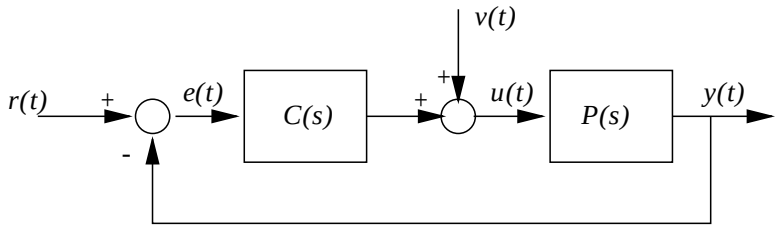
EE 752 Winter 2004 Final Exam Part 1

This is the "Take Home" part of the final examination. It is worth 55% of the total Final Exam grade. You are asked to work alone and sign the pledge.

In this examination we deal with the following standard feedback control system, with linear time invariant controller and plant.



Problem 1. (30 points)
Given a plant

$$P(s) = \frac{e^{-hs}}{(s+a)}$$

design an integral control

$$C(s) = \frac{K_i}{s}$$

such that feedback system is robustly stable for all values of $a \in [1\ ,\ 3]$, and $h \in [0\ ,\ 2]$, and the steady state error for the unit ramp input is as small as possible.

Problem 2. (25 points)
For the plant

$$P(s) = \frac{e^{-hs}(s+1)}{s(s-1)} \quad \text{with } h = 0$$

we know that there exists a proportional controller $C(s) = K$ stabilizing the feedback system.

(a) Find the range of K stabilizing the feedback system for $h = 0$.

(b) For every fixed $h \in [0\ ,\ \widehat{h}_{\max})$ we can still find a proportional controller $C(s) = K$ stabilizing the feedback system. What is the largest value of $\widehat{h}_{\max}$?

(c) Find a proportional controller $C(s) = K$ stabilizing the feedback system for $h = \frac{\widehat{h}_{\max}}{2}$, and maximizing the quantity $\min\{GM_{\text{lower}}^{-1}\ , GM_{\text{upper}}\}$.

(d) What is the delay margin of the system designed in part (c)?