STUDENT NUMBER..

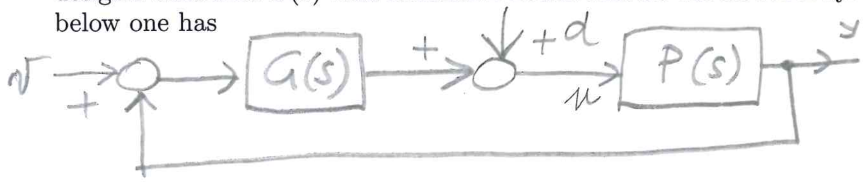
CONTROL SYSTEMS (A) - 2/2/2018

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

1) With

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

design a controller $G(s)$ with dimension 2 such that for the feedback system below one has



(i) asymptotic stability (use the Nyquist criterion)

(ii) $|y_1| \leq 0.1$ (y_1 is the output steady state response to $d(t) = t$)

and for the open loop system one has

(iii) as large as possible phase margin m_ϕ^*.

2) Given

$$P(s) = \frac{(s+2)^2}{(s-1)(s+4)(s+6)}$$

a) draw the root locus of $P(s)$ (with the help of the Routh criterion)
b) determine a controller $G(s)$ such that the feedback system has poles with real part ≤ -3

3) Given $\dot{x} = Ax + Bd, y = Cx$ with $x(0) = x_0 \in \mathbb{R}^2$, input d, output y and

$$A = \begin{pmatrix} -3 & 1 \\ 0 & 2 \end{pmatrix}, \; C = (1 \quad 0) \tag{1}$$

(i) set $d = 0$ and determine the initial conditions x_0 for which the output response $y(t)$ tends to 0 as $t \to +\infty$

(ii) set $x_0 = 0$ and give conditions on B under which the output response $y(t)$ is 0 for all $t \geq 0$ and all inputs d

(iii) set $B = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $x_0 = 0$ and calculate the output response to $d(t) = \sin(t)\delta_{-1}(t-1)$