Mechanics and Machines, Lecture 3

Types of drives: kinematics, where to find other info

Drives: friction, belts, chains, gears, universal, geneva

Innopolis University

Goal of the lecture

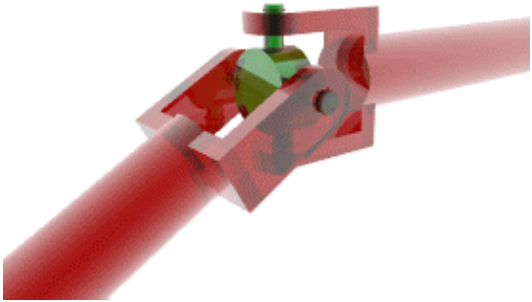
Make an overview of typical drives.

Give a hint how to work with it.

Explain how to find information about particular drive.

Universal Joint

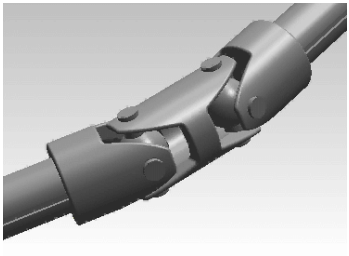
Visualisation



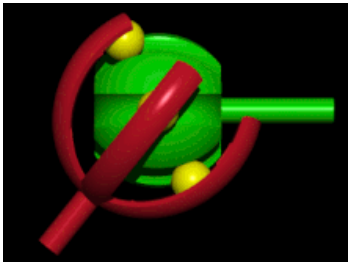
Universal Joint

Types of universal joint

Cardan



Double cardan joint



Constant-velocity universal ball joint

Universal Joint

Drive kinematics (1)

Angle relationship — $\tan(\psi) = \tan(\psi')\cos(\beta)$

Angular velocities relationship —

$\omega\cos(\beta) = \omega'(\sin^2(\psi) + \cos^2(\psi)\cos^2(\beta))$

Universal Joint

Features and facts

- It’s effective tool for transferring a torque for max 30 degrees.
- Constant-velocity universal ball joint (шрус) is not a small device and it’s not easy to find it (it can be found as a car detail).

Universal Joint

What can be interesting to find (queries)

1. Correlation between velocities and angle between links in Universal joint
2. Cardan dynamics

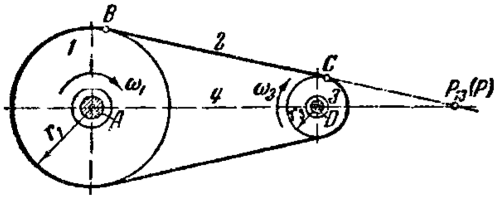
Universal Joint

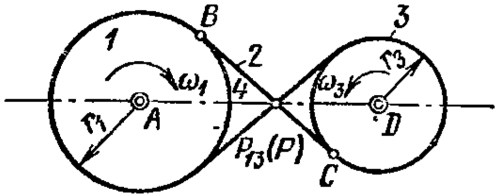
Reference material

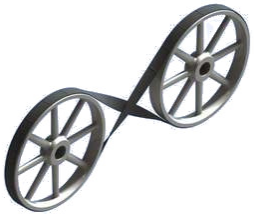
1. **Other names**: cardan joint, Hooke's joint, кардан, универсальный шарнир
2. Universal joint (wiki)
3. *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 168–172*
4. Find U-joint parameters using quaternions
5. Dynamics of universal joints

Belt

Visualisation

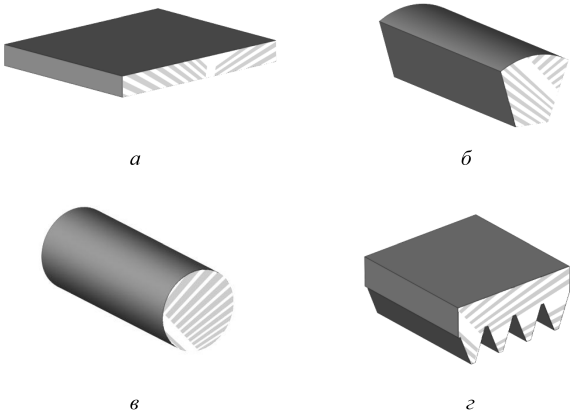






Belt

Types of belts



а) flat (плоская), *б*) vee belt (клиновидная), *в*) round (круглая), *г*) timing (toothed, зубчатый)

Belt

Drive kinematics (1)

- Linear velocity of a pulley — $v_1 = \omega_1 \frac{d_1}{2}$, d — diameter of a pulley (шкив)
- Length of pulley — $l = 2a + \frac{\pi}{2}(d_1 + d_2) + \frac{(d_2 - d_1)^2}{4a}$, where a — distance between center of pulleys.

Belt

What can be interesting to find (queries)

- How to find the appropriate diameter of a pulley
- Min and max distance between pulleys
- Appropriate angle of covering the pulley

Belt

Features and facts

- Simple design and operation, relatively low cost.
- Smooth and quiet operation due to elasticity belt.
- Possibility to transfer power over long distances (with V-belts up to 15 m) at speed up to 100 m/s.
- Softening of vibrations and shocks due to elasticity of the belt.
- Possibility to protect machines from overloading due to elastic belt tension and slippage
- Reduced requirements for axle alignment shafts.

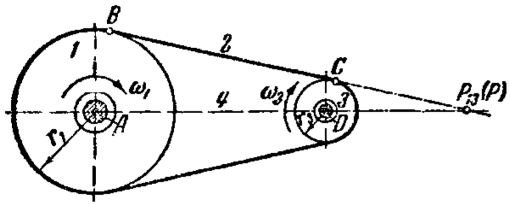
Belt

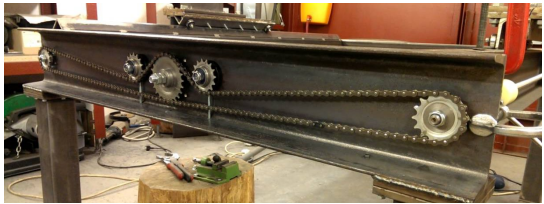
Reference material

1. **Other names**: ременная передача
2. Belt drive (wiki)
3. *”Теория механизмов и машин” Артоболевский И. И. 1988, pdf pages 166–168*
4. Детали машин. 9 лекция
5. Belt formulas

Chain

Visualisation





Chain

Types of chain transmissions

Chain

Drive kinematics (1)

Chain

Drive kinematics (2)

Chain

What can be interesting to find (queries)

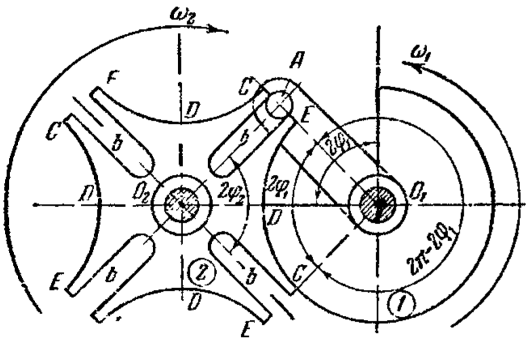
Chain

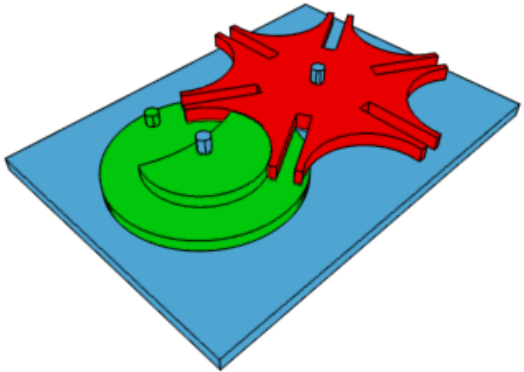
Reference material

1. **Other names**: цепная передача
2. Roller chain (wiki)
3. *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 166–168*
4. Детали машин. 10 лекция
5. Sprockets & Chains For Engineers

Geneva drive

Visualisation





Geneva drive

Types of geneva drive

Geneva drive

Drive kinematics (1)

Geneva drive

Drive kinematics (2)

Geneva drive

What can be interesting to find (queries)

Geneva drive

Reference material

1. **Other names**: мальтийский крест
2. Geneva drive (wiki)
3. *”Теория механизмов и машин” Артоболевский И. И. 1988, pdf pages 172–174*
4. How to draw a geneva drive

Friction drive

Visualisation

Friction drive

Types of friction drive

Friction drive

Drive kinematics (1)

Friction drive

Drive kinematics (2)

Friction drive

What can be interesting to find (queries)

Friction drive

Reference material

1. **Other names**: фрикционная передача
2. Friction drive (wiki)
3. *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 141–146*
4. Детали машин. 22 лекция, 2 страница
5.

Gears

Visualisation

Gears

Types of Gears

Gears

Drive kinematics (1)

Gears

Drive kinematics (2)

Gears

What can be interesting to find (queries)

Gears

Reference material

1. **Other names**: зубчатая передача
2. Gears (wiki)
3. *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 145–166*
4. Детали машин. 5-8 лекции
5. *"Design of machinery" Robert L. Norton, pdf pages 517–557* **2.0 — 2.11**

Ballscrew

Visualisation

Ballscrew

Types of ballscrew

Ballscrew

Drive kinematics (1)

Ballscrew

Drive kinematics (2)

Ballscrew

What can be interesting to find (queries)

Ballscrew

Reference material

1. **Other names**: шарико-винтовая передача
2. Ball screw (wiki)
3. *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 166–168*
4. Детали машин. 10 лекция
5.

Reference material

- *"Mechanisms and Machines: Kinematics, Dynamics, and Synthesis" Michael M. Stanisic, pdf pages 21–56* **1.1 — 1.6**
- *"Theory of Machines and Mechanisms" John J. Uicker, pdf pages 33–59* **1.4 — 1.7**
- *"Design of machinery" Robert L. Norton, pdf pages 57–79* **2.0 — 2.11**
- *"Механика. Теория механизмов и машин" Конищева О. В., pdf pages 7–23*
  Структурный анализ и классификация плоских механизмов
- *"Теория механизмов и машин" Артоболевский И. И. 1988, pdf pages 21–63*
  Структурный анализ и классификация механизмов

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