STUDENT NUMBER.....

CONTROL SYSTEMS - 27/10/2018

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

1) Given $P(s) = \frac{1}{s(s+1)}$ design a controller $G(s)$ of dimension 2 such that the unit feedback system $W(s) = PG(s)/(1 + PG(s))$ is
- asymptotically stable (use Nyquist criterion)
- zero steady state error to constant inputs $v(t)$
- zero steady state output to constant disturbances $d(t)$, additive in the input,

and the open loop system $PG(s)$ has
- maximal crossover frequency ω_t with phase margin $m_\phi \geq 60^\circ$

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

2) Given

$$P(s) = \frac{(s+1)^2}{(s-1)(s-2)(s-4)}$$

- design a first controller $G_1(s)$ such that the closed-loop system is asymptotically stable with all real poles.
- design a second controller $G_2(s)$ such that the closed-loop system is asymptotically stable with all real poles $= -1$.

Draw the root locus of $PG_2(s)$ using the Routh criterion to determine the exact picture on the imaginary axis.

3) Given

$$\begin{aligned} \dot{x}_1 &= x_2 \\ \dot{x}_2 &= -k^2 x_1 - k x_2 + u,\ y = x_1 \end{aligned} \tag{1}$$

with $k \in \mathbb{R}$, find the forced output response $y(t)$ and steady state output response $y_{ss}(t)$ to an input $u(t) = 1 + \sin t$ and find values of $k \in \mathbb{R}$ such that $|y(t) - y_{ss}(t)| \leq 0.05$ for all $t \geq 10^{-2} sec.$