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

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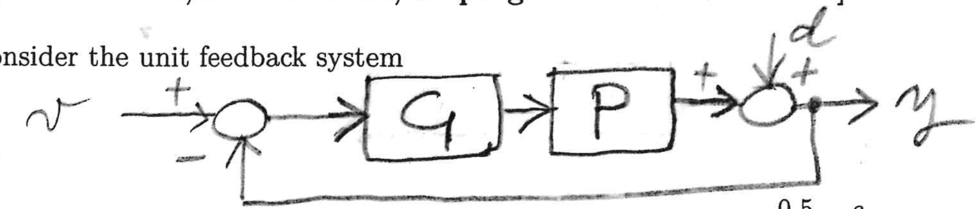
CONTROL SYSTEMS - 4/2/2020 (B)

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

1) Consider the unit feedback system

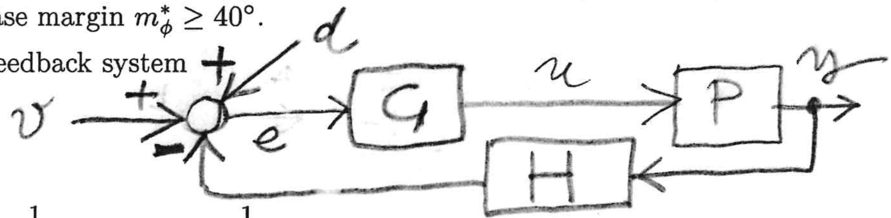


with input v, error e, output y, disturbance d and $P(s) = \dfrac{0.5 - s}{s^2 + 12s + 20}$.
Design a controller $G(s)$ such that

(i) the closed-loop system is asymptotically stable (use Nyquist criterion with approximate Bode plots) and steady state output response y_{ss} to disturbances $d(t) = \delta_{-1}(t)$ such that $|y_{ss}| \le 0.04$,

(ii) the open loop system $PG(s)$ has crossover frequency $\omega_t^* \ge 10$ rad/sec and phase margin $m_\phi^* \ge 40°$.

2) Consider the feedback system



with $P(s) = \dfrac{1}{s+1}$ and $H(s) = \dfrac{1}{s}$. Design a controller $G(s)$ such that

(i) the closed-loop system is asymptotically stable

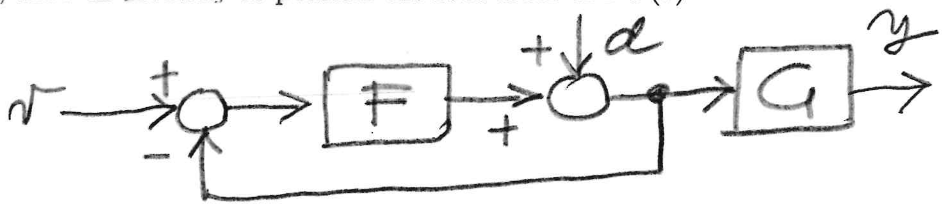
(ii) its steady state error $e_{ss}(t)$ to inputs $v(t) = t$ is 0,

(iii) its steady state output $y_{ss}(t)$ to both constant disturbances $d(t)$ and sinusoidal disturbances $d(t) = \sin t$ is 0,

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

Finally, draw as precisely as possible the root locus of $PG(s)$.

3) Given



with $F(s) = \dfrac{s+1}{s+2}$ and $G(s) = \dfrac{1}{s+2}$ find the transfer functions from d to y and from v to y. Finally, calculate the output response $y(t)$ to $d(t) = (\cos(3t) - 2)\delta_{-1}(t)$.