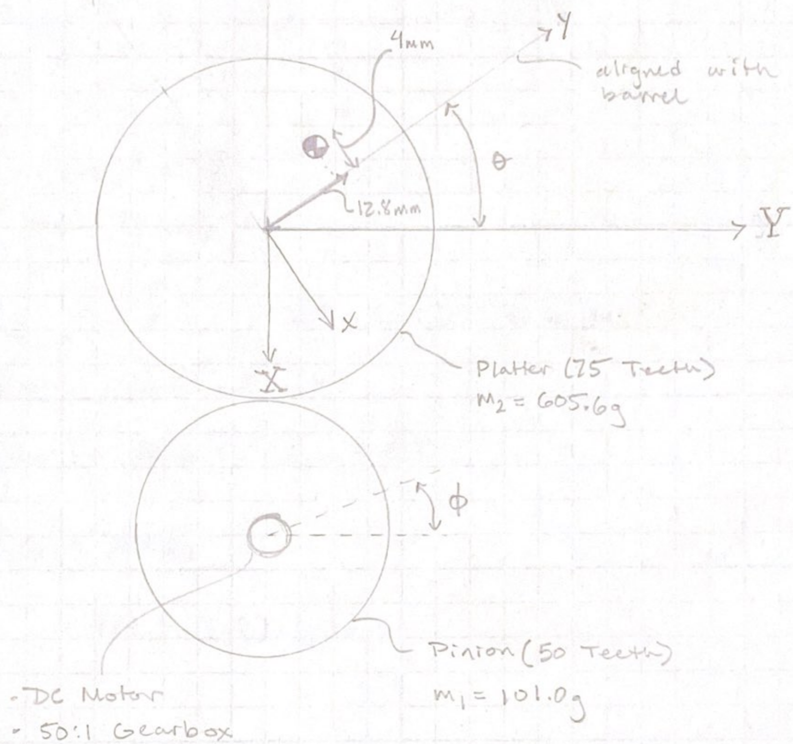
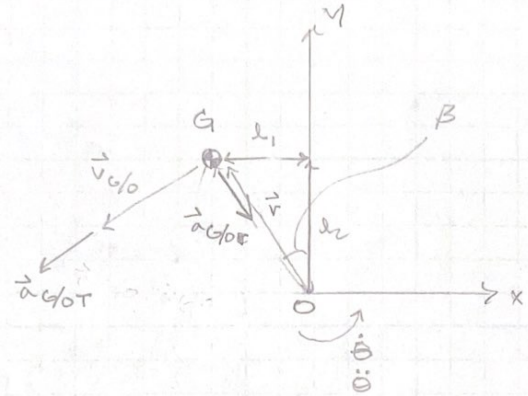


Y
4mm
aligned with barrel
θ
12.8mm
Y
X
X
Platter (75 Teeth)
$m_2 = 605.6g$
ϕ
Pinion (50 Teeth)
$m_1 = 101.0g$
- DC Motor
- 50:1 Gearbox

FOR TURRET LOCAL FRAME:



$\vec{r} = -l_1\hat{\imath} + l_2\hat{\jmath}$ $\quad\quad \beta = \tan^{-1}\left(\frac{l_1}{l_2}\right)$

$|r| = \sqrt{l_1^2 + l_2^2}$

$\vec{v}_{G/O} = \vec{r} \times \dot{\vec{\theta}} = (-l_1\hat{\imath} + l_2\hat{\jmath}) \times (\dot{\theta}\hat{k})$

$\vec{v}_{G/O} = l_2\dot{\theta}\hat{\imath} + l_1\dot{\theta}\hat{\jmath}$

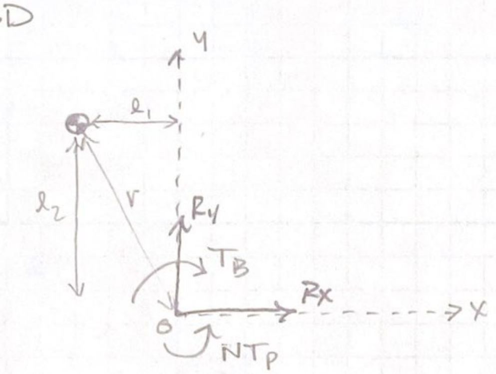
$|\vec{v}_{G/O}| = \dot{\theta}\sqrt{l_1^2 + l_2^2} = \dot{\theta}r$

$\vec{a}_{G/O_T} = \vec{r} \times \ddot{\theta}$

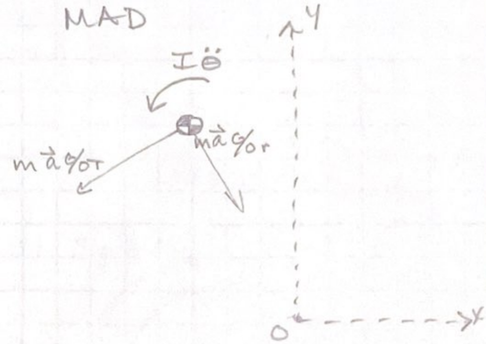
$= (-l_1\hat{\imath} + l_2\hat{\jmath}) \times (\ddot{\theta}\hat{k})$

$\vec{a}_{G/O_T} = l_2\ddot{\theta}\hat{\imath} + l_1\ddot{\theta}\hat{\jmath}$

FBD



MAD



$$\left(\sum M_{FBD}\right)_O = \left(\sum M_{MAD}\right)_O$$

$$NT_p\hat{k} - T_B\hat{k} = I\ddot{\theta}\hat{k} + \vec{r}\times\vec{a}_{G/O_T}\, m$$

$$NT_p\hat{k} - \dot{\theta}b\hat{k} = (I_{yy}+mr^2)\ddot{\theta}\hat{k} + (-l_1\hat{i} + l_2\hat{j})\times(ml_2\ddot{\theta}\hat{i} + ml_1\ddot{\theta}\hat{j})$$

$$= (I_{yy}+mr^2)\ddot{\theta}\hat{k} + m(-l_1^2\ddot{\theta}\hat{k} - l_2^2\ddot{\theta}\hat{k})$$

$$NT_p - \dot{\theta}b = (I_{yy} + m(r^2 - l_1^2 - l_2^2))\ddot{\theta}$$

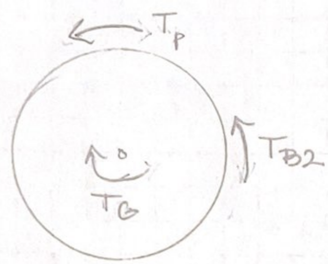
$$NT_p - \dot{\theta}b = (I_{yy} + m\,\cancel{(r^2 - r^2)})\ddot{\theta}$$

$$\boxed{\ddot{\theta} = -\dot{\theta}\frac{b}{I_{yy}} + \frac{N}{I_{yy}}T_p}$$

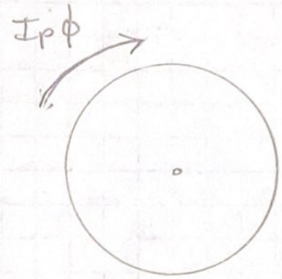
Determine Torque to Platter Through Pinion gear

Pinion gear:

FBD



MAD



$$\Sigma M_{FBD} = \Sigma M_{MAD}$$

$$T_p + T_{B2} - T_G = -I_p \ddot{\phi}$$

$$\boxed{T_p = -b_2 \dot{\phi} - I_p \ddot{\phi} + T_G}$$

Assuming Motor Gearbox has no inertia/damping

$$\boxed{\underbrace{T_G}_{\text{Gearbox torque}} = 50 \underbrace{T_m}_{\text{Motor Torque}} = 50\, \underline{K_t\, i_m}}$$

Motor Equations:

$$\boxed{\frac{d\Omega_m}{dt} = \frac{1}{J}(K_T \cdot i_m - b\Omega_m) = \frac{K_T}{J} i_m - \frac{b}{J}\Omega_m}$$

$$\boxed{\frac{d\,i_m}{dt} = \frac{1}{L}(v_m - i_m R - K_v \Omega_m) = -\frac{R}{L} i_m - \frac{K_v}{L}\Omega_m + \frac{1}{L} v_m}$$

$$\theta = N\phi \qquad \phi = \frac{1}{N}\theta$$
$$\dot{\theta} = N\dot{\phi} \qquad \dot{\phi} = \frac{1}{N}\dot{\theta}$$
$$\ddot{\theta} = N\ddot{\phi} \qquad \ddot{\phi} = \frac{1}{N}\ddot{\theta}$$

$$T_p = -b_2\frac{1}{N}\dot{\theta} - I_p\frac{1}{N}\ddot{\theta} + T_G$$

$$\ddot{\theta} = -\dot{\theta}\frac{b}{I_{yy}} + \frac{N}{I_{yy}}\left(-\frac{b_2}{N}\dot{\theta} - \frac{I_p}{N}\ddot{\theta} + 50k_t\, i_m\right)$$

$$\ddot{\theta} = -\dot{\theta}\frac{b}{I_{yy}} - \frac{b_2}{I_{yy}}\dot{\theta} - \frac{I_p}{I_{yy}}\ddot{\theta} + \frac{N50k_t}{I_{yy}}i_m$$

$$\ddot{\theta}\left(\frac{I_{yy}+I_p}{I_{yy}}\right) = -\dot{\theta}\left(\frac{b_1 - b_2}{I_{yy}}\right) + \frac{N50k_t}{I_{yy}}i_m$$

$$\boxed{\frac{d\dot{\theta}}{dt} = -\dot{\theta}\left(\frac{b_1 - b_2}{I_{yy}+I_p}\right) + \frac{N50k_t}{I_{yy}+I_p}i_m}$$

$$\frac{d}{dt}\begin{bmatrix}\dot{\theta}\\ \Omega_m\\ i_m\end{bmatrix} =$$