ME-426

Micro/Nanomechanical devices

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Cursus	Sem.	Type
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.
Microengineering minor	H	Opt.
Microtechnics	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

In this course we will see an overview of the exciting field of Micro and Nanomechanical systems. We will go over the dfferent scaling laws that dominate the critical parameters, how size affects material properties, how these devices are manufactured, designed and later used.

Content

The idea of this course is to give a full view of the field of MEMS/NEMS mostly from a mechanical engineering standpoint. The course will be divided into the following sections:

1. ***Introduction - Scaling laws:*** we will briefly see the where does the interest on this devices stems from. Reduction of dimensions not only to fit things into small places.
2. ***Fabrication:*** Briefly, we will study how these devices are manufactured and how this departs from the more typical (classical) way of machining.
3. ***Static deflection:*** due to forces, due to surface stress and/or temperature changes, and due to acceleration.
4. ***Normal modes calculation:*** normal modes calculation (frequencies and mode shapes), mechanical nonlinearities.
5. ***Material properties:*** We will analyze if and how material properties depend on the size of the fabricated device.
6. ***Quality factor:*** The fundamental damping sources for small mechanical resonators will be analyzed, including thermoelastic damping, anchor losses, and stress-based dissipation dilution.
7. ***Transduction:*** Since these devices are very small, the usual ways of detecting and creating motion cannot be applied anymore. We will briefly study the different options with their advantages and disadvantages.
8. ***Noise:*** A study of how noise appears in these systems will be performed.
9. ***Applications:*** The different applications of these devices will be briefly reviewed.

Keywords

- NEMS/MEMS
- Nanomechanics
- Quality factor
- Nonlinear dynamics

Learning Outcomes

- Explain the advantages of NEMS/MEMS in basis of scaling laws Analyze micro- and nano-mechanical systems Deduce behaviour of NEMS/MEMS both in static and dynamic mode Estimate nonlinear limits Estimate energy loss mechanisms Perform simulations to model these systems Recognize the different transduction mechanisms Analyze and design assemblies of simple mechanical elements in the framework of static and buckling, S2 Carry out Predict

and optimize the vibration behaviour of multiple-degree-of-freedom or continuum systems, S3 Apply the models for the behaviour of composite materials to compute the respnse of simple composite structures, S7

- Participate and contribute to class discussions on scientific articles

Transversal skills

- Summarize an article or a technical report.
- Demonstrate the capacity for critical thinking

Teaching methods

- Ex catedra - recorded videos
- Exercises on the form of Scientific Works discussion

Assessment methods

- In the exam period, written exam (100%).

Supervision

Office hours	Yes
Assistant.e.s	Yes

Resources

Bibliography

http://www.springer.com/us/book/9783319286891
(Available for free from EPFL - electronic copy)

Ressources en bibliothèque

- Find the references at the Library

Moodle Link

- https://go.epfl.ch/ME-426