Definitions and Formulas

Linear movement

m	= mass	[kg]
d	= linear displacement	[m]
v	= linear speed	[m/s]
a	= linear acceleration	[m/s^2]
r	= radius	[m]
p	= pitch	[m]
η	= transmission efficiency	[–]
F	= force	[N]

Angular movement

J	= inertia	[kgm^2]
θ	= angular displacement	[rad]
ω	= angular speed	[rad/s]
α	= angular acceleration	[rad/s^2]
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 · a	[N]

Torque

M	= J · α	[Nm]
ΔM	= viscous damping = k_v · Δω	[Nm]

Work - Energy

W	= F · d	[Nm]

W	= M · θ	[Nm]

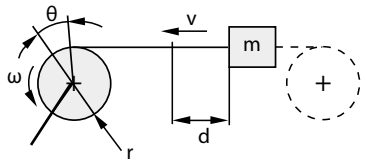
Mechanical power

P_m	= F · v	[W]

P_m	= M · ω	[W]

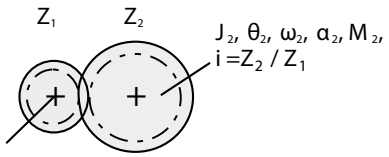
Inertia

Moment of inertia of a ring:	J	m · r^2	[kgm^2]
Moment of inertia of a cylinder:	J	= $^1/_2$ m · r^2 = π/2 · r^4 · h · ρ	[kgm^2]
Moment of inertia of a hollow cylinder:	J	= $^1/_2$ m ($r_1^2 + r_2^2$) = π/2 · (r_1^4 - r_2^4) · h · ρ	[kgm^2]
	ρ	= specific mass [kg/m^3] h = height	[m]

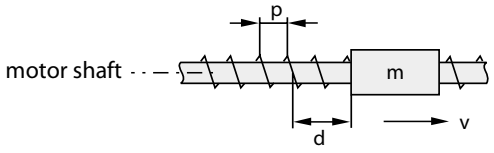


motor shaft

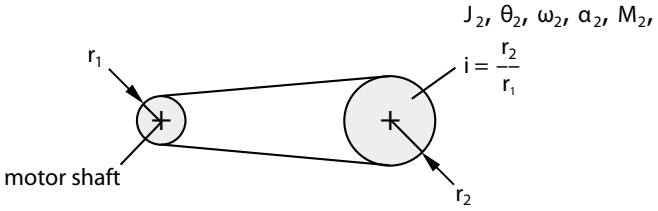
$J = m \cdot r^2$ [kgm^2] $M = F \cdot r / \eta$ [Nm]
$\theta = d / r$ [rad]
$\omega = v / r$ [rad/s] $r_{opt.} = \sqrt{J_m/m}$ [m]
$\alpha = a / r$ [rad/s^2]



motor shaft



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



$J_1 = J_2 / i^2$ [kgm^2] (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/s^2]
$M1 = M_2 / i \cdot \eta$ [Nm]
$i_{opt.} \neq \sqrt{J_2/J_m}$ [–]