# Machine Components 2
# Moodle examination from SS 2020

time to finish: 60 min.

## 1. Springs (18 Min.)

A combination of 2 helical springs is given as shown (not drawn to scale).

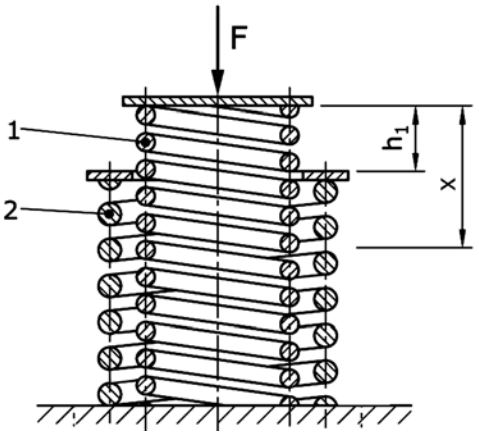
Given:

Number of active turns $i_2 = 0{,}5 * i_1$

Spring wire diameter $d_2 = 1{,}5 * d_1$

Coil diameter $D_2 = 1{,}5 * D_1$

distance $h_1 = 10\text{mm}$




a) to be determined: spring rate $c_2$ of spring 2, if $c_1$=12 N/mm is given for spring 1. [36 N/mm]

**Continue calculating with the following (independent from your result in a)):**

**$c_1 = 10$ N/mm, $c_2 = 3c_1 = 30$ N/mm**

To be determined:

b) the spring forces $F_1$ and $F_2$ of the two single springs, if $x = 3 * h_1$, as well as the overall spring rate c at the end of this suspension path. [300 N; 600 N; 40 N/mm]

c) the deflection $x_0$, if the torsional stress in both springs 1 and 2 is equal. What total force $F_0$ is acting in that case? [40mm; 1300 N]

## 2. Durability of antifriction bearings (10 Min.)

The front wheel hub of a man´s bicycle is equipped with two ball bearings, which both have a catalog load rating of 1000 N each. The weight of the bicycle is 16 kg, the driver weighs 100 kg, incl. baggage. The total mass is distributed by 2:3 in ratio of front- to rear-wheel. The circumference of the wheels is 2100 mm.

a) What overall distance $s_H$ in km can be expected with this bearing arrangement until the nominal operating life time is reached? Give also the result for $L_{h10}$ ! [178000 km]

b) What overall distance $s_D$ in km can be reaches with a ladies´ bicycle, if the load to the front wheel is reduced by 20% (all others remain unchanged)? [348000 km]

c) Give reason, why those operational life times are never reached with ordinary bicycles.

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## 3. Spur gear dimensioning (10 Min.)

After a heavy overload all teeth of an old single-stage spur gear are broken and the wheel body is destroyed. Only at the (larger) wheel 2 it can be seen that it had $z_2 = 39$ teeth and the dedendum circle (root) diameter was $d_{f2} = 146$ mm. The center-to-center distance has been established to $a = 118$ mm.

To be determined:

a) Re-design of the gearing data for a replacement (gears with straight teeth without profile shift):

Module m in mm

Number of teeth $z_1$

Addendum circle (outside) diameter $d_{a1}$, $d_{a2}$ in mm

[4mm; 20; 88mm; 164mm]

b) How could an alternative set-up of a new gear-train be arranged to reduce the noise during operation.

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c) What kind of damage is possibly risked with this alternative gear-train, if everything else remains unchanged (give reasons)?

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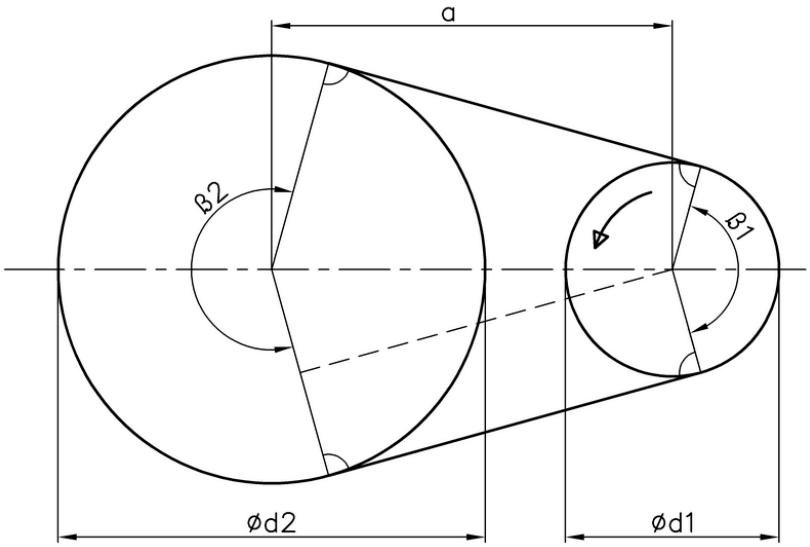
# 4. Flexible element drive (22 Min.)




Given is the sketched flat belt drive:

Center-to-center distance: a = 350 mm

Effective disc diameter $d_1$ = 200 mm; $d_2$ = 400 mm

Permissible belt tensile force in the tight side: $R_{zul}$ = 1100 N, friction coefficient μ = 0,45

Eytelwein equation for the belt tensile forces $R_2 > R_1$; $R_2/R_1 = e^{\mu ß}$

All others (centrifugal forces, loss of efficiencies, slippages, etc.) to be neglected!

To be determined:

a) Angle of wrap $ß_1$ and $ß_2$ in degrees [°] [146,8°; 213,2°]

**Continue calculating with $\beta_1$=150° (independent from your results in a)):**

b) Belt tensile force $R_1$ in the slack side and the maximum transmissible torque $T_{1max}$ at the driving disc 1, if the maximum permissible belt tensile force $R_{max} = R_2$ in the tight side is used to full capacity. [339N; 76,1Nm]

c) during assembly of the belt: necessary preload force $R_0$ in the belt and the resulting total force $F_R$ to the discs. [719N; 1390N]

d) Give both an advantage and a disadvantage of a flat belt versus a timing belt:

Advantage:_____

Disadvantage:_____

e) Give both an advantage and a disadvantage of a flat belt versus a V-belt:

Advantage:_____

Disadvantage:_____