Reg. No. 200604393R

COURSE OUTLINE

Academic Year	2018/19	**Semester**	1 & 2
Course Coordinator	Professor Pang Hock Lye John Assistant Professor Lau Gih Keong Dr Sellakkutti Rajendran		
Course Code	MA3002		
Course Title	Solid Mechanics and Vibration		
Pre-requisites	MA2001 Mechanics of Materials		
No of AUs	3		
Contact Hours	26 hours of recorded lectures 12 hours of tutorials		
Proposal Date	14 August 2018		

Course Aims

This core engineering course aims to introduce advanced analytical methods to solve problems in engineering mechanics such as elastic deformation, fracture mechanics, and effects of vibration on mechanical systems. You will use the concepts and skills learned in this course in your final year projects, and it is an essential foundation for professional engineers who will design and develop mechanical systems subject to fatigue and breakage.

Intended Learning Outcomes (ILO)

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

1. Calculate the stress and deformation within a structure and assess their failure modes.
2. Analyse and assess material performance in mechanical engineering applications.
3. Solve engineering vibration problems involving structures, machinery and vehicle by mathematical modelling.
4. Apply vibration theory to suppress or enhance vibrations encountered in machines.

Course Content
Energy method for Elastic Deformation (5 Hours) 1. The Principle of Virtual Displacements 2. Principle of Virtual Work 3.The Principle of Virtual Complementary Work 4. Energy Theorems & Unit Load Method 5. Virtual Strain Energy 6. Statically Determinate Structure 7. Statically Indeterminate Structure 8. Elastic Yielding Supports 9. Impact Loads **Fracture mechanics (5 Hours)** 1. Introduction 2. Linear Elastic Fracture Mechanic 3. Irwin's Theory of Fracture: Stress Intensity Factor and Typical Values of Fracture 4. Fracture Mechanics of Ductile Materials: Crack-Tip Opening Displacement(COD) 5. J-Integral, Correlation between Fracture Toughness and Impact Strength **Fatigue (4 Hours)** 1. Introduction 2.Types of Loads 3. Fatigue Test Methods 4. Test Data 5. Effect of Mean Stress 6. Micro-mechanism of fatigue 7. Crack Growth Rate 8. Fatigue Life Prediction 9. Variable Amplitude 10. Multi-axial loading **Vibration (12 Hours)** 1. Introduction to mechanical vibration; Free vibration of undamped systems 2. Damping; Damped free vibration 3. Forced vibrations under harmonic excitation; Rotating unbalance and base excitation 4. Vibration control and isolation; Transient forced vibration 5. Forced vibration of a 2-DOF system 6. Free vibration of a 2-DOF system; Natural frequencies and mode shapes

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
1.Final Examination (Restricted Open Book; 2.5hrs)	1, 2, 3, 4	EAB SLO* a – d, l	60%	Individual	
2.Continuous Assessment 1 (CA1): Quiz	1, 2	EAB SLO* a – d, l	20%	Individual	
3. Continuous Assessment 2 (CA2): Quiz	3, 4	EAB SLO* a – d, l	20%	Individual	
Total			100%		

Formative feedback

Solution guide is outlined either online or in a extra revision session post the quiz.

Feedback on your overall performance in quizzes and final examination are communicated to you through the course site in *NTULearn*.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	In the lecture, students learn the concepts and analytic methods for solving problems in advanced solid mechanics. This gives the background information and concept to achieve the learning outcomes 1-4.
Tutorial	Students will work on problem solving exercises while the tutor provides feedback and suggestions when students encounter difficulties with the solution method. This gives students an opportunity to practice the skills required in the learning outcomes 1-4.

Reading and References

1) P. P. Benham, R. J. Crawford and C. G. Armstrong, Mechanics of Engineering Materials, 2nd edition, Pearson Prentice H
2) R. F. Steidel, An Introduction to Mechanical Vibrations, 3rd Edition, John Wiley & Son, 1989, 1996. (Only Chapters 9, 19 and 20 are needed for this course.)

Course Policies and Student Responsibilities

(1) General

Students are strongly advised to self-study lecture materials and to attempt tutorial questions before the tutorial class. Lecture notes and tutorial solutions should be referred to.

(2) Compulsory Continuous Assessments

1. Continuous Assessment (40%) will be based on two quizzes, one to be conducted on the week before the Recess Week and the other to be conducted on the week prior the Revision Week. Quiz 1 topics will be from Part 1 Solid Mechanics. Quiz 2 topics will be from Part 2 Vibration.
2. Final Examination (60%) – Restricted Open Book; One double-sided A4-size reference sheet is allowed.

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
Pang Hock Lye John	N3.2-02-04	6790 4963	MHLPANG@ntu.edu.sg
Sellakkutti Rajendran	N3.2-02-49	6790 6891	MSRajendran@ntu.edu.sg
Lau Gih Keong	N3.2-01-17	6790 6825	MGKLAU@ntu.edu.sg
Seah Leong Keey	N3-02b-47	6790 4824	MLKSEAH@ntu.edu.sg
Shu Dong Wei	N3.2-02-19	6790 4440	MDSHU@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Principle of virtual displacements (for rigid bodies); Principle of virtual work (for deformable bodies)	1,2	Lecture Notes and Chapter 9 of P. P. Benham's textbook
2	Principle of virtual complementary work; Energy Theorems and Unit Load Method	1,2	Lecture Notes and Chapter 9 of P. P. Benham's textbook
3	Statically determinate and indeterminate structures; Elastic yielding supports and impact loads	1,2	Lecture Notes and Chapter 9 of P. P. Benham's textbook
4	Linear-elastic fracture mechanics. Griffith's Theory (G); Irwin's Theory, Stress intensity factor, Fracture Toughness	1,2	Lecture Notes and Chapter 19 (Sections 19.1-19.5) of P. P. Benham's textbook
5	Fracture mechanics for ductile materials; J-Integral Testing and Impact testing	1,2	Lecture Notes and Chapter 19 (Sections 19.6-19.9) of P. P. Benham's textbook
6	Fatigue loading, Fatigue Test	1,2	Lecture Notes and

	Methods, Data Analysis, Fracture mechanics for fatigue.		Chapter 20 (Sections 20.1-20.5) of P. P. Benham's textbook
7	Effect of Mean Stress, Micro-mechanisms of fatigue: initiation and propagation. Fatigue Crack Growth Rate Fatigue life prediction, Variable Amplitude, Multi-axial loads	1,2	Lecture Notes and Chapter 20 (Sections 20.6-20.9) of P. P. Benham's textbook
8	Introduction to mechanical vibration; Free vibration of undamped systems	3,4	Chapters 2 & 3 of Steidel's textbook
9	Damping; Damped free vibration	3,4	Chapters 6 of Steidel's textbook
10	Forced vibrations under harmonic excitation; Rotating unbalance and base excitation	3,4	Chapters 4 & 7 of Steidel's textbook
11	Vibration control and isolation; Transient forced vibration	3,4	Chapters 4, 7, 5 of Steidel's textbook
12	Forced vibration of a 2-DOF system	3,4	Chapters 9 of Steidel's textbook
13	Free vibration of a 2-DOF system; Natural frequencies and mode shapes	3,4	Chapters 9 of Steidel's textbook