Principles of Engineering

Unit 1.1.5 – Mechanisms - Gears, Pulley Drives, and Sprockets

Mechanisms used to transfer energy through _____ motion.

Change the _____ of rotation.

Change the _____ of rotation.

Change the amount of _____ available to do work.

Gears

A gear train is a mechanism used for transmitting rotary motion and torque through interlocking _____.

A gear train is made when two or more gears are _____.

_____ gear causes motion.

Motion is transferred to the _____ gear.

Mating gears always turn in _____ directions.

An _____ gear allows the driver and driven gears to rotate in the same direction.

Mating gears always have the same size _____ (diametric pitch).

The rpm of the larger gear is always _____ than the rpm of the smaller gear.

Gears locked together on the same shaft will always turn in the _____ direction and at the _____ rpm.

Gear Ratios

Variables to know:

n = _____ d = _____ ω = _____ (speed) τ = _____

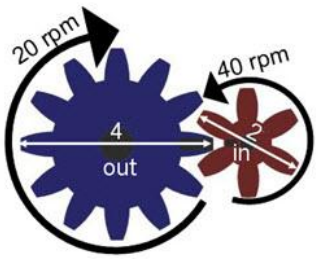
*** Subscripts **in** and **out** are used to distinguish between gears ***

n_{in} = _____ n_{out} = _____

d_{in} = _____ d_{out} = _____

ω_{in} = _____ ω_{out} = _____

τ_{in} = _____ τ_{out} = _____



Equations to know

GR = Gear Ratio

GR = MA

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}} = \frac{\tau_{out}}{\tau_{in}}$$

$$\frac{?}{1} \quad \frac{12}{6} \quad \frac{4in.}{2in.} \quad \frac{40rpm}{20rpm} \quad \frac{80\,ft-lb}{40\,ft-lb}$$

$$\frac{2}{1}$$

Gear Ratios

What is the gear ratio between gear A and B?

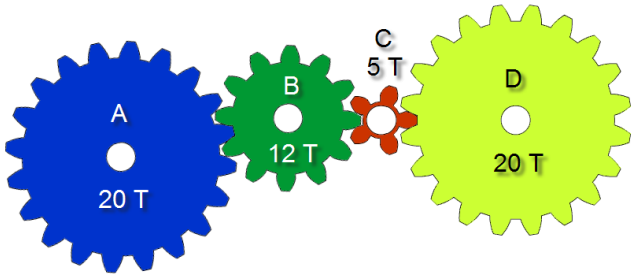
$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{12}{20} = \frac{.6}{1}$$

What is the gear ratio between gear B and C?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{5}{12} = \frac{.42}{1}$$

What is the gear ratio between gear C and D?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{20}{5} = \frac{4}{1}$$



What is the TOTAL gear train gear ratio?

$$\frac{0.6}{1} \bullet \frac{0.42}{1} \bullet \frac{4}{1} = \frac{1}{1}$$

If gear A and D were directly connected to each other, what would the resulting gear ratio be?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{20}{20} = \frac{1}{1}$$

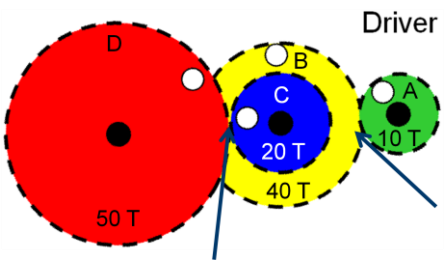
What would the total gear ratio be if the last gear had 40 teeth?

$$\frac{0.6}{1} \bullet \frac{0.42}{1} \bullet \frac{8}{1} = \frac{2}{1} \quad \text{or} \quad \frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{40}{20} = \frac{2}{1}$$

Compound Gear Train

The two middle gears share a _____ _____, so they rotate at the same speed.

This allows the final gear to rotate _____ and produce more _____ than if it were connected only to the driver gear.



What is the gear ratio between gear A and B?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{40}{10} = \frac{4}{1}$$

What is the gear ratio between gear C and D?

$$\frac{GR}{1} = \frac{n_{out}}{n_{in}} = \frac{50}{20} = \frac{2.5}{1}$$

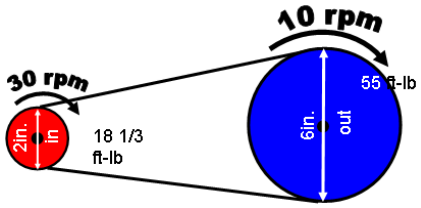
What is the gear ratio of the entire gear train?

$$\frac{4}{1} \bullet \frac{2.5}{1} = \frac{10}{1}$$

Pulley and Belt Systems

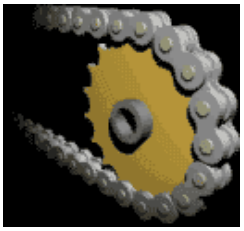
Equations: $\frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}} = \frac{\tau_{out}}{\tau_{in}}$

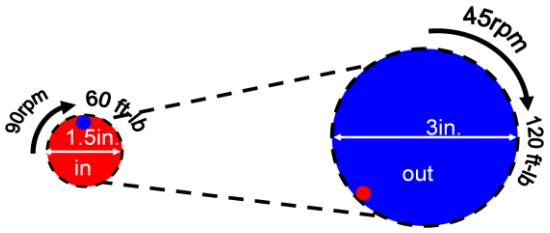
$\frac{6in.}{2in.} \quad \frac{30rpm}{10rpm} \quad \frac{55\,ft-lb}{18\frac{1}{3}\,ft-lb}$



d = _____ ω = _____ *(speed)* τ = _____

Sprocket and Chain Systems





$$\frac{n_{out}}{n_{in}} = \frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}} = \frac{\tau_{out}}{\tau_{in}}$$

$\frac{22}{11} \quad \frac{3in.}{1.5in.} \quad \frac{90rpm}{45rpm} \quad \frac{120\,ft-lb}{60\,ft-lb}$

n = number of teeth *d = diameter* ω *= angular velocity (speed)* τ *= torque*

Comparing Pulleys and Sprockets

	Pulley	Sprocket
Method of Transmitting Force	_____	_____
Advantages	Quiet, no lubrication needed, inexpensive	No slip, greater strength
Disadvantages	Can slip	Higher cost, needs lubrication, noisy