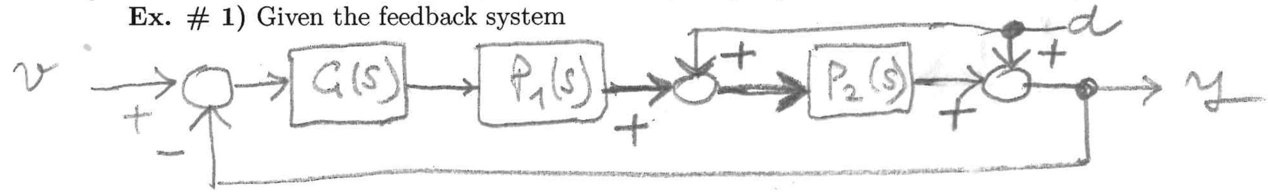
CONTROL SYSTEMS - 24/01/2022

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

Ex. # 1) Given the feedback system



with $\mathbf{P}_1(s) = \frac{1}{s}$ and $\mathbf{P}_2(s) = \frac{1}{s-1}$, design $\mathbf{G}(s)$ with minimal dimension such that

(i) the feedback system is asymptotically stable (check with Nyquist criterion) with steady-state response $\mathbf{y}_{ss}(t) = 0$ to ramp disturbances $d(t) = t$ and steady-state error $|\mathbf{e}_{ss}(t)| \leqslant 0.01$ to ramp inputs $v(t) = t$,

(ii) the open-loop system has crossover frequency $\omega_t \leqslant 10$ rad/sec with maximal phase margin.

Ex. # 2) Given

$$\mathbf{P}(s) = \frac{(s+1)(s+2)}{(s-2)^2(s+3)}$$

(i) Draw the root locus of $\mathbf{P}$ (use the Routh criterion to determine the intersections with the imaginary axis).

(ii) design $\mathbf{G}(s) = K$ such the feedback system $\mathbf{W}(s) = \frac{\mathbf{PG}(s)}{1+\mathbf{PG}(s)}$ has all real negative poles.

(iii) design a controller $\mathbf{G}(s)$ with dimension $\leqslant 1$ such that the feedback system $\mathbf{W}(s) = \frac{\mathbf{PG}(s)}{1+\mathbf{PG}(s)}$ has all real negative poles inside the interval $[-3, -2]$.

Ex. # 3) Given

$$P(s) = \frac{1}{s+1}$$

design a controller $G(s)$ with dimension $\leqslant 1$ such that the feedback system $\mathbf{W}(s) = \frac{\mathbf{PG}(s)}{1+\mathbf{PG}(s)}$ is asymptotically stable with 5% settling time $\leqslant 0.01$ sec.