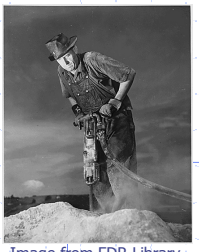


Image from FDR Library and Museum

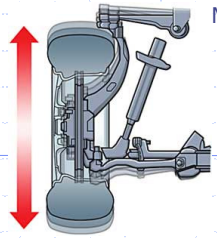


Image from Hunter Engineering Co.

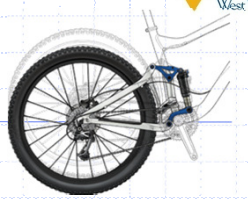


Image from Giant Bicycle Inc.

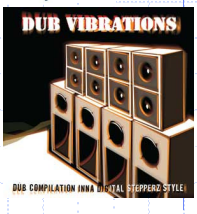


Image from dub-connection

Introduction to Mechanical Vibrations

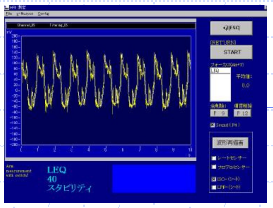


Image from A-Tech Instruments Ltd.

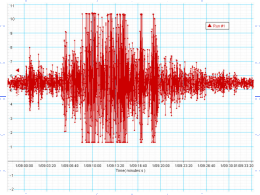


Image from Sound by Singer

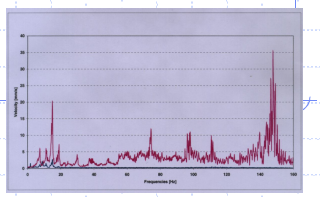


Image from E. Klingelé

Vibration

- Vibration is the study of:

  the repetitive motion of objects relative to a stationary frame of reference or nominal position (e.g., the equilibrium position)
- Vibration is an important factor in many designs:
  - Products that break if they vibrate too much:
    - Buildings and bridges
    -
    -

Vibration

- Products that can't be used if they vibrate too much:
  - Power/machine tools
  - Robots
  -
- Products that customers don't like to vibrate too much:
  - Seat for automobile/tractor/airplane
  -
- Products that have to vibrate in a specific way:
  -
  -
  -

Free vs. Forced Vibration

- Free Vibration vs. Forced Vibration
  - Free Vibration

    All **interfaces** of the body with the environment **are static**.
  - Forced Vibration

    At least one point of the **body** is **subjected to periodic forces** or displacements.

SDOF vs. MDOF Systems

- In a Single-Degree-of-Freedom (**SDOF**) System we study the motion of a rigid body in **one direction**.

The motion may be **rectilinear** or **rotational**.

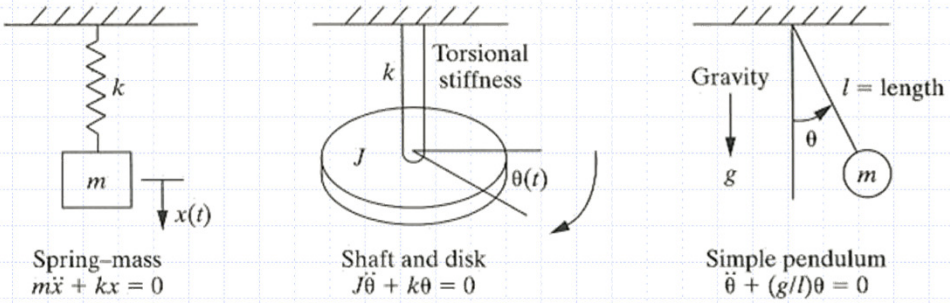
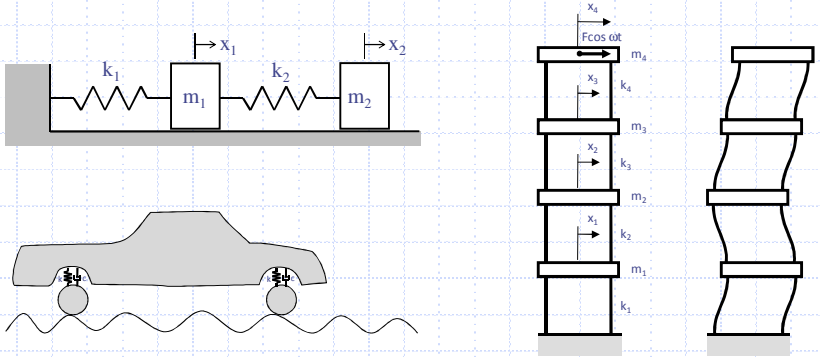


Image from D Inman, *Engineering Vibration*.

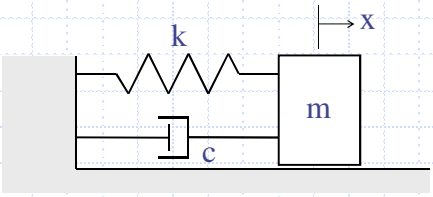
SDOF vs. MDOF Systems

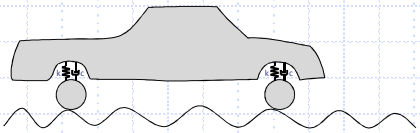
- In a Multi-Degree-of-Freedom (**MDOF**) System we study the independent motions of **multiple rigid bodies** or one rigid body in **multiple directions**.

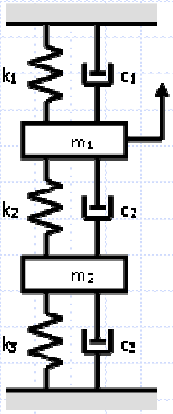


Discrete vs. Continuous Systems

- A **discrete system** has rigid (lumped) masses connected by massless, flexible members (e.g., massless springs and dampers)

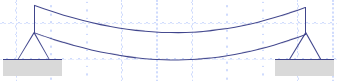






Discrete vs. Continuous Systems

- A **continuous system** has flexible members whose distributed mass is significant to the vibrations



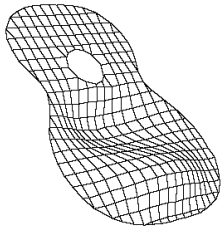


Image from www.jeffkemp.com

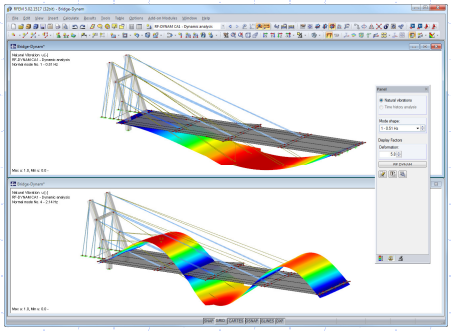


Image from Dlubal Software GmbH

Spring-Mass System

Spring-Mass System

- Solving differential equation

Spring-Mass System

- How do we find A and ϕ?

Graphing $x(t)$

Working with Vibration Amplitudes

- If we have any two of:
  - Natural frequency =
  - Displacement amplitude =
  - Velocity amplitude =
  - Acceleration amplitude =

then we can get the other two.

Vibration Nomograph

- Use it to specify limits on vibration:
  - Frequency
  - Displacement amplitude
  - Velocity amplitude
  - Acceleration amplitude