國立清華大學
NATIONAL TSING HUA UNIVERSITY

PME 534400 Structural Dynamics | 結構動力學

Spring 2023

Instructor:
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Lectures: Wednesday 3, 4, noon (10:10-12:50) in Engineering Building I – 210
Office Hours: Appointment by email
Textbook: Lecture notes from the instructor
References: D. Wagg and S. Neild, *Nonlinear Vibration with Control*, Springer
L. Meirovitch, *Fundamentals of Vibrations*, McGraw Hill
L. Humar, *Dynamics of Structures*, CRC Press

Course Descriptions:
The understanding of dynamics and vibrations of structural systems is critical to design, analysis, and diagnosis of a variety of engineering systems. This course will cover the fundamental modeling approaches for structures and the methodology for analyzing their structural dynamics. Both analytical and numerical tools for analyzing the linear and nonlinear structures will be introduced. The specific course learning objectives are:

- Linear vibration theory: vibrations of single DOF oscillators and multi-DOF oscillators; modal analysis; reduced-order modeling.
- Nonlinear dynamics: nonlinear vibration phenomena; approximate analytical methods.
- Numerical tools for solving structural dynamics problems.

Course Objectives:
1. Introduce fundamental theories about analysis of structural dynamics.
2. Develop skills using MATLAB to perform analyses.
3. Develop ability to read technical papers and understand current research trends.

Exams:
An Exam will be given in the semester to test your familiarity of lecture materials.

Project:
Projects will be chosen by the students with approval from the Professor to explore additional advanced topics related to structural dynamics. The students are expected to (*a*) read technical papers and perform analyses, (*b*) prepare a presentation to summarize and defend the result, and (*c*) write a technical report.

Grades:
The course grade will be determined as follows :

Exam		40 %
Project	Written report	30 %
	Presentation	30 %

Minimum grades will be determined based on the suggested university grade scale, the course will be curved if necessary to improve the average:

Grade	Percentage		Grade	Percentage		Grade	Percentage		Grade	Percentage
A+ (4.3)	90 – 100		B+ (3.3)	77 – 79		C+ (2.3)	67 – 69		D (1.0)	50 – 59
A (4.0)	85 – 89		B (3.0)	73 – 76		C (2.0)	63 – 66		F (0)	1 – 49
A- (3.7)	80 – 84		B- (2.7)	70 – 72		C- (1.7)	60 – 62		X (0)	0

Note: You have one week from the time any homework, quiz or exam grade is posted to discuss with me any change in score after that **the score will not be changed**.

Course Outline:

1. Introduction of structural dynamics
2. Formulation of the equations of motion
3. Linear vibrations
    a. Analytical and numerical methods for solving single DOF system
    b. Analytical and numerical methods for solving multiple DOF system
    c. Modal analysis
    d. Reduced order modeling
4. Nonlinear dynamics and vibrations
    a. Nonlinear vibration phenomena
    b. Numerical tools for analyzing nonlinear dynamics
    c. Approximate analytical methods for analyzing nonlinear vibrations

Tentative Schedule (subject to change)

Week	Lecture topics	Note
W1	Introductions of course and syllabus Formulation of equation of motion	
W2	Formulation of equation of motion	
W3	Linear vibration – SDOF system (free vibration)	Submission of project topic
W4	Linear vibration – SDOF system (forced harmonic vibration)	
W5	Linear vibration – SDOF system (general periodic loading)	
W6	Linear vibration – SDOF system (general dynamic loading)	
W7	Linear vibration – SDOF system (general dynamic loading), Multi-DOF system (free vibration)	
W8	No class this week - Children's Day, Tomb Sweeping Festival, Intercollegiate Activities)	
W9	Linear vibration – Multi-DOF system (free vibration)	
W10	Project meeting	Discussion with the professor on the progress of the project
W11	Linear vibration – Multi-DOF system (free vibration)	
W12	Linear vibration – Multi-DOF system (forced vibration)	
W13	Reduced order modeling	Submission of the draft report
W14	Nonlinear vibration – Introduction	
W15	Nonlinear vibration – Numerical method	
W16	Project presentations and discussions	
W17	Project presentations and discussions	
W18	Exam	Submission of the final report