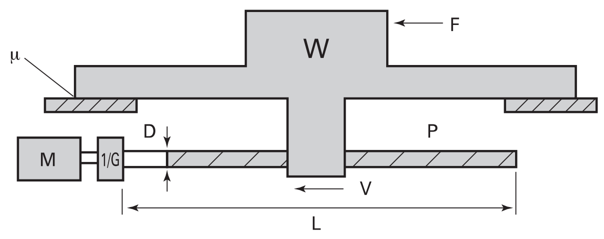
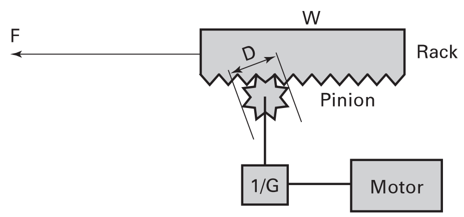
1 : What driving method are you employing?

Ball screw



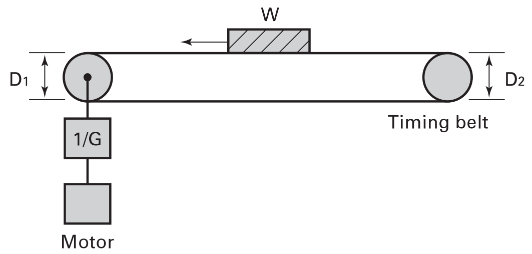
· Mass of moving part	W	kg
· Coefficient of friction	μ	
· External force	F	kg
· ball screw pitch	P	cm
· ball screw diameter	D	cm
· ball screw length	L	cm
· transfer efficiency	η	
· Specific gravity of "W"	ρ	kg/cm³
· Reduction gear ratio	1/G	

Rack and pinion



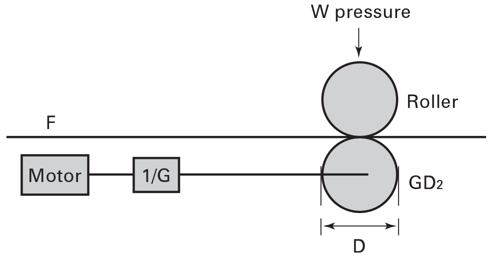
· Mass of moving part	W	kg
· Coefficient of friction	μ	
· Pinion pitch	P	cm
· Pinion diameter	D	cm
· Pinion thickness	t	cm
· Transfer efficiency	η	
· Specific gravity of "W"	ρ	kg/cm³
· Reduction gear ratio	1/G	

Timing belt



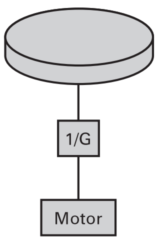
· Mass of moving part	W	kg
· Coefficient of friction	μ	
· Pulley pitch	P	cm
· Pulley diameter (motor side)	D_1	cm
· Pulley diameter (load side)	D_2	cm
· Pulley thickness(motor side)	t_1	cm
· Pulley thickness(load side)	t_2	cm
· Transfer efficiency	η	cm
· Specific gravity of "W"	ρ	kg/cm³
· Reduction gear ratio	1/G	

Roll feed



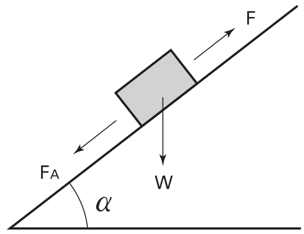
· Load	GD^2	kg · m²
· Coefficient of friction	μ	
· Tension	F	N
· Pressure	W	N
· Diameter of roller	D	cm
· Transfer efficiency	η	
· Reduction gear ratio	1/G	

Rotary object



· Load	GD^2	kg·m²
· Load torque	TL	N·m
· Transfer efficiency	η	
· Reduction gear ratio	1/G	

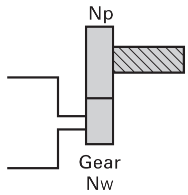
Note) 1) Thrust force on the slope



Calculate the thrust(F) on the slope.

$F = F_A + W(\sin\alpha + \mu\cos\alpha)$

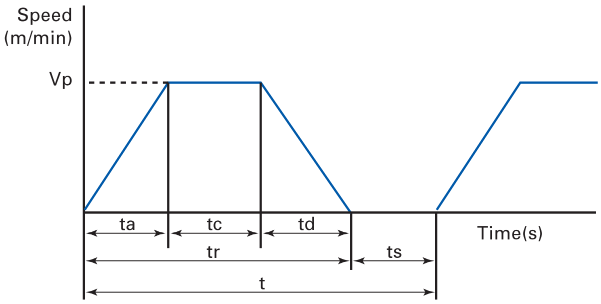
2) Gear ratio



Calculate the gear ratio(G)

$$\frac{Np}{Nw} = \frac{1}{G}$$

2 : Sketch the operation pattern.



・Speed for positioning (Np) [min^{-1}]
Calculate the maximum feed speed (Vp) [m/min.] from the positioning distance(Lp) [mm] and the positioning time (tr) [sec].
According to the operation pattern diagram on the left:

$$\frac{Vp \times 10^3}{60} \times \frac{2tr}{3} = Lp \text{(Provided that ta=tb=tr/3)}$$

$$\therefore Vp = Lp \times \frac{3}{2tr} \times \frac{60}{10^3} \text{ [[m/min]]}$$

$$Np = \frac{Vp \times 10^3}{P} \times \frac{G}{1} \text{ [min}^{-1}\text{]}$$

3 : Calculate the motor shaft equivalent load torque(TL).

$$TL = \frac{(F + \mu W)}{\eta} \cdot \frac{D}{2} \cdot \frac{1}{G} \times \frac{9.8}{100} \text{ [N·m]}$$

Note) When using the ball screw

$$\frac{D}{2} = \frac{P}{2\pi}$$

4 : Calculate the motor shaft equivalent load inertia(JL).

・Inertia of the moving part(JB) ・Work piece inertia

$J_L = J_B + J_W$
*Gear inertia is negligible.

$$J_B = \left(\frac{1}{G}\right)^2 \cdot \frac{\pi \rho D^4 A}{32 \times 10^4} \text{ [kg·m}^2\text{]} \qquad J_W = \left(\frac{1}{G}\right)^2 \cdot \frac{W}{10^4} \cdot \left(\frac{P}{2\pi}\right)^2 \text{ [kg·m}^2\text{]}$$

"A" in the above equation stands for the ball screw length (L), the pinion thickness (t) or the pulley thickness (t).

5 : Tentatively select the motor type.

Select the motor type which satisfies the above requirements (JL), (TL),and (NP), referring to the catalogue.

6 : Calculate the acceleration/deceleration torque.

・Acceleration torque

$$Ta = \frac{2\pi(N_2 - N_1) \cdot (J_L + J_M)}{60 \cdot ta} + T_L \text{ [N·m]}$$

・Deceleration torque

$$Tb = \frac{2\pi(N_2 - N_1) \cdot (J_L + J_M)}{60 \cdot tb} - T_L \text{ [N·m]}$$

Does the tentatively selected motor type still satisfy the above requirements (Ta) and (Tb)?

7 : Calculate the rms(root-mean-square) torque(Trms).

$$Trms = \sqrt{\frac{Ta^2 \cdot Ta + T_L^2 \cdot tc + Tb^2 \cdot tb}{t}} \text{ [N·m]}$$

Does the tentatively selected motor type still satisfy the original requirement(Trms)?