Course plan for SE2134 Dynamic Problems in Solid Mechanics 7.5 credits (VT 2019)

Intended learning outcomes

Why should I study this course?

A large number of structural failures in machinery and even in electronic assemblies happen due to undesirable vibrations or other transient (time-dependent) effects. These effects can be caused by external factors, such as impact, for example, or by the internal factors, such as components of the product at some operational modes. Therefore, a dynamic analysis is an essential part of the product development process in a number of industries. Conducting such an analysis, interpreting the results and making necessary design improvements require certain skills, which are exceptionally rare among engineers and are in demand by the industry. This course will help you to gain some of these skills and to build an analytical foundation for advancing further in this field.

Not yet convinced? Here is a simple fact: over 90 % of the students taking Solid Mechanics program at KTH face dynamic problems already during the Master's thesis work.

What will I be able to do after the course?

After the course, you should be able to

- formulate the problems and present the solutions using terms, concepts and vocabulary of the course;
- construct a model for representing a structure with single and multiple degrees of freedom;
- use analytical methods to solve dynamic problems in solid mechanics after appropriate model simplification;
- analyze and interpret the results of dynamic analyses;
- carry out comprehensive dynamic analyses of thin beams and plates, which constitute a very broad class of engineering structures;
- use numerical finite element analysis to determine natural frequencies and modes of an arbitrary 3D structure;
- perform harmonic analyses of an arbitrary 3D structure with finite element method;
- perform spectrum and random vibration analyses of an arbitrary 3D structure with finite element method;
- modify the structural design to avoid undesirable vibrations,
- lead and participate in the projects in the competitive environment,
- communicate complex topics related to the course with a general audience.

Eligibility

Course equivalent to SE1010 or 4C1020 or SE1055, SE1025. Differential Equations and Transform Methods I or/and II.

Course registration

The course should be available to self-registration, which needs to be completed by the first deadline for submitting the homework.

Lector and examiner

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Teaching assistant

Recitations and correction of home assignments: Bugra Ucel (ucel@kth.se).

Offered by

SCI/Solid Mechanics

Version

Course plan valid from: Spring 13
Examination information valid from: Spring 13

Course literature

1) **Olsson, M., Kulachenko, A. "Dynamics of solid – a primer", KTH, 2014.**
2) "Solid Mechanics Handbook", Solid Mechanics, KTH, 2015.
3) Timoshenko, S., Young, D., Weaver, W., "Vibration Problems in Engineering", Wiley-Interscience; 5+ edition, 1990+.

The first two books can be bought at the Student Office of the Solid Mechanics Department.

Here are the snippets from students' reviews of the course material conducted in 2012:

Student 1: *"Timoshenko book was, in my opinion, one of the best course books I have read."*
Student 2: *"Timoshenko's book was great, a lot of good examples. The compendium was also good but not so complete."*
Student 3: *"The Timoshenko book was of a great use when solving the home assignments and I have learnt a lot from it!"*
Student 4:"*Timoshenko's book is great, and the Compendium provides an introduction to each area of interest.*"
Student 5: "*Timoshenko's book was really helpful and easy to follow while the handbook was maybe too dense. However, both books together make a good literature for the course from my point of view.*"

Another optional book is:

4) Thorby, D., Structural dynamics and vibration in practice: an engineering handbook, Butterworth-Heinemann, 2008.

Lectures

The content of the lectures is structured assuming that you come to the class after reading the corresponding material in the book. In other words, we will rarely repeat what is already written in the books during lectures but rather discuss and complement the presented content. We will make sure that you understood the material in its entirety by considering the application of the theory to the realistic problems and addressing typical misconceptions. We will use peer-teaching methodology and student response system Socrative. In order to participate in class activities interactively, please, take a device having Internet access or install a mobile application Socrative Student.

Iphone: https://itunes.apple.com/us/app/student-clicker-socrative/id477618130?mt=8
Android: https://play.google.com/store/apps/details?id=com.socrative.student&hl=sv
Windows: https://www.microsoft.com/sv-se/store/apps/socrative/9wzdncrdjm42
Web-based (any device): https://b.socrative.com/login/student/

Further instructions will be given at the lectures.

Seminars

In the seminar, we will discuss your questions relevant to the course. First, you form groups of approximately 6 students and create a challenge for another group. Being in one of the active groups is mandatory in this course. The active group should consist of minimum 3 students and all of them should be present at the seminar.

The challenge can be about certain phenomena or theoretical aspects. The questions are reviewed prior to being revealed to another group of your fellow students, who should answer the question and prepare a short presentation on this topic.

An example of such a challenge is "Explain how skyscrapers can survive earthquakes?" or "What has been done to prevent a new Takoma bridge disaster?" Several questions can be submitted at a time but only one will be chosen.

The answers should be presented in a pedagogical manner using the course vocabulary. The teaching team will select the best presentation and provide the reasoning behind the decision shortly after the seminar. The decisions will be delivered separately to each team.

The members of the winning group will have a possibility to select between answering to the theoretical question and solving the problem during the exam. This means that by scoring in either of these two tasks they can raise the grade by two steps. The extra point acquired through the seminar will only be granted in case you show up on the exam and submit the correct solution to the problem or properly answer the theory question.

Note, there would be just one presenter from each group, and this person will be selected randomly. Make sure all your team members are competent enough to deliver a high-quality presentation. If your team received the Best Presentation Award, but you were not present at the seminar, you would not be entitled to the benefits associated with the victory. The students, who are unable to attend the seminar for a legitimate reason, can exchange the mandatory participation in the seminar to providing a detailed and original written report on the seminar topic.

Recitations

We will have 6 recitations in the course. During them, you will be exposed to a great variety of problems. The problems will be revealed before each recitation so that you can prepare and try to solve them yourself. We will mostly focus on the first essential steps of problem solving, namely, analysis and mathematical formulation. Attending the recitations is highly recommended for improving the problem-solving skills and succeeding at the exam.

Home assignments

Your grade will be partly based on the completion of homework. We will have three home assignments, each containing three problems. The assignments will be distributed before weekends and should be submitted within two following weeks.

We expect you to present the solutions with your own words regardless of whether you worked on the solution alone or in a group with other students. The assignment is submitted in two stages. The first submission is not graded but is required to be eligible to submit the final version, which will be graded. The quality of the first submission should be sufficient in order to qualify for eligibility. It means the solution of the attempted problems should contain, at least: 1) an analysis; 2) a detailed plan of the solution; 3) a mathematical model in the form of equations of motion with appropriate boundary conditions. Only the attempted and approved problems are qualified for the final submission.

The use of Matlab, Maple or Mathematica is encouraged. The focus of the assignment will be on taking the abstraction step and analyzing the result. The solutions should be thoroughly commented. The expectations regarding the written presentation are higher than for the exam. Submitting 2 of 3 home assignments is required for the admission to the exam.

Plagiarism and copying will be rigorously tracked and subjected to disciplinary measures according to KTH policy. You may work in a team on the home assignments, but you should submit an individual, original solution composed solely by yourself. In case we have doubts about the solution of certain tasks, you can be asked to present the it orally before the teaching team. If the offer to present the solution within the given interval is declined, it will not be accepted, and grades as failed.

The exact deadlines for the first and second submissions as well as the submission guidelines are stated per "Home assignment submission guidelines and deadlines", which is to be found on the course homepage. The submissions not complying with the guidelines or submitted after the deadlines will be rejected.

Make sure you distribute the work load wisely to avoid unnecessary hassle before the deadlines.

Laboratory work

Two laboratory works will be carried out in the commercial finite element software ANSYS. At the end of each session, you will be requested to submit answers to questions about the lab. Pass/fail evaluation will be used. Attending the laboratory works and getting the approval of the answers to the lab questionnaire are required for admission to the exam.

Participation in the laboratory works is mandatory in the course. You are expected to form the groups of 3-4 students and the responses to the lab questionnaire should be submitted from the entire group with clearly stated members.

Examination

The grade will be formally assigned to the exam. Upon successful completion of all the 9 problems from the home assignments, both laboratory works and the seminar, you will be awarded the grade **B**. Completing 8,7,6 problems will give you **C**, **D**, **E** respectively. Higher grades can be acquired through an open-book exam. The written exam will consist of one problem and one theory question (short exam). Completing each exam question will raise your grade by a step (from **F** to **E** and so on). The grade can also be improved through re-examination. Re-examination will consist of five problems and one concept question (long exam).

Note 1: The examiner does not guarantee that the grade acquired through the homework will be available prior to the exam.

Note 2: The examiner reserves the right to request an oral completion of the answer to the theory question presented in the exam.

Oral completion of the answer to the theory question on the exam

In a case of an incomplete answer to the theory question or in a case when the answer contains redundant information, which raises doubts about knowledge of the subject, we provide an opportunity to defend the answer through an oral completion. The students will receive an invitation to the oral completion by an e-mail. The oral completion should take place within 7 working days after sending the invitation. Students will be allowed to use books or lecture notes preparing to the answers. The oral completion should not take more than 30 minutes including the preparation time. Refusal to attend the oral completion within the stipulated period of time will abolish the possibility to get an extra point for the answer to the theory question.

Supplementary information

We will run a group on Facebook where we will post and discuss interesting links and information. The participation in the group is optional.

Summary

We encourage everyone to take an active part in the course and do the best in every activity in encompasses. To a large degree, the grade will be deterred by your homework.

You get the minimum grade **E** if you:

1) Complete 2 labs (mandatory).
2) Participated in the seminar (mandatory).
3) Submit 2 original home assignments (mandatory) in which you get all the 6 problems correct with 1 allowed resubmission per homework.

You get the maximum grade **A** if you:

1) Complete 2 labs (mandatory).
2) Participated in the seminar (mandatory).

Scenario#1:

4) Submit 3 original home assignments in which you get **8** of **9** problems correct with 1 allowed resubmission per homework.
3) Go to the exam, solve a problem and answer a theoretical question correctly at the exam.

Scenario#2:

4) Submit 3 original home assignments in which you get **all 9** problems correct with 1 allowed resubmission per homework.
5) Go to the exam and either solve a problem or answer a theoretical question correctly at the exam.

Students, who are among the best presenters, are entitled to an additional point according to rules described in the section concerning the seminar.

Detailed timetable and important dates

Presented in separate documents.