# Definitions and Formulas

## Linear movement

| | | |
|---|---|---|
| m | = mass | [kg] |
| d | = linear displacement | [m] |
| v | = linear speed | [m/s] |
| a | = linear acceleration | [m/s²] |
| r | = radius | [m] |
| p | = pitch | [m] |
| η | = transmission efficiency | [–] |
| F | = force | [N] |

## Angular movement

| | | |
|---|---|---|
| J | = inertia | [kgm²] |
| θ | = angular displacement | [rad] |
| ω | = angular speed | [rad/s] |
| α | = angular acceleration | [rad/s²] |
| r | = radius | [m] |
| Z | = number of teeth | [–] |
| i | = reduction ratio | [–] |
| $k_v$ | = viscous damping constant | [Nm/rad/s = Nms] |
| η | = transmission efficiency | [–] |
| M | = torque | [Nm] |

## Force

| | | |
|---|---|---|
| F | $= m \cdot a$ | [N] |

## Torque

| | | |
|---|---|---|
| M | $= J \cdot \alpha$ | [Nm] |
| ΔM | = viscous damping $= k_v \cdot \Delta\omega$ | [Nm] |

## Work - Energy

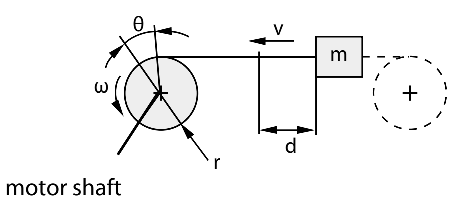
| | | |
|---|---|---|
| W | $= F \cdot d$ | [Nm] |
| W | $= M \cdot \theta$ | [Nm] |

## Mechanical power

| | | |
|---|---|---|
| $P_m$ | $= F \cdot v$ | [W] |
| $P_m$ | $= M \cdot \omega$ | [W] |

## Inertia

| | | | |
|---|---|---|---|
| Moment of inertia of a ring: | J | $m \cdot r^2$ | [kgm²] |
| Moment of inertia of a cylinder: | J | $= \frac{1}{2} m \cdot r^2 = \pi/2 \cdot r^4 \cdot h \cdot \rho$ | [kgm²] |
| Moment of inertia of a hollow cylinder: | J | $= \frac{1}{2} m (r_1^2 + r_2^2) = \pi/2 \cdot (r_1^4 - r_2^4) \cdot h \cdot \rho$ | [kgm²] |
| | ρ | = specific mass [kg/m³] h = height | [m] |

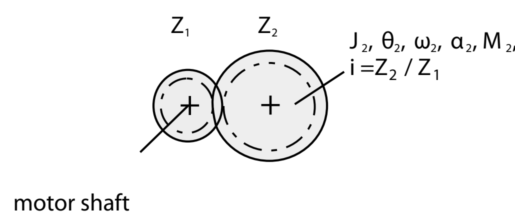


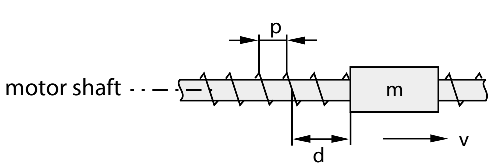

$J = m \cdot r^2$ [kgm²] $M = F \cdot r / \eta$ [Nm]

$\theta = d / r$ [rad]

$\omega = v / r$ [rad/s] $r_{opt.} = \sqrt{J_m / m}$ [m]

$\alpha = a / r$ [rad/s²]



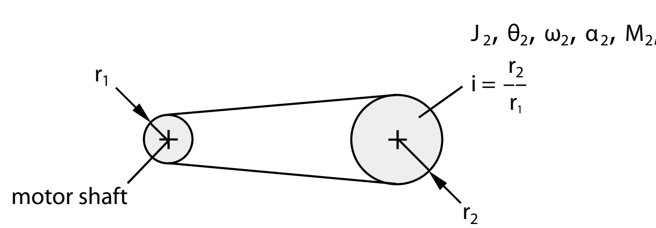




$J = m (p / 2\pi)^2$ [kgm²] $M = F \cdot p / 2\pi \cdot \eta$ [Nm]

$\theta = 2\pi \cdot d / p$ [rad]

$\omega = 2\pi \cdot v / p$ [rad/s] $P_{opt.} = 2\pi \sqrt{J_m / m}$ [m]

$\alpha = 2\pi \cdot a / p$ [rad/s²]




$J_1 = J_2 / i^2$ [kgm²] (load inertia reflected to the motor shaft)

$\theta = \theta_2 \cdot i$ [rad]

$\omega_1 = \omega_2 \cdot i$ [rad/s]

$\alpha_1 = \alpha_2 \cdot i$ [rad/s²]

$M1 = M_2 / i \cdot \eta$ [Nm]

$i_{opt.} = \sqrt{J_2 / J_m}$ [–]