CONTROL SYSTEMS - 3/11/2023

[time 3 hours; no textbooks; no programmable calculators; all the mathematical passages must be motivated and clearly explained]

Ex. # 1) Given the feedback system

with $\mathbf{P}(s) = \frac{1-s}{s^2}$ design a one-dimensional controller $\mathbf{G}(s)$ such that

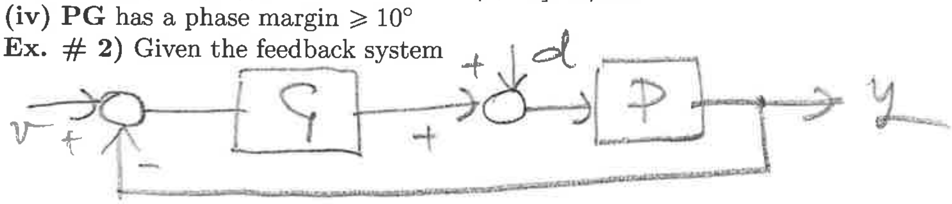
(i) the feedback system $\mathbf{W}(s) = \frac{\mathbf{PG}(s)}{1+\mathbf{PG}(s)}$ is asymptotically stable (use Nyquist criterion)

(ii) $20log_{10}|\mathbf{G}(j\omega)| \leqslant -8dB$ for all $\omega > 0$

(iii) $20log_{10}|\mathbf{PG}(j\omega)| \geqslant 9dB$ for all $\omega \in (0, 0.1]$rad/sec

(iv) **PG** has a phase margin $\geqslant 10°$

Ex. # 2) Given the feedback system



with $\mathbf{P}(s) = \frac{s+2}{s^2(s-1)}$, design a minimal dimensional controller $\mathbf{G}(s)$ such that the feedback system

(i) is asymptotically stable with steady-state output response $|\mathbf{y}_{ss}(t)| \leqslant 0.1$ to disturbances $\mathbf{d}(t) = t$ and $\mathbf{y}_{ss}(t) \equiv 0$ to $\mathbf{d}(t) = 1$

(ii) has all the poles with real part $\leqslant -3$.

(iii) Draw the root locus of $\mathbf{P}(s)$.

Ex. # 3) Given $\mathbf{P}(s) = \frac{s+2}{s-10}$, design a one dimensional controller $\mathbf{G}(s)$ such that the feedback system $\mathbf{W}(s) = \frac{\mathbf{PG}(s)}{1+\mathbf{PG}(s)}$ is asymptotically stable with a 5% settling time (for an output response to a unit step input) less than 0.1 sec.