STUDENT NUMBER..

CONTROL SYSTEMS - 3/7/2018

[time 2 hours; no textbooks; no programmable pocket calculator]

1) Given

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

design a controller $G(s)$ such that

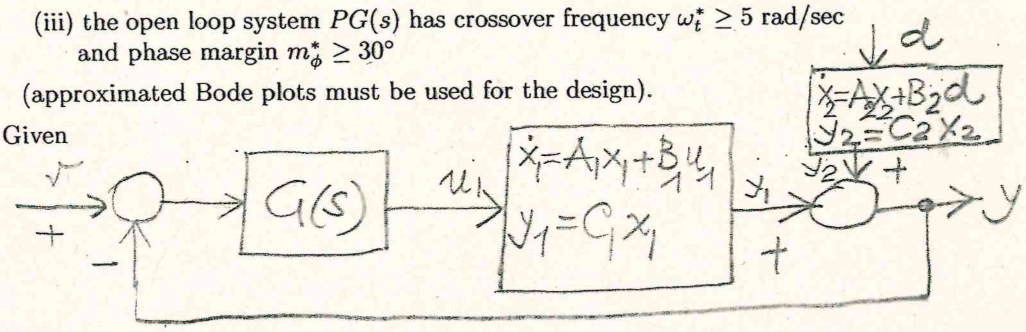
(i) $|G(j\omega)|_{dB} \leq 36dB$ for all $\omega \geq 0$,

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

(iii) the open loop system $PG(s)$ has crossover frequency $\omega_t^* \geq 5$ rad/sec and phase margin $m_\phi^* \geq 30°$

(approximated Bode plots must be used for the design).

2) Given



with

$$A_1 = \begin{pmatrix} 0 & 1 \\ 0 & 2 \end{pmatrix}, \; B_1 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \; C_1 = (1 \;\; 0),$$
$$A_2 = -3, \; B_2 = 1, \; C_2 = 1, \qquad (1)$$

design a controller $G(s)$ such that the closed-loop system is asymptotically stable and the steady state output response to constant $d(t)$ is zero. Draw the root locus of $PG(s)$ using the Routh criterion to determine the exact picture on the imaginary axis.

3) Given

$$\frac{y(s)}{u(s)} = P(s) = \frac{s+2}{s(s+1)(s-3)}$$

find the state response $x(t)$ with input $u(t) = 0$ ensuing from the initial state $x_0 = (1,1,0)^T$. For which initial conditions x_0 the state response $x(t)$ with input $u(t) = 0$ tends asymptotically to zero? Which is the output response $y(t)$ with $x_0 = (0,0,0)^T$ to a constant input $u(t)$?