

NO CAD REQUIRED

This question appeared on the GrabCad questions forum

<https://grabcad.com/questions/can-anyone-design-this-system-in-catia>

To solve this engineering text book problem, absolutely no CAD required. Of course after you have used basic mechanical theory to work out the answer you can for the fun of it build a workable CAD model based around the solution you have worked out

Problem 2: One stage gear reducer with spur gears (Figure) knowing:

Electric motor power $P = 22 \text{ kW}$,
Motor rotational speed $n_m = 1465 \text{ rpm}$,
Belt drive ratio $U_b = 2.4:1$, Gear ratio $U_g = 3.95:1$,
Gear input operating conditions: uniform,
Gear output operating conditions: moderate shock,
A running time of the reducer: $t = 3 \text{ hrs/day}$.

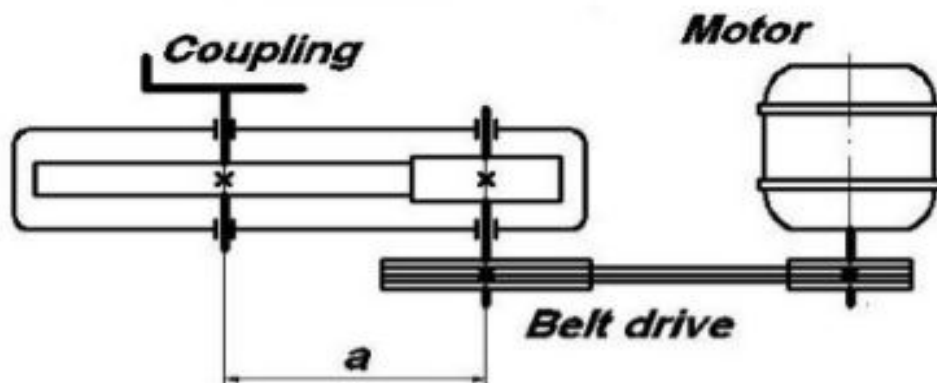


Figure 1: Spur gear reducer

Calculate output torque at the coupling. (Use: Service factor, Following Table 1; see next page)

Example of Prime Mover	Driven Machine Load Classification		
	Uniform	Moderate Shock	Heavy Shock
Uniform Electric Motor Hydraulic Motor Turbine	1	1.25	1.75
Moderate Shock Multi-cylinder Petrol Engine	1.5	1.75	2.25
Heavy Shock Single-cylinder Petrol engine	1.75	2	2.5

Some Basic Mechanical Theory as it Applies to Solving Problem 2.

Work done

Work done is *the force multiplied with the distance moved by the force* - and can be expressed as

$$W = F s \quad (1)$$

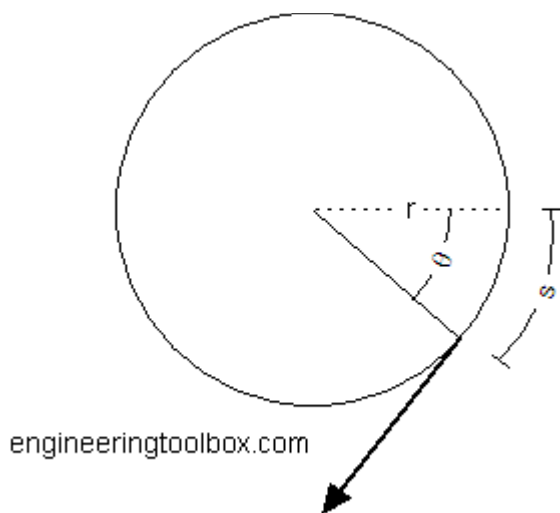
where

W = work done (J, Nm)

F = force (N)

s = distance moved by force (s)

For an angular motion



the work done can be expressed as

$$W = F \theta r$$

$$= T \theta \quad (2)$$

where

W = work (Joules)

θ = angle ([radians](#))

r = radius (m)

Power transmitted

Power is the ratio between the work done and the time taken and can be expressed as

$$P = W / dt$$

$$= T \theta / dt$$

$$= T \omega$$

$$= 2 \pi n T$$

$$= 2 \pi (n_{rpm} / 60) T$$

$$= 0.105 n_{rpm} T \quad (3)$$

where

P = power (Watts)

dt = time taken (s)

$\omega = \theta / dt = 2 \pi n$ = angular velocity (rad/s)

n = speed (rev/s)

n_{rpm} = speed (rev/min, rpm)

Note! - a machine must rotate to produce power! A machine with no rotation can deliver torque - like an electric motor - but since no distance is moved by force - no power is produced. As soon as the machine starts to rotate power is produced.

Example - required Torque to produce Power

A machine rotates with speed 3000 rev/min (rpm) and consumes 5 kW. The torque at the shaft can be calculated by modifying (3) to

$$T = P / 2 \pi n$$

$$= (5 \text{ kW}) (1000 \text{ W/kW}) / 2 \pi (3000 \text{ rev/min}) / (60 \text{ sec/min})$$

$$= \underline{15.9 \text{ Nm}}$$