## Exercise 1

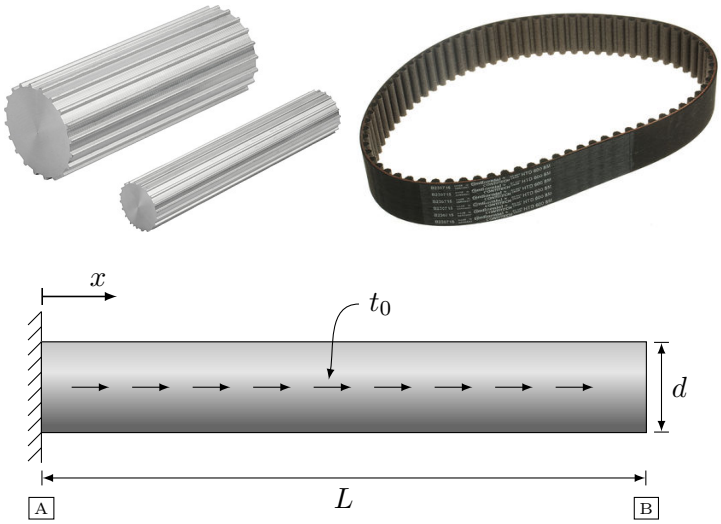


Figure 1: Bar loaded with a distributed torque. Such a load can arise for example from a broad belt driving a shaft.

Transmission belts are a way to transmit power from one shaft to another. The torque in that case is no longer a point torque applied to a bar, but is distributed across the length of the bar. A round shaft (see figure 1) with diameter $d$ and length $L$ is fixed on one side. A distributed torque $t_0 = T_0/L$ is applied on the whole length of the shaft. The shaft is made of a material with known shear modulus $G$.
Calculate and sketch the internal moment $T(x)$ and the angle of twist $\varphi(x)$ over the length of the shaft.

## Exercise 2

You have a football made of cowhide (Young's Modulus: $E = 7000PSI$). Its diameter is $d = 8.6inches$ and the specification reads that it should be inflated to $p_{norm} = 0.9Bar$.

- Calculate the hoop stress in the leather if its thickness is $t = 2mm$.
- The yield strength of cowhide is $\sigma_{yield} = 20N/mm^2$. What is the maximum allowable pressure inside the ball? What is the safety factor when the ball is inflated to the norm? Assume that the ball's diameter and the leather thickness remain constant.

## Exercise 3

A thin-walled cylindrical pressure vessel with a circular cross section is subjected to internal gas pressure $p$ and simultaneously elongated by an axial load $F =$

1.5 N. The cylinder has inner radius $r_1 = 2.1\,\text{mm}$ and outer radius of $r_2 = 2.25\,\text{mm}$. Determine the maximum allowable internal pressure if the ultimate stress of the material is 1 MPa.


Figure 2: Pressure vessel.