Mechanical Vibrations (FMEN11) 7.5 credits, HTLP2, 2019

Course literature: (l) Lidstr6m P. Lecture Notes on Mechanical Vibrations. Division of Mechanics, LTH.
(2) Lidstr6m P. Mechanical Vibrations Exercises. Division of Mechanics, LTH.
Alternative course literature: Gérardine M. and Rixen D. Mechanical Vibrations Theory and Application to Structural Dynamics, John Wiley & Sons Ltd.
Hand out material including hand-in examination tasks.

Teacher: Oleksandr Gutnichenko (Lectures, exercise sessions)
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Timetable: http://www.mek.lth.se/education/fmen11/

Home page: http://www.mek.lth.se/education/fmen11/

Plan for Lectures and Exercise sessions

	Weekly curriculum (Preliminary):		Chapter in Lecture Notes	Chapter in Gérardin Rixen
w1	November 4 - November 8			
	Lecture 1:	Course objective. Examination. Introduction. Equations of motion. External and internal forces. Constraints. d`Alembert's principle.	1-3	1
	Lecture 2-3:	Lagrange's method. Conservative and non- conservative forces. Dissipation. Energy balance. Stability. Linearization. The equation of motion for a vibrating mechanical system.	4-11	1, 2.1
	Exercise session 0:	Homework: Introductory exercises. (1 , 2, 5a, 6, 7, 8, 9 and 10)	Recapitulation	
w2	November 11-15			
	Exercise session 1:	Equations of motion. Linearization.		
	Lecture 4:	Un-damped vibrations. Classical normal modes. Un-damped vibrations. Forced vibrations.	12	2.2-2.4
	Lecture 5:	Mechanical Admittance. Resonance. Anti-resonance.	12	2.5-2.9
	Exercise session 2:			
w3	November 18-22			
	Lecture 6:	Un-damped vibrations. Normal frequency characterization. Rayleigh quotient. Minimax principle. Constrained systems. Damped vibrations. Diagonalization with normal modes.	13-15	2.10-3.1
	Lecture 7:	Rayleigh-damping. Non-proportional damping. Damping mechanisms. Damped vibrations. Forced vibrations.	15-17	3.1
	Exercise session 3:	Damped vibrations.		
w4	November 25-29			
	Lecture 8:	Damped vibrations. Complex modes. State space formulation. Damped vibrations. Transfer function. Frequency response function.	18-19	3.2
	Lecture 9:	Site visit		
	Exercise session 4:	Damped vibrations		
w5	December 2-6			
	Lecture 10:	Continuous systems. The vibrating string. Continuous systems. One-dimensional bodies.	20-21	4.1-4.5
	Lecture 11:	he vibrating bar. Wave propagation. Continuous systems. The vibrating beam	21	4.5
	Exercise session 5:	Continuous systems. String, bar and beam.		
w6	December 9-13			
	Lecture 12:	Continuous systems. The two-dimensional body. Continuous systems. The vibrating membrane and the vibrating thin plate.		
	Lecture 13:	Approximate methods. Rayleigh-Ritz method.		
	Exercise session 6:	Continuous systems. Beam, membrane and plate. Rayleigh-Ritz		
w7	December 16-20			
	Lecture 13:	Applications and Summary		
	Exercise session 7:	Applications and Summary		
	Written examination: Thursday, December 19, 08:00-13:00, MA:10A-B			

Course objectives:

The objectives of this course are to present the theory of Mechanical Vibrations in multi-dimensional systems with applications to machine and structural dynamics. The student will have the opportunity to engage in relevant problem solving techniques and to discuss the topic with peers.

Course contents:

Topics presented at lectures and in "Lidström P. Lecture Notes on Mechanical Vibrations".
Exercises and hand-in examination tasks.
The scope of the course is defined by the curriculum above and the lecture notes "Lidström P. Lecture Notes on Mechanical vibrations". Course material (1) and (2) may be purchased at the Division of Mechanics at a total cost of 200 SEK.

The teaching consists of Lectures and Exercise sessions:

Lectures: Lectures will cover the topics of the course in accordance with the curriculum above. In connection with the lectures it is possible to discuss problem solving techniques.

Site visit: One lecture is in the form of a mandatory site visit to workshop. Detailed information will be distributed via e-mail to course participants.

Exercise sessions: Problems for the Exercise sessions are found in "Lidström P. Mechanical Vibrations Exercises" and the student is recommended to study these tasks, especially those recommended below. During the Exercise sessions the student will have the opportunity to discuss problem-solving techniques with the teacher and peers. Both exercises as well as hand-in examination tasks may be discussed.

Recommended exercises:

1:2	2:2	3:3	4:1	5:2	6:5
1:7	2:5	3:7	4:2	5:8	6:7
1:10	2:9	3:8		5:9	6:10

Examination:

The examination consists of the following parts (for more details, see separate sheet):
1. Solutions to 3 hand-in examination tasks. Students work in pairs with the hand-in examination tasks, handing in one set of solutions per task. The hand-in examination tasks will be published on the course homepage. An additional task will be distributed to the students not attending the mandatory site visit.

Dates for handing in examination tasks:

Examination task 1: Wednesday, November 20

Examination task 2: Wednesday, December 4

Examination task 3: Wednesday, January 8, 2020 (may be handed in by e-mail)

Final deadline, Friday, January 10, 2020

2. Written examination containing five (5) tasks focusing on the theoretical parts of the course content covered by the recommended exercises in chapters 1-5 and Rayleigh-Ritz, as well as hand-in examination tasks 1-3. Total possible score 5x3p = 15 p.

Written examination date: **Thursday, December 19, 2019, 08:00 - 13:00, MA:10A-B.**

Grade requirements:

Grade 3: Correct solutions to hand-in examination tasks with 80% correctly solved. Site visit attendance or additional task. Written examination with 50% of the tasks correctly solved (7.5p).

Grade 4: Correct solutions to hand-in examination tasks with 80% correctly solved. Site visit attendance or additional task. Written examination with 67% of the tasks correctly solved (10p).

Grade 5: Correct solutions to all hand-in examination tasks. Site visit attendance or additional task. Written examination with 83% of the tasks correctly solved (12.5p).