1. Introduction to Vibrations

MECH 463: Mechanical Vibrations

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Suggested Readings:

1. Topic 1 from notes package.
2. Sections 1.1–1.6 in the course textbook.

Your Notes

1.1 Learning Objectives

1. Understand the importance of vibrations in mechanical design and learn about force and energy perspectives.

2. Identify degrees of freedom of a mechanical system.

3. Identify different types of vibrations and vibration analysis procedures.

4. Apply principle of superposition (in this and later topics).

5. Develop lumped parameter models (in this and later topics).

Your Notes

1.2 Why study vibrations? (T 1.3, NP 1.2)

Fill in the class

Your Notes

1.3 What is vibration? (T 1.4.1, NP 1.3)

Any fluctuating motion about an equilibrium or an operating point is a vibration.

Fill in the class

Your Notes

1.4. Why should a mechanical system vibrate? (T 1.4.2, NP 1.4)

Consider the example of a simple pendulum, comprising a rigid mass suspended by a string or a metal wire, sketched below.

Fill in the class

Your Notes

Force Perspective on Vibrations — # 1

Q: What brings the pendulum back to equilibrium after initial displacement?

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Your Notes

Force Perspective on Vibrations — # 2

Q: Once it is brought to equilibrium why does the pendulum swing through to the other side? Why can't it just creep back to equilibrium and stay there?

Fill in the class

Your Notes

Energy Perspective on Vibrations — # 1

Fill in the class

Your Notes

Learning Points — # 1

1. Vibration can be viewed as an energy exchange mechanism in which potential energy is continuously transformed into kinetic energy, and vice versa, in a periodic manner.

2. Vibration is an interplay between inertial and restoring forces.

3. All *realistic* vibrations involve dissipative forces as well.

4. Free body diagrams are useful to understand vibration problems.

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 1

The number of degrees of freedom (dof) of any mechanical system in motion is defined as the **minimum** number of **independent** co-ordinates required to determine completely the position of all its parts during motion.

Q: What are the dofs a particle and rigid body, if we constrain their motion to a plane?

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 2

Compound Pendulum:

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 3

Double pendulum

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 4

Four-bar mechanism:

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 5

Rolling of a rigid circular disc on a flat surface:

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 6

Rigid cantilever beam:

Fill in the class

Your Notes

1.5. Degrees of Freedom (T.1.4.3, NP1.5) — # 7

Flexible cantilever beam:

Fill in the class

Your Notes

Learning Points — # 1

1. Kinematic constraints on motion—imposed by supports and other objects in contact— influence the number of degrees of freedom.

2. The choice of co-ordinates is not *unique* and it is *subjective*.

3. Rigid body assumption is essentially a constraint: the distance between two points on the body is always fixed during its motion.

4. Distributed parameter (continuous) systems such as beams and plates require infinite number of dofs to completely specify their motion.

5. Discrete systems require finite number of dofs.

Your Notes

Next Lecture — # 1

1. Revise this material.

2. Read the sections 1.6–1.8 from the course package and the corresponding text book sections.

3. Drop me a note on how this session went for you.

Your Notes