# EE 105 Feedback Control Systems
# Department of Electrical and Computer Engineering
# Tufts University Fall 2018
# Homework #6

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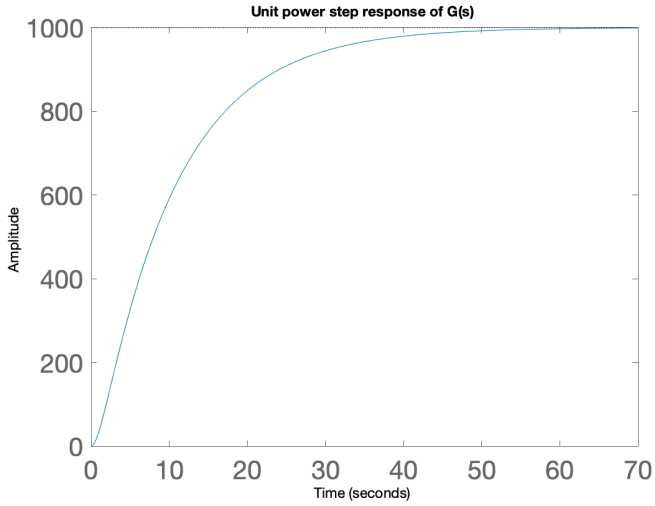
## 1 Problem 1

### 1.1 Part A

The transfer function is:

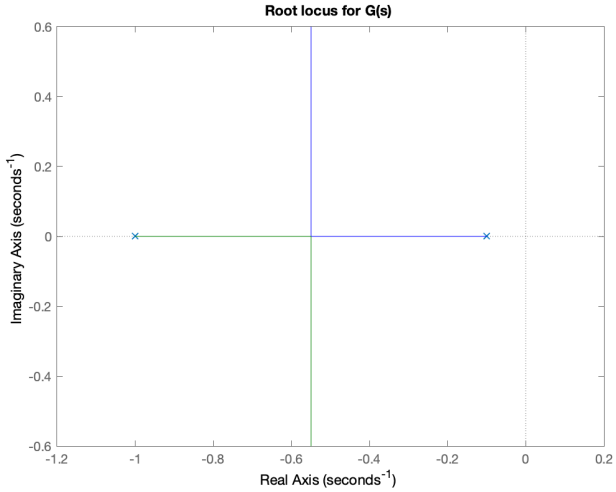
$$G(s) = \frac{100}{(s+0.1)(s+1)}$$

So the step response is:




### 1.2 Part B

Root locus of the system with proportional control only:



## 1.3 Part C

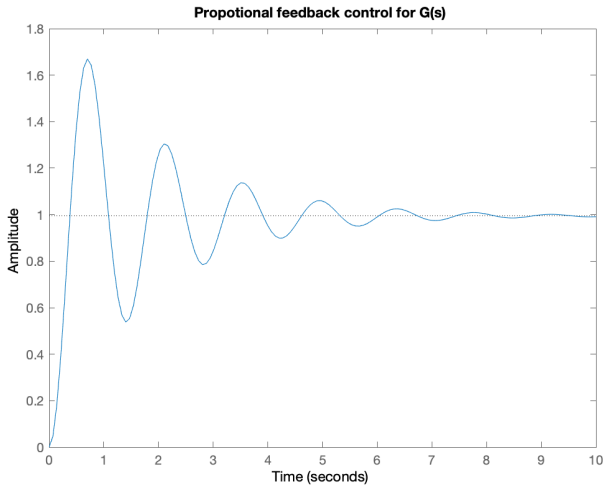
Adjust the gain to high enough to meet the rise time specification ($t_r < 1s$):

$$K = 0.2$$

The transfer function is:

$$P(s) = \frac{100KG(s)}{1 + 100KG(s)} = \frac{K'G(s)}{1 + K'G(s)}$$

The step response is:

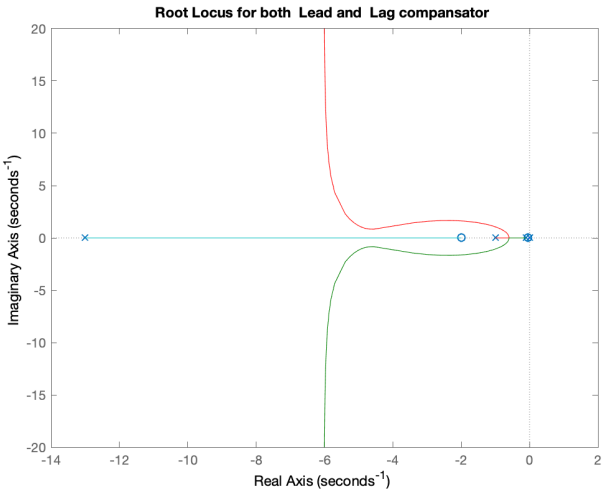



## 1.4 Part D

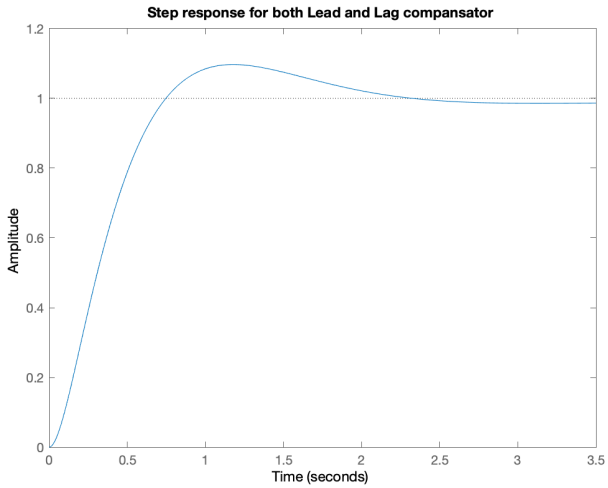
If required a system with none steady error to a step, we need to design the lag compansator with zero pole to make a open loop transfer function a type one transfer function. Since we always have no idea about the complete dynamics of such a thermadynamic system, we can not accurately cancel a poles by applying some lead or lag controller. Thus our open loop transfer function $H(s) = D(s)G(s)$ will become:

$$H(s) = K' \frac{1}{(s+1)(s+0.1)} \cdot \frac{s+2}{s+13} \cdot \frac{s+0.04}{s}$$

The root locus of $H(s)$ is(where $K' = 30$):




Response to a step:




## 1.5 Part E

While applying a lag compensator $D_{lag} = (s + 0.04)/s$, which will add a really slow decay term in the transfer function of time domain. That's where the small tail come from.