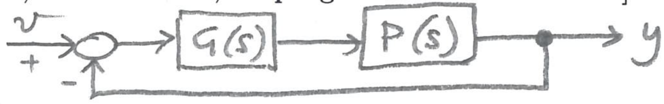
NAME, SURNAME AND STUDENT NUMBER (* required fields):

....

CONTROL SYSTEMS (B) - 4/6/2019

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

1) Given



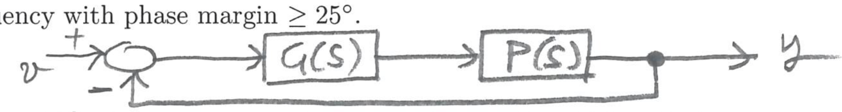
with $P = \frac{1}{s(s-1)}$ design a controller $G(s)$ such that

(i) the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ is asymptotically stable (use the Nyquist criterion with reasonable approximations for the Bode plots),

(ii) $|G(j\omega)|_{dB} < 20\,dB$ for all ω,

(iii) the open loop system $PG(s)$ has as largest as possible crossover frequency with phase margin $\geq 25°$.

2) Given



with $P(s) = \frac{s+2}{s^2+1}$, determine a one-dimensional controller $G(s)$ such that the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ has the following properties:
i) it is asymptotically stable
ii) its steady state error e_{ss} to inputs $v(t) = \delta_{-1}(t)$ is 0.
Draw the root locus of $PG(s)$.
Determine if a one-dimensional controller $G(s)$ can be designed in such a way that, besides satisfying (i) and (ii), there exists $\alpha > 0$ for which all the poles of the feedback system $W(s) = \frac{PG(s)}{1+PG(s)}$ have real part $\leq -\alpha$.

3) Given the system $\dot{x} = Ax$, $y = Cx$, with

$$A = \begin{pmatrix} 0 & -\alpha \\ 1 & -(1+\alpha) \end{pmatrix}, \quad C = \begin{pmatrix} \beta & -\beta \end{pmatrix}$$

discuss the values of $\alpha, \beta \in \mathbb{R}$ and $\gamma > 0$ for which there exists a state observer $\dot{\xi} = A\xi + K(y - C\xi)$ such that the eigenvalues of $A - KC$ have real part $\leq -\gamma$ and determine K.