NAME, SURNAME AND STUDENT NUMBER (* mandatory fields):

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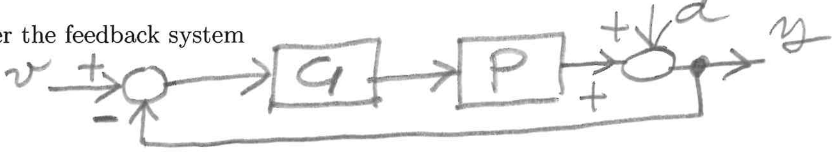
CONTROL SYSTEMS - 26/10/2019

[time 3 hours; no textbooks; no programmable calculators]

1) Consider the feedback system



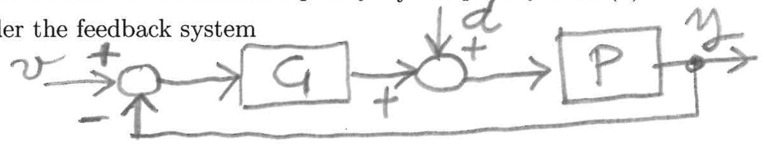
with disturbance d, input v, output y and $P(s) = \frac{1}{s(s+1)(s+5)}$. Design a controller $G(s)$ with minimal dimension such that

(i) the closed-loop system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable (use Nyquist criterion) with steady state output response $y_{ss}(t) \equiv 0$ to constant disturbances $d(t)$,

(ii) $|G(j\omega)|_{dB} \leq 30dB$ for all ω

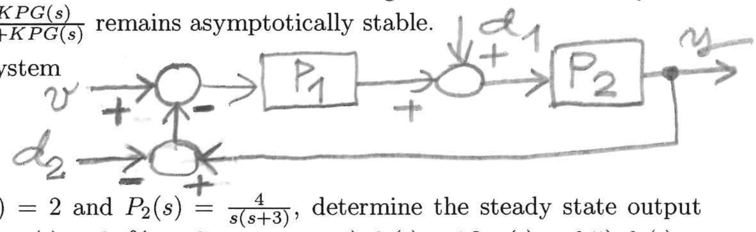
(iii) the open loop system $P(s)G(s)$ has phase margin $m_\phi^* \geq 40°$ rad/sec and maximal crossover frequency ω_t^* compatibly with (ii).

2) Consider the feedback system



with disturbance d, input v and output y and $P(s) = \frac{s-1}{s(s-2)}$. Design a controller $G(s)$ with minimal dimension such that the closed-loop system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable with steady state output response $y_{ss}(t) \equiv 0$ to constant disturbances $d(t)$. Draw the root locus for $PG(s)$ and find all the real values of the gain K for which the system $W(s) = \frac{KPG(s)}{1+KPG(s)}$ remains asymptotically stable.

3) Given the system



with $P_1(s) = 2$ and $P_2(s) = \frac{4}{s(s+3)}$, determine the steady state output responses $y_{ss}(t)$ and 5% settling times to i) $d_1(t) = 2\delta_{-1}(t)$ and ii) $d_2(t) = 0.5\delta_{-1}(t)$.