- given information -

Load and linear guide

Total mass of loads and table	m	=	0.5	[kg]
Friction coefficient of the guide	μ	=	0.1	

Drive pulley specifications

Drive pulley diameter		D_p	=	5	[mm]
Drive pulley mass		m_p	=		[kg/pc]
Drive pulley length		L_p	=	45	[mm]
Drive pulley material	Aluminum	ρ	=	2800	[kg/m ^{3}]
Number of drive pulleys		n	=	20	[pc]
Efficiency		η	=	98	[%]

External force

F_A = 45 [N]

Transmission belt and pulleys or gears

	Primary pulley (gear)	Secondary pulley (gear)
pitch circle diameter (PCD)	D_{p1} = 5 [mm]	D_{p2} = 5 [mm]
mass	m_{p1} = [kg]	m_{p2} = [kg]
thickness	L_{p1} = 45 [mm]	L_{p2} = 45 [mm]
material	ρ_{p1} = 2800 [kg/m ^{3}]	ρ_{p2} = 2800 [kg/m ^{3}]
	Aluminum	Aluminum

Mechanism Placement

Mechanism angle α = 0 [°]

Other requirement(s)

Is it necessary to hold the load even after the power supply is turned off? → NO

Is it necessary to hold the load after the motor is stopped, but not necessary to hold after the power supply is turned off? → YES

Operating conditions

Variable speed operation	Operating speed	V_1 = 250	[mm/s]
		V_2 = 0	[mm/s]
	Acceleration / deceleration time	t_1 = 1	[s]

Stopping accuracy

Stopping accuracy Δl = 3 [mm]

Safety factor

Safety factor S·F = 1.5

- calculated result -

Load Inertia

$J_m = m \times ((D_p \times 10^{-3}) / 2)^2$

$= 0.5 \times ((5 \times 10^{-3}) / 2)^2 = 3.1250\text{e-}6 \ [\text{kg·m}^2]$

$J_{Dp} = (\pi/32)\ \rho\ L_p\ D_p^4\ n$

$= (3.14 / 32) \times 2800 \times (45 \times 10^{-3}) \times (5 \times 10^{-3})^4 \times 20 = 1.546\text{e-}7 \ [\text{kg·m}^2]$

$J_{Dp1} = (\pi / 32)\ \rho_{p1}\ (L_{p1} \times 10^{-3})\ (D_{p1} \times 10^{-3})^4$

$= (3.14 / 32) \times 2800 \times (45 \times 10^{-3}) \times (5 \times 10^{-3})^4 = 7.731\text{e-}9 \ [\text{kg·m}^2]$

$J_{Dp2} = (\pi / 32)\ \rho_{p2}\ (L_{p2} \times 10^{-3})\ (D_{p2} \times 10^{-3})^4$

$= (3.14 / 32) \times \underline{2800} \times (\underline{45} \times 10^{-3}) \times (\underline{5} \times 10^{-3})^4 \quad = \underline{7.731e-9}$ [kg·m ^{2}]

$J_L = (J_m + J_{Dp} + J_{Dp2})(D_{p1} / D_{p2})^2 + J_{Dp1}$

$= (\underline{3.1250e-6} + \underline{1.546e-7} + \underline{7.731e-9}) \times (\underline{5} / \underline{5})^2 + \underline{7.731e-9} \quad = \underline{3.2951e-6}$ [kg·m ^{2}]

Required Speed

$V_{m1} = V_1 (60 / (\pi D_p))(D_{p2} / D_{p1})$

$= \underline{250} \times (60 / (3.14 \times \underline{5})) \times (\underline{5} / \underline{5}) \quad = \underline{954.9}$ [r/min]

$V_{m2} = V_2 (60 / \pi D_p)(D_{p2} / D_{p1})$

$= \underline{0} \times (60 / (3.14 \times \underline{5})) \times (\underline{5} / \underline{5}) \quad = \underline{0}$ [r/min]

Required Torque

$T = (T_a + T_L)$ (Safety Factor)

$= (\underline{3.2948e-4} + \underline{0.1160}) \times \underline{1.5} \quad = \underline{0.1746}$ [N·m]

Acceleration Torque

$T_a = J_L (V_m / (9.55 \times t_1))$

$= \underline{3.2951e-6} \times (\underline{954.9} / (9.55 \times \underline{1})) \quad = \underline{3.2948e-4}$ [N·m]

Load Torque

$F = F_A + (m \times 9.8)(\sin\alpha + \mu\cos\alpha)$

$= \underline{45} + (\underline{0.5} \times 9.8)(\sin \underline{0} + \underline{0.1} \times \cos \underline{0}) \quad = \underline{45.49}$ [N]

$T_L = (F \times D_p \times 10^{-3}) / (2 \eta \times 0.01)(D_{p1} / D_{p2})$

$= (\underline{45.49} \times \underline{5} \times 10^{-3}) / (2 \times \underline{98} \times 0.01) \times (\underline{5} / \underline{5}) \quad = \underline{0.1160}$ [N·m]

Required Stopping Accuracy

$\Delta\theta = \Delta l \; (360° / \pi \, D_p) \; (D_{p2} / D_{p1})$

$= \underline{\quad 3 \quad} \times (360 / (3.14 \times \underline{\quad 5 \quad})) \times (\underline{\quad 5 \quad} / \underline{\quad 5 \quad})$ $= \underline{\quad 68.75 \quad}$ [deg]

Other requirement(s)

Holding Torque

- end of the report -