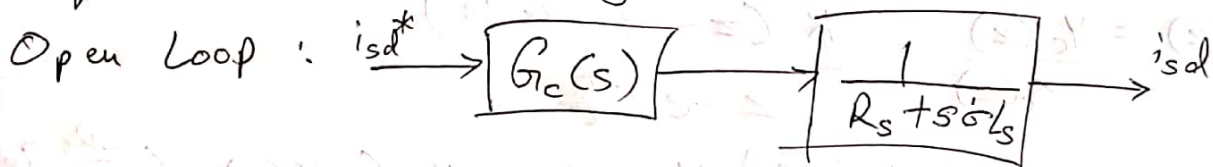


d & q axis controller design.



Open Loop T.F., $G(s) = G_c(s) \cdot \frac{1}{R_s + s\sigma L_s} = \cancel{G_c(s)}$

Final open loop T.F. we want is of form $G(s) = \frac{1}{1+sT}$

$$\Rightarrow \frac{1}{1+sT} = G_c(s) \cdot \frac{1}{R_s + s\sigma L_s}$$

$$\Rightarrow \boxed{G_c(s) = \frac{R_s + s\sigma L_s}{1+sT}}$$

s-domain to z-domain:-

$$G_c(s) = \frac{R_s + s \sigma L_s}{1 + s\tau}$$

T_s = sampling period

$$\Rightarrow \text{pole of } G_c(s) \text{ at } s = -1/\tau \Rightarrow \text{pole of } \mathcal{Z}\{G_c(s)\} = G_c(z) \text{ at } z = e^{-T_s/\tau}$$

$$\Rightarrow \text{zero of } G_c(s) \text{ at } s = -\frac{R_s}{\sigma L_s} \Rightarrow \text{zero of } G_c(z) \text{ at } z = e^{-\frac{R_s}{\sigma L_s} T_s}$$

$$\Rightarrow G_c(z) = \frac{K \cdot (z - e^{-\frac{R_s}{\sigma L_s} T_s})}{z - e^{-T_s/\tau}}$$

$$\text{To find } K \Rightarrow G_c(z) \Big|_{z=1} = G_c(s) \Big|_{s=0}$$

$$\Rightarrow \frac{K(1 - e^{-\frac{R_s}{\sigma L_s} T_s})}{1 - e^{-T_s/\tau}} = \frac{R_s + 0 \cdot \sigma L_s}{1 + 0\tau}$$

$$\Rightarrow K = \frac{R_s(1 - e^{-T_s/\tau})}{(1 - e^{-\frac{R_s}{\sigma L_s} T_s})} = R_s$$

$$\Rightarrow G_c(z) = R_s \cdot \frac{(z - e^{-\frac{R_s}{\sigma L_s} T_s})}{(1 - e^{-\frac{R_s}{\sigma L_s} T_s})} \cdot \frac{(1 - e^{-T_s/\tau})}{(z - e^{-T_s/\tau})}$$

$$\Rightarrow \mathcal{Z}G_c(z) = \frac{Y_c(z)}{X_c(z)} = \frac{K(z - e^{-\frac{R_s}{\sigma L_s} T_s})}{z - e^{-T_s/\tau}}$$

$$\Rightarrow zY_c(z) - (e^{-\frac{T_s}{\tau}})Y_c(z) = K \cdot (zX_c(z) - (e^{-\frac{R_s}{\sigma L_s} T_s})X_c(z))$$

\Rightarrow Taking z common from both sides & cancelling

$$Y_c(z) - z^{-1}(e^{-\frac{T_s}{\tau}})Y_c(z) = KX_c(z) - z^{-1}K(e^{-\frac{R_s}{\sigma L_s} T_s})X_c(z)$$

Taking inverse z-transform,

$$y_c(n) - \underbrace{e^{-\frac{T_s}{\tau}}}_{K_1} \cdot y_c(n-1) = Kx_c(n) - \underbrace{K(e^{-\frac{R_s}{\sigma L_s} T_s})}_{K_2} x_c(n-1)$$

$$\Rightarrow y_c(n) = K_1 y_c(n-1) + Kx_c(n) - K K_2 x_c(n-1)$$

New Training Set

1	2	3	4	5	6	7	8	9
i_{sd}^*	i_{sq}^*	i_{sd}	i_{sq}	$y_{cd}(n-1)$	$y_{cq}(n-1)$	ω_m	ϕ	$d\phi/dt$

i/p \rightarrow +

10	11
$e_{d\text{past}}$	$e_{q\text{past}}$

without decoupling		with decoupling	
V_{sd}^*	V_{sq}^*	V_{sd}	V_{sq}
$y_{cd}(n)$	$y_{cq}(n)$		

o/p