Vibration Engineering

Aims: Knowledge of the interaction of forces and movements of mechanical systems and the interplay of potential energy and kinetic energy. Modeling, simulation and optimization of dynamical systems and mechanisms.

Prerequisites: Statics, dynamics, differential equations, matrix analysis

Model-building by the principles of Newton and of Lagrange. Linearization of nonlinear systems by Taylor series. Model representation in time domain and frequency domain. Analytic solution of linear differential equations by Laplace transformation. Efficient numerical solution of nonlinear differential equations by single-step (Runge-Kutta-Fehlberg) and multi-step methods (Adams-Bashfort) with step-size control. Principles of differential-algebraic systems (DAE).

Free and forced vibrations of undamped and damped systems with one, two and more degrees of freedom. Effects of different damping phenomena. Approximation and interpolation of harmonic and non-harmonic excitations, Fourier approximation. Introduction of matrix calculus: Eigen-analysis. Decoupling of system equations by analytical modal analysis. Realisation and visualization of modal forms by experimental modal analysis.

Design of vibration isolators and vibration absorbers, critical speeds of rotating shafts and disks. Passive versus active vibration suppression.

Continuous systems and their design by finite element analysis: Beams, membranes, plates and shells. Introduction to nonlinear vibration and acoustics.

Computer aided analysis with standard engineering spreadsheets: Maple, Mathematica, Matlab. Symbolic and numerical solutions, graphical visualization of large amount of data.

Credits: 4

Location and Time: W–1.07, Tue 4–7 pm

Examination: written (90 min), assessment by marks

Lecturer: Dr. Dieter Kraft