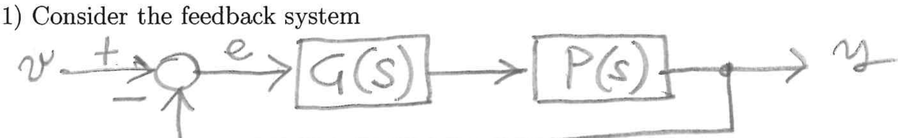
CONTROL SYSTEMS - 6/5/2020

[time 2 hours and 30 minutes; no textbooks; no programmable calculators]

1) Consider the feedback system



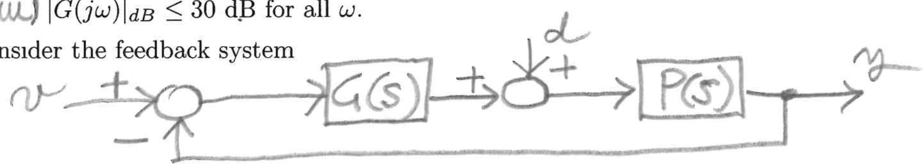
with input v, error e, output y, controller $G(s) = K\dfrac{1+s\tau_1}{1+s\tau_2}$ and process $P(s) = \dfrac{4}{(s-2)(s+2)}$. Design $K, \tau_1, \tau_2 \in \mathbb{R}$ in such a way that

(i) the closed-loop system is asymptotically stable (use Nyquist criterion with approximate Bode plots) with steady state error $e_{ss}(t)$ to constant inputs $v(t) = \delta_{-1}(t)$ such that $|e_{ss}(t)| \le 0.5$,

(ii) the open loop system $PG(s)$ has largest as possible phase margin,

(iii) $|G(j\omega)|_{dB} \le 30$ dB for all ω.

2) Consider the feedback system



with input v, disturbance d, output y, controller $G(s)$ and process $P(s) = \dfrac{s-1}{s(s-2)}$. Design $G(s)$ such that

(i) the closed-loop system is asymptotically stable with steady state output response $y_{ss}(t) \equiv 0$ to constant disturbances $d(t) = \delta_{-1}(t)$,

(ii) $G(s)$ has minimal dimension.

Draw as precisely as possible the root locus of $PG(s)$.

3) Given the feedback system in exercise 1 with controller $G(s) = \dfrac{1-\tau s}{s+1.8}$ and process $P(s) = \dfrac{1}{s}$, determine all the values of $\tau \in \mathbb{R}$ for which the closed loop system $W(s) = \dfrac{GP(s)}{1+GP(s)}$ has all its poles in $\mathbb{C}^-$ with damping $\zeta \in [0, \frac{1}{\sqrt{2}}]$.