

Zo - S1 - Q2

Q: (a) $C(kT) = ?$

Solution $G_1 G_2(s) = \frac{1-e^{-Ts}}{s} \frac{1}{s+2}$

$$\begin{aligned} G_1 G_2(z) &= (1-z^{-1}) Z\left\{\frac{1}{s(s+2)}\right\} \\ &= (1-z^{-1}) \frac{1}{z} \frac{(1-e^{-1})z^{-1}}{(1-z^{-1})(1-e^{-1}z^{-1})} \\ &= \frac{(1-e^{-1})z^{-1}}{z(1-e^{-1}z^{-1})} \\ &= \frac{0.3161 z^{-1}}{1-0.3679 z^{-1}} \quad \checkmark \end{aligned}$$

$$\frac{C(z)}{R(z)} = \frac{G_1 G_2(z)}{1+G_1 G_2(z)}$$

$$R(z) = 1$$

$$\begin{aligned} \text{So } C(z) &= \frac{G_1 G_2(z)}{1+G_1 G_2(z)} \\ &= \frac{0.3161 z^{-1}}{1-0.3679 z^{-1}} \\ &= \frac{0.3161 z^{-1}}{1+ \frac{0.3161 z^{-1}}{1-0.3679 z^{-1}}} \end{aligned}$$

$$= \frac{0.3161 z^{-1}}{1 - 0.3679 z^{-1} + 0.3161 z^{-1}}$$

$$= \frac{0.3161 z^{-1}}{1 - 0.0518 z^{-1}} \quad \#19 \quad \checkmark \quad \underline{=} \quad 0.3161 (0.0518)^{k-1}$$

(b) design $C(z)$

Solution

$$u(z) = \frac{Y(z)}{G_{zas}(z)} = \frac{Y(z)}{R(z)} \frac{R(z)}{G_{zas}(z)} = G_{cc}(z) \frac{R(z)}{G_{zas}(z)}$$

$$= G_{cc}(z) \frac{\frac{1}{1-z^{-1}}}{\frac{0.5 z^{-1} (1+0.5 z^{-1})}{(1-0.8 z^{-1})(1-0.368 z^{-1})}}$$

$$= G_{cc}(z) \frac{(1-0.8 z^{-1})(1-0.368 z^{-1})}{(1-z^{-1}) 0.5 z^{-1} (1+0.5 z^{-1})}$$

design $G_{cc}(z) = k 0.5 z^{-1} (1+0.5 z^{-1})$

\therefore zero steady state error $\therefore G_{cc}(1) = 1$

$\therefore 1 = k 0.5 (1+0.5)$

$1 = k \frac{1}{2} \frac{3}{2}$

$k = \frac{4}{3} \quad \checkmark$

$\therefore G_{cc}(z) = \frac{2}{3} z^{-1} (1+0.5 z^{-1})$

$$\therefore C(z) = \frac{1}{G_{\text{ZAS}}(z)} \frac{G_{\text{cc}}(z)}{1 - G_{\text{cc}}(z)}$$

$$= \frac{(1 - 0.8z^{-1})(1 - 0.368z^{-1})}{0.5z^{-1}(1 + 0.5z^{-1})} \frac{\frac{2}{3}z^{-1}(1 + 0.5z^{-1})}{1 - \frac{2}{3}z^{-1}(1 + 0.5z^{-1})}$$

$$= \frac{\frac{4}{3}(1 - 0.8z^{-1})(1 - 0.368z^{-1})}{0.5z^{-1}(1 + 0.5z^{-1})}$$

↓ 分母

$$\frac{\cancel{\frac{2}{3}z^{-1}(1 + 0.5z^{-1})}}{1 - \frac{2}{3}z^{-1}(1 + 0.5z^{-1})}$$

$$1 - \frac{2}{3}z^{-1} - \frac{1}{3}z^{-2}$$

$$= \frac{(1 - 0.8z^{-1})(1 - 0.368z^{-1})}{0.5z^{-1}(1 + 0.5z^{-1})}$$

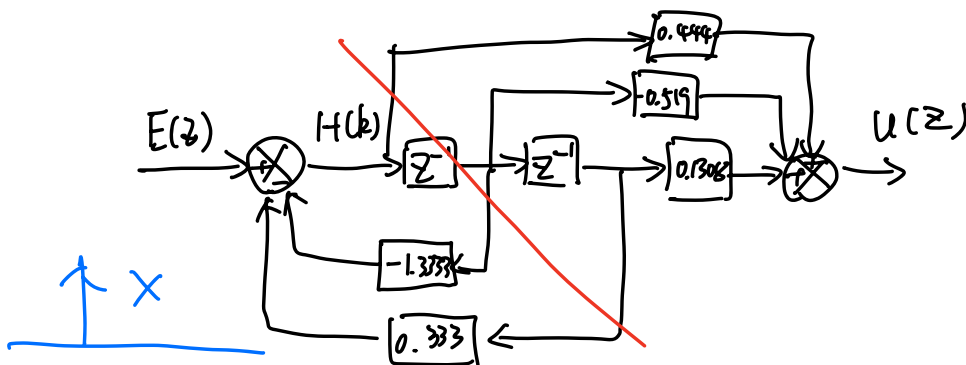
↓ X

$$\frac{\frac{2}{3}z^{-1}(1 + 0.5z^{-1})}{(1 + z^{-1})(-3 + z^{-1})}$$

$$= \frac{1.333(1 - 0.8z^{-1})(1 - 0.368z^{-1})}{(1 - z^{-1})(3 - z^{-1})}$$

$$(c) \quad C(z) = \frac{1.333(1 - 1.168z^{-1} + 0.2944z^{-2})}{3 - 4z^{-1} + z^{-2}}$$

$$= \frac{0.4444 - 0.519z^{-1} + 0.1308z^{-2}}{1 - 1.333z^{-1} + 0.3333z^{-2}}$$



↑ X

$$= \frac{1.3333 (1 - 0.8z^{-1}) (1 - 0.368z^{-1})}{1 - \frac{2}{3}z^{-1} - \frac{1}{3}z^{-2}}$$

$$= \frac{1.3333 - 1.5573z^{-1} + 0.3925z^{-2}}{1 - 0.6667z^{-1} - 0.3333z^{-2}}$$

