechanical, structural, civil, microelectronics, chemical etc. It is particularly important in mechanical and structural engineering, where the understanding of the causes and mechanisms of failure is crucial for designing safe and reliable structures and systems, for preventing repeat failures and for forensic purposes. Graduate engineers have been equipped with the fundamentals of materials science & engineering, mechanical structure design as well as materials / mechanical characterisation tools. These postgraduate courses thus aims to complement student's fundamental knowledge with the practical aspect of failure analysis.

These 2 courses are part of a Failure Analysis series that is proposed. Other potential courses will include: General Failure Analysis, Integrated Circuits, Electronics Packaging, Aerospace & Marine etc.

The Failure Analysis of Engineering Materials (Civil and Mechanical) course proposes to prepare engineers to analyse mechanical, structural & other failures related to civil structures like foundation materials, building structures, mechanical & electrical (M&E) facility infrastructure (eg. HVAC (heating, ventilation & air conditioning) systems), façade installations (eg. tiles) and mechanical components. Focusing on materials failure perspective, this will lead to an understanding of the shortcomings in design, materials selection, materials design and application of the failed materials and structures.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Understand basic and advanced observations of failed structures in Civil and Mechanical settings.
ILO 2	Learn to form failure mechanism hypotheses.
ILO 3	Design testing methods to test failure mechanism hypotheses and sub-hypotheses through materials characterisation.
ILO 4	Analysis and Documentation of Results. Analyse materials testing results in the context of the failure mechanism hypotheses. Comprehensive but succinct documentation and presentation of results.
ILO 5	Integrate various sub-hypotheses into a reasonable conclusion.

Course Content

- Introduction to Failure Analysis of Engineering Materials (Civil and Mechanical).
- Macroscopic and Microscopic observation skills, tools and techniques. Introduction to various macroscopic (eg. photographic) and microscopic (eg. polarized, brightfield etc) modes and techniques in observing failed components related to Civil and M&E Infrastructure.
- Understanding and probing case background & history.
- Deriving Materials Failure Hypotheses. Defining potential failure mechanisms based on macroscopic and microscopic examination results, coupled with understanding of basic materials failure mechanisms in the context of Civil and Mechanical components failures.
- Testing Materials Failure Hypotheses. Design of experiments or simulations to test the validity of hypotheses. This can include various mechanical testing methods and computer modelling / simulations. Issues surrounding testing of Civil and Mechanical components.
- Documenting Results / Analysis. Documentation of results / analysis / conclusions and recommendations for preventing similar failures in the future.
- Integration of Sub-Hypotheses into Conclusion. Based on the evidence gathered and the results of your tests, draw conclusions about the most likely cause or causes of the material failure.

Reading and References (if applicable)

1. Handbook of Materials Failure Analysis, With Case Studies from the Construction Industries, Makhlouf & Aliofkhazraei, Elsevier 2018.

2. Failure Analysis: Fundamentals and Applications in Mechanical Components, JL Otegui, Springer 2014.

3. Various industry case studies from practice (Unpublished, proprietary content will be provided in class).

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction to Failure Analysis – Civil and Mechanical	1-5	1-2	Online	Online class (live)
2	Macroscopic Observations / Case Background History / Deriving Materials Failure Hypothesis	1	1-2	Online	Recorded lecture
3	Microscopic Investigations	1	1-2	Online	Recorded lecture
4	Case Study 1: Visual Observations / Case History / Deriving Materials Failure Hypothesis / Microscopic & Macroscopic Investigations	1	3	Online	Online class (live)
5	Case Study 2: Visual Observations / Case History / Deriving Materials Failure Hypothesis / Microscopic & Macroscopic Investigations	2	3	Online	Online class (live)

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
6	CA1 (Brief and Q&A) – Individual Written Submission	1-2	3	Online	Online class (live)
7	CA1 Consultation	N/A	N/A	Online	Online class (live)
8	Materials Fracture	3	3	Online	Recorded lecture
9	Case Study 3: Materials Fracture	3	3	Online	Online class (live)
10	Materials Testing Methods / Analysis	4	1-2	Online	Recorded lecture
11	Case Study 4: Materials Testing Methods / Analysis	4	1-2	Online	Online class (live)
12	CA2 (Brief and Q&A) – Group Project Written Submission	1-5	3	Online	Online class (live)
13	CA2 Consultation	N/A	N/A	Online	Online class (live)

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Blended learning with active use of multi-media resources (TEL)	This will permit flexibility of access to learning materials, activities and assessments and can help you develop independent learning and critical thinking skills.
Showing real-world applications	Most of the concepts that are dealt in the course have real-world implications and applications. Therefore, they are used as examples while discussing the related concepts.
Weekly Consultation	Weekly consultation hours will be available to encourage discussions that will reinforce students' understanding on various concepts and applications. Instead of providing answers directly to students' queries, they will be guided to think and make intelligent guesses based on sound principles. This approach will cultivate critical thinking.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Report/Case study(Continuous Assessment 1 (CA1): Individual Project Written Submission)	1-2		60	Individual	Holistic	Multistructural
2	Continuous Assessment (CA): Report/Case study(Continuous Assessment 2 (CA2): Group Project Written Submission)	1-5		40	Team	Holistic	Relational

Description of Assessment Components (if applicable)

Continuous Assessment (CA) 1: Individual Project Written Submission
Individual Research Assignment (Report) on Failure Analysis Background, History, Macro Analysis and Hypothesis Derivation.

Continuous Assessment (CA) 2: Group Project Written Submission
Group Assignment (Report) on Failure Analysis Case integrating all components taught in the course.

Formative Feedback

- In-video tutorial classes and discussions / feedback during group presentations
- Grading and general feedback after each CA.
- You are encouraged to attend coordinator's consultation hours to clarify any doubts in the lecture and discuss any issues, if needed.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Problem Solving	Intermediate
Transdisciplinarity	Basic
Critical Thinking	Intermediate
Design Thinking	Advanced
Systems Thinking	Intermediate

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

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