COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2023/24	**Semester**	1 & 2
Course Coordinator	Huang Weimin		
Course Code	MA4807		
Course Title	Marine Structural Integrity		
Pre-requisites	MA2001 Mechanics of Materials & MA2079 Engineering Innovation and Design (NA to Ex..Student)		
No of AUs	3		
Contact Hours	Lectures: 39 hours		
Proposal Date	April 2023		

Course Aims

This course focuses on analytical and predictive methods that are useful to the engineering designer in avoiding structural failure. Emphasis is placed on the ship structural failures resulting from excessive deformation, fracture, and fatigue. The operational loads on marine structures will be introduced and their effects on marine structures are analysed via appropriate failure analyses related to yielding, fatigue and fracture. The structural integrity design of welded structures will also be highlighted by virtue of its significance in ship construction assembly.

Intended Learning Outcomes (ILO)

Upon successful completion of the course, you should be able to:

1. Explain the operating loads on ship structures.
2. Analyse the effects of loads and stresses on ship structures.
3. Determine the bending and buckling loads of beams and plate structures.
4. Explain the fundamental concepts of fatigue and fracture mechanics for brittle and ductile fracture.
5. Perform failure analysis on marine materials subject to cyclic stress and strain loading.
6. Relate structural integrity design between welded structures and offshore structures.

Course Content

	Topic	Hours
1	**Introduction to Marine Structural Integrity** Definition of Structural Integrity; Structural Failures and Failure Modes; analysis tools for Failure Modes; examples of various types of structural failures: yielding failure, fracture failure, fatigue failure, and buckling failure. Ship design methodologies, rules and standards.	2
2.	**Loads and its Effects on Marine Structures** Static and Dynamic Loads on Ship Structure, Buoyancy and Weight Curves, Shipbuilding Material, Basic Ship Structural Components, Ship Structural Strengths, Longitudinal strength of ship on ship structure.	6
3.	**Bending and bucking of beam and plate structures** Total Potential Energy Theorem, Rayleigh-Ritz Method, Bending and Buckling of Beam-Columns, Derivations of plate equations and Methods of Solution, Buckling of Unstiffened Plates, Post Buckling Behaviour and Stiffened Plates.	10
4.	**Introduction to Fracture and Fatigue** Difference between fracture and fatigue, examples in marine structural design that require fracture and fatigue analysis, charts for analysis and comparison.	2
5.	**Fracture analysis** Definition of fatigue, brittle/ductile fracture, their corresponding fracture surfaces and stress versus strain relationship. Difference between the strain energy release rate and the critical strain energy release rate. Difference between stress intensity factor and critical stress intensity factor. Why K_{Ic} is commonly used and how to experimentally determine K_{Ic}. Correlation between fracture toughness and the Charpy impact strength. Irvin's modification of brittle fracture theory for ductile materials. Influential factors in brittle/ductile fracture, in particular the role of environmental temperature.	5
6.	**Fatigue analysis** Importance of fatigue. Different types of cyclic loading/fatigue. Stress versus number of cycle (S-N) curve and the endurance limit. Graphical method and formulas to determine fatigue failure. Fractography for failure analysis. Miner's rule for cumulative fatigue damage analysis.	5
7.	**Structural Integrity Design of welded structures** Main consideration of connection design. Reasons why welding, in particular fillet welding, are popular in marine structural integration. Quality control measure and quality inspection in welding. Welding calculation for static and cyclic loading.	6

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/ Individual	Assessment rubrics
1.Continuous Assessment 1 – Quiz 1	LO1,2,3	*SLO a, b, c*	20%	Individual	
2.Continuous Assessment 2 – Quiz 2	LO4,5,6	*SLO a, b, c*	20%	Individual	
3.Final Examination – Closed Book; 2.5hrs	LO1,2,3, 4,5,6	*SLO a, b, c*	60%	Individual	
Total			100%		

Formative feedback

As highlighted in the next section.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Online lectures augmented by a weekly face-to-face session.	A weekly face-to-face session with you will allow you to clarify doubts in your learning and we could also highlight examples and practical aspects of the course contents.
CA 1 & 2 and feedbacks	The CAs will motivate you to learn progressively. We will review the CA solutions with you to highlight common errors made by the class.
Final Exam	The final exam will motivate you to study thoroughly and in-depth in order for you to obtain a good grade for this course.

Reading and References

Textbook / References

1. S. Timoshenko & S. Woinowsky-Krieger, Theory of Plates and Shells, 2nd ed., McGraw-Hill, New York, 1959.

2. Richard W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th Edition, John Wiley, 1996.

3. Norman E. Dowling, Mechanical Behavior of Materials, International edition, Prentice Hall, 1993.

4. S. J. Maddox, Fatigue Strength of Welded Structures, Abington Publishers, 1991.

5. BS 7910:1999, Guidance on methods for assessing the acceptability of flaws in welded structures.

6. Background to new fatigue design guidance for steel welded joints in offshore structures, Department of Energy, UK, 1984.

Course Policies and Student Responsibilities

(1) You are to follow and complete the online lectures in accordance with the teaching schedule.
(2) You are expected to complete all the tutorial questions given to you for this course.
(3) You are encouraged to attend the face-to-face sessions to clarify your doubts in learning and tutorial questions, if any.
(4) You are to take all Continual Assessments (CA) for this course. If you are absent for the CA, a valid medical certificate must be produced and endorsed by the course coordinator before submitting it to the MAE Undergraduate Office.

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. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Ong Lin Seng	N3-02c-76	6790 5528	MLSONG@ntu.edu.sg
Huang Weimin	N3.2-02-11	6790 4859	MWMHUANG@ntu.edu.sg

Planned Weekly Schedule

Week	Topic (1 – 7)	Course LO	Readings/ Activities
1	Introduction to Marine Structural Integrity	ILO2, 4, 5	Online lectures
2	Loads and its Effects on Marine Structures	ILO1, 2	Online lectures Face to face session
3	Loads and its Effects on Marine Structures	ILO1, 2	Online lectures Face to face session
4	Bending and bucking of beam and plate structures	ILO3	Online lectures Face to face session
5	Bending and bucking of beam and plate structures	ILO3	Online lectures Face to face session
6	Bending and bucking of beam and plate structures	ILO3	Online lectures Face to face session CA1
7	Introduction to Fracture and Fatigue	ILO4	Online lectures Face to face session
8	Fracture Analysis	ILO4	Online lectures Face to face session
9	Fracture Analysis	ILO4	Online lectures Face to face session
10	Fatigue Analysis	ILO5	Online lectures Face to face session
11	Fatigue Analysis	ILO5	Online lectures Face to face session CA2
12	Structural Integrity Design of welded structures	ILO6	Online lectures Face to face session