ME 301
Theory of Machines I

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1. Introduction and Basic Concepts

Introduction and Application Examples
Definitions
Degree of Freedom
  Kutzbach Formula
  General Equation
  Exceptions
Grübler’s Equation
Kinematic Inversion
Enumeration
Basic Definitions

**Machine:** A self contained assembly of components that transmits / modifies energy to perform or assist a specific task.

- It has an energy source (input / prime mover / motor)
- It accomplishes a well defined task (output / work)

**(Mechanical) Machine:** Mechanical forces of nature, accompanied by motion, are compelled to do the work (task).

**Theory of Machines:** An applied science used to understand / generate motions of parts of the machine and the forces that produce / accompany these motions.
Various Phases of Machine Design

- Satisfying motion transmission requirements
- Calculation of driving force(s) and accompanying reactions (internal forces)
- Satisfying dynamic requirements (smooth operation, control of vibration, noise)
- Satisfying strength and rigidity requirements
- Satisfying economic, ergonomic, esthetic, safety requirements
Mechanics

Mechanics concerned with the behavior of bodies/matter under the action of forces

Solid Mechanics

- Mechanics of Deformable Bodies (Strength of Materials)
  - Statics
  - Kinematics
- Mechanics of Rigid Bodies
  - Dynamics
  - Kinetics

Fluid Mechanics

- Mechanics of Rigid Bodies

Matter is assumed to be a continuous distribution of infinitely many infinitesimal particles (continuum approximation)!
Definitions

**Kinematics of machinery** deals with the motion transmission characteristics in isolation from forces. Also named as *Mechanisms*.

**Mechanism** is a group of rigid bodies (**links**) connected to each other by rigid joints (**kinematic pairs**) having the purpose of motion transmission.

**Link**: A rigid body (a body that does not change its shape and size under the action forces (**an idealization**) that has rigid kinematic elements.

**Kinematic Pair / Joint**: Two or more kinematic elements joining two or more links permitting certain relative motion between the links, (unlike the ‘**joint**’ in ME 307 Machine Elements!)
Mechanism

• It is a group of rigid bodies (*links*) connected to each other by rigid kinematic pairs (*joints*) to transmit force and motion.

• It is a kinematic chain where **one of the links is fixed**.

• A mechanical machine is defined as a combination of resistant bodies so arranged that by their means the mechanical forces of nature can be compelled to do work accompanied by certain determinate motion\(^1\).

_Mechanisms are the basic building blocks of mechanical machines. A machine is designed for a specific task using appropriate mechanisms._

\(^1\) Reulæaux, Kinematics of Machinery, 1876
Examples

Reciprocating Air Compressor

Two-Stroke Internal Combustion Engine
Examples

Slider-crank mechanism

Kinematic Diagram
Examples

Windshield Wiper
Examples

Crank-Rocker Four Bar Mechanism
Examples

Physical Examples of Instructor

Six short asynchronous lectures.

Examples in the textbook pp. 5-9

https://ocw.metu.edu.tr/pluginfile.php/3958/mod_resource/content/19/ch1/1-2_2.htm
https://ocw.metu.edu.tr/pluginfile.php/3958/mod_resource/content/19/ch1/1-2_3.htm
https://ocw.metu.edu.tr/pluginfile.php/3958/mod_resource/content/19/ch1/1-2_4.htm
https://ocw.metu.edu.tr/pluginfile.php/3958/mod_resource/content/19/ch1/1-2_5.htm

Similar to above but in Turkish


Slides 15-21, 24-28, 43