

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

Course Overview

Expected Implementation in Academic Year (New format)	AY2026-2027
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1
Course Author * Faculty proposing/revising the course	Professor Chen Zhong & Dr Liu Tie
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Course Title	Failure Analysis in Marine Engineering
Course Code	MS6019
Academic Units	3
Contact Hours	39
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

This course aims to showcase the systematic investigation process for failure analysis (FA) in marine engineering, covering topics from the FA procedure to the materials principles behind failures, and recommendation towards failure prevention, etc. This is a platform on which you will be exposed to the most common types of failure in marine engineering and the failure mechanisms and learn how to apply the basic knowledge on materials science and engineering, and other engineering skills to carry out failure analysis in the real marine engineering cases. With proper understanding how and why the component/materials, the system, or the process failed, you will be able to make proper recommendation/suggestion to mitigate or prevent future failure. In some circumstances, there may be follow-up actions for insurance claim, arbitration, mediation, etc. This course intends to enhance your knowledge on failure mechanisms and application skills required as an MSE graduate and to increase your competitiveness in the job market.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Identify the most common structures/components/systems/processes in marine engineering and the associated challenges, potential risks, common failure modes and mechanisms
ILO 2	Plan/propose a proper scope of work and choose appropriate materials testing and characterization tools for failure analysis from an industry perspective
ILO 3	Perform cross analysis/evaluation of the data/results and the background information to determine the immediate and/or the root cause(s) of a failure
ILO 4	Make recommendation on the corrective actions based on the findings when necessary

Course Content

1. Introduction to marine structures/components/systems/processes and Failure Analysis in Marine Engineering: The roles of failure analysis and its general procedures in marine engineering.
2. Types of Failures and Failure Mechanisms in Marine Engineering: Various types of failures that occur in materials that are widely used in marine engineering, including corrosion, stress corrosion cracking, hydrogen embrittlement, fatigue/corrosion fatigue, etc., and their mechanisms.
3. Plan / Proposal: scope of work with consideration of technical & economic feasibility and availability of the necessary testing and characterization techniques, etc. for real failure case(s) from an industry perspective.
4. Root Cause Analysis and Prevention: Identifying the root cause of a failure by carrying out the proposed/planned scope of work, cross analysing and evaluating the data/results, reviewing the background information, and developing hypotheses through case studies. Recommendations to prevent or mitigate similar failures.

Reading and References (if applicable)

1. Construction of Marine and Offshore Structures, Ben C. Gerwick Jr., CRC Press, 2007
2. ASM Handbook Vol. 13, "Corrosion", ASM International, 1987
3. ASM Handbook Vol. 12, "Fractography", ASM International, 1987
4. ASM Handbook Vol. 11 "Failure Analysis and Prevention" & Vol. 11A "Analysis and Prevention of Component and Equipment Failures", ASM International, 2021
5. Metals Handbook "Failure Analysis and Prevention", Vol. 10 (8th ed.), ASM international, 1975

Note: The above listing comprises the foundational reading and references for the course and more up-to-date relevant reading and references will be provided when they become available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introduction to Marine Engineering; Introduction to common failure mechanisms in Marine Engineering	1	Online	Pre-recorded lecture (2 hr), consultation (1 hr), readings	Ref 1-5
2	Crevice Corrosion Failure: 1) Mechanisms & failure features 2) Case study – SS316L tube leaking Stress Corrosion Cracking Failure: 1) Mechanisms, failure features, materials properties 2) Case Study: cracking of Ni-based couplers on subsea equipment	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5
3	Galvanic Corrosion Failure 1) Mechanisms & failure features 2) Case study: CuNi seawater cooling system leaking Pitting Corrosion Failure 1) Mechanisms & failure features 2) Case study: stainless steel tube leaking on offshore platform	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
4	Fatigue Failure 1) Mechanisms & failure features 2) Case study: Cracking of a pipe fitting Corrosion Fatigue Failure 1) Mechanisms & failure features 2) Case study: Fracture of Al fan hub tube	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5
5	Continual Assessment 1 (CA1): Individual Mid-Term Quiz & Feedback	1-4	In-person	Continual Assessment 1 (CA1): Individual Mid-Term Quiz (1 hr), Feedback (CA answers and discussion) (2hr)	N/A
6	Continual Assessment 3 (CA3): Project Assignment Briefing & Discussion	1-4	Online	Continual Assessment 3 (CA3): Project Assignment Briefing & Discussion (3 hr)	N/A
7	Cavitation Corrosion 1) Mechanisms & failure features 2) Case Study: Cavitation corrosion of CuNi seawater cooling pipe Erosion Corrosion 1) Mechanisms & failure features 2) Case Study: Impingement attack on the disc of seawater backwash valve	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
8	Welding imperfections 1) Mechanisms & failure features 2) Case Study: stainless steel tube leaking due to welding imperfection Improper Repair Weld Failure 1) Mechanisms & failure features 2) Case Study: Weld cracking in the Hull Plate of a Ship	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5
9	Continual Assessment 3 (CA3): Project Assignment Consultation	1-4	Online	Continual Assessment 3 (CA3): Project Assignment Consultation (3 hr)	N/A
10	Microbiologically-induced-corrosion (MIC) failure 1) Mechanisms & failure features 2) Case study: MIC of a hot water pipe 3) Case Study: MIC of a seawater treatment package	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings	Ref 1-5
11	Continual Assessment 3 (CA3): Project Assignment Consultation	1-4	Online	Continual Assessment 3 (CA3): Project Assignment Consultation (3 hr)	N/A

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
12	Hydrogen Assisted Cracking (HAC) 1) Mechanisms of HAC & its features 2) Cast Study: subsea bolts under cathodic protection Hydrogen Embrittlement 1) Mechanisms & failure features 2) Hydrogen embrittlement of stud bolt due to improper plating	2-4	Online	Pre-recorded lecture (2 hr), consultation & IRAT (1 hr), readings Submission of Continual Assessment 3 (CA3): Project Assignment	Ref 1-5
13	Continual Assessment 2 (CA2): Individual Final Quiz & Feedback	1-4	In-person	Continual Assessment 2 (CA2): Individual Mid-Term Quiz (1 hr), Feedback (CA answers and discussion) (2hr)	N/A

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Flipped classroom (pre-recorded lectures) with consultation sessions	Lectures are pre-recorded. You are required to catch up or refresh necessary materials science and engineering knowledge to understand what are conveyed in this course. Help will be provided during the consultation session to assist you to learn how to integrate knowledges from different aspects of materials science and engineering in solving some intricate problems encountered.
Case studies	Case studies teach you the failure analysis procedure and analytical process through real engineering examples. You will also benefit through direct interaction with industrial expert in this area.
Project assignment	You will be assigned to analyse failure cases. During the process, you will collect information, hypothesize the root cause, and propose ways to verify your hypothesis. In the end, a failure analysis report will be submitted.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz(Individual Reading Assessment Tests (iRAT) - Weekly)	1-4		5	MCQ & Short-answer Questions	Individual	Holistic	Relational
2	Continuous Assessment (CA): Test/Quiz(Continual Assessment 1 (CA1): Individual Mid-Term Quiz)	1-4		25	MCQ & Short-answer Questions	Individual	Holistic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(Continual Assessment 2 (CA2): Individual Final Quiz)	1-4		30	MCQ & Short-answer Questions	Individual	Holistic	Multistructural
4	Continuous Assessment (CA): Project(Continual Assessment 3 (CA3): Project Assignment)	1-4		40	Project Report (based on Pre-assigned Case Studies)	Individual	Holistic	Relational

Description of Assessment Components (if applicable)

Formative Feedback

You are encouraged to approach the course instructor to clarify your doubts on the taught concepts and principles, to raise questions related to assignment topics. This interaction allows you to understand better what has been taught and to prepare yourself for the assessment. The discussions also enable the instructor to recognize where you are struggling and provide remedial measures to assist your learning.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Curiosity	Intermediate
Decision Making	Advanced
Problem Solving	Advanced
Information Literacy	Intermediate
Critical 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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