Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title:	Mechanical Vibrations
Course code:	47506
Scientific sector:	ING-IND/13
Degree:	Master in Industrial Mechanical Engineering Major Mechanics and Automation
Semester:	I (winter semester)
Year:	II (second year of master)
Academic year:	2021-2022
Credits:	5 ECTS
Modular:	No
Total lecturing hours:	28
Total lab hours:	10
Total exercise hours:	8
Attendance:	Recommended
Prerequisites:	Fundamentals of mechanics learned in bachelor degree studies of mechanical engineering
Course page:	See Online Learning Environment ole.unibz.it
Specific objectives:	Understanding and knowledge of the fundamentals for both the theoretical as well as the experimental sides of mechanical vibrations. This includes the mathematical modeling of dynamical problems, the solving of these derived mathematical models and understanding of the results. Furthers, the students will gain practical experience of mechanical vibrations in a laboratory environment.

Lecturer	Dr.-Ing. Erich Wehrle
Scientific sector of lecturer:	ING-IND/13
Language of instruction:	English
Office hours:	See timetable online: www.unibz.it/en/timetable/ and by appointment
Teaching assistant (T.A.):	N.N.
Office hours of T.A.	See timetable online: www.unibz.it/en/timetable/ and by appointment

List of topics covered:

Introduction, review and preliminaries
- Modeling of dynamic systems
- Free-body diagrams
- Analytical mechanics

One-degree-of-freedom systems
- Undamped free vibrations
- Damped free vibrations
- Forced vibrations
- Shock
- Transient responses

Multiple-degree-of-freedom systems
- Undamped free vibrations
- Damped free vibrations
- Forced vibrations
- Shock
- Transient responses

Continuous systems
- Vibrations of beams
- Modes of beams

Applied aspects in design and analysis
- Design optimization with mechanical vibrations
- Sensitivity analysis considering vibrations
- Finite-element analysis with mechanical vibrations

Experimental vibration measurement
- Measurement of vibration responses
- Introduction to laboratory equipment and software
- Sensors including accelerometers
- Sampling and filtering
- Set-up and carrying out dynamical experiments

Teaching formats: Frontal lectures, hand-calculation exercises, computer exercises, laboratory exercises, group project

Learning outcomes:

Knowledge and understanding

1. Knowledge and understanding of the fundamentals of

mechanical vibrations.

Applying knowledge and understanding

2. Applying knowledge and understanding to analyze dynamical components, structures and systems.

Making judgments

3. The structural-mechanical design under consideration of dynamical considerations including vibrations requires understanding and ability to make judgments based on theory and experiments

Communication skills

4. Communication skills to convey and transfer understanding of mechanical vibrations.
5. Communication skills to explain results of dynamical analysis and their consequences to structural-mechanical design

Ability to learn

6. Learning skills to independently study the specific fields of mechanical vibrations for applications beyond this lecture.

Assessment:

Formative assessment:

Form	Details	Learning outcomes assessed
In-class exercises	Continuously in exercise courses	1, 2, 3, 4, 5

Summative assessment:

Form	Part	Details	Learning outcomes assessed
Written exam	2/3	2 h	1, 2, 3, 4, 5
Group project	1/3	Teams of two students, practical project based on laboratory experiments culminating in a written report (ca. 5–15 pages) and a presentation (ca. 15 min)	1, 2, 3, 4, 5, 6

Assessment language: English

Evaluation criteria and criteria for grade:

The written examination will include analytical and numerical examples to show ability to solve problems of mechanical vibrations as well as knowledge-based questions to show understanding of the material. The test does not allow any material (e.g. no calculators, no books, no notes) and allows two hours to complete. It consists of short-answer questions and

problem sets.

The project is carried out in groups of two, although groups of three or individual projects will be considered after approval from the lecturer. This is an independent project following the didactic principle that knowledge should not only be transferred to students but also generated by the students. The students have the possibility of choosing a topic of their own interest within the wide field of mechanical vibrations, whereby the exact topic and scope is to be agreed upon with the lecturer. The students also have the option of taking an interesting topic assigned by the lecturer. This can be a theoretical, simulation-based, experimental or a project combining these. The grade for this will be based upon a the report and a fifteen-minute presentation.

Form	Evaluation criteria and weight
Written examination (2/3)	Theoretical knowledge (35%) Correctness of methods (30%) Correctness in solution (30%) Appropriate use of units (5%)
Group project (1/3)	Understanding of project goals (10%) Correctness of methods (30%) Correctness in results (30%) Communication of results (30%)

Required readings:

Notes taken during lecture

Compendium of lecture notes: updated continuously during course of semester, see Online Learning Environment ole.unibz.it for up-to-date version.

Supplementary readings:

See Online Learning Environment ole.unibz.it for supplementary material to be provided during the course of the semester

Rao, S. S. (2019) *Mechanical Vibrations* (6th edition SI version) Springer.

Schmitz, T. L. and Smith, K. S. (2012) *Mechanical vibrations*, Springer.

Den Hartog, J. P. (1985) *Mechanical Vibrations*, Dover.

Magnus, K., Popp, K., Sexto, W. (2013) *Schwingungen: Physikalische Grundlagen und mathematische Behandlung von Schwingungen*, Springer.

Giovagnoni, M. (2009) *Analisi delle vibrazioni nei sistemi meccanici*, Edizioni Libreria Cortina.