MCE441/541

MIDTERM PROJECT SOLUTION – FALL 2011

PRE-DESIGN

1. system is type I (1 free integrator in $G(s)K(s)$)
The steady-state error to step inputs is zero.

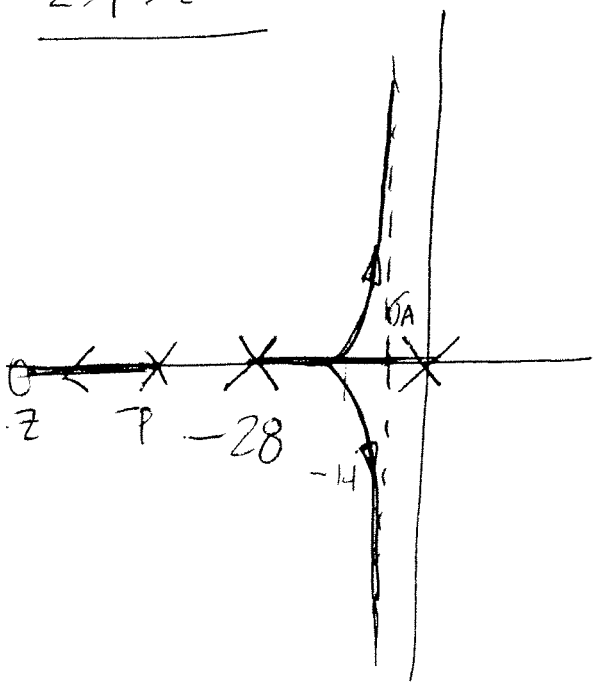
2,3. $G(s)K(s) = K\dfrac{(s+z)\cdot 73}{s(s+p)(s+28)}$

$n = 3,\ m = 1$: 2 asymptotes at 90° & 270°.

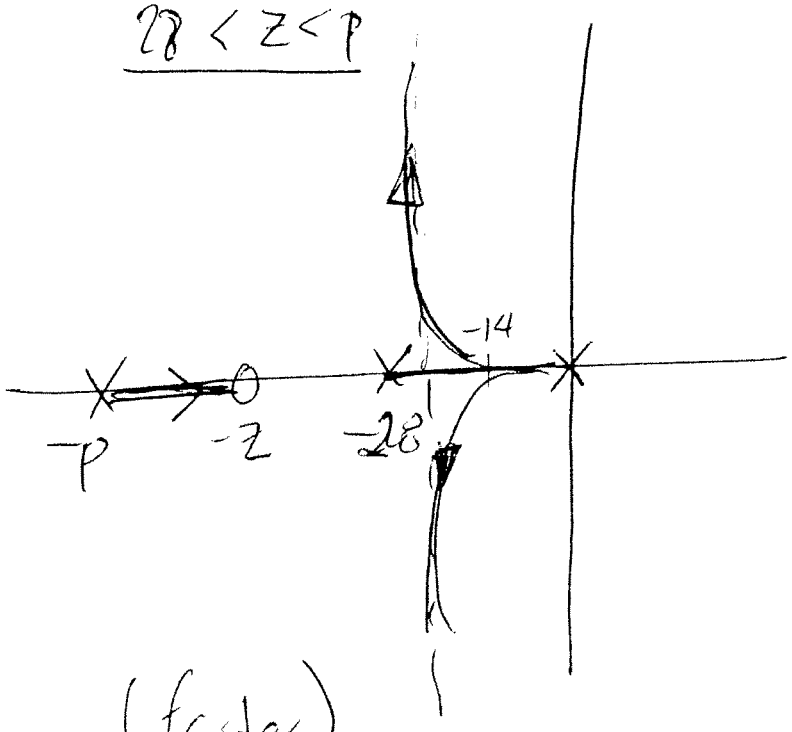
$\sigma_A = \dfrac{(-p-28)-(-z)}{2} = \dfrac{(z-p)-28}{2}$

- When $z > p$, $z-p$ is positive and $\sigma_A > -14$
- When $z < p$, $z-p$ is negative and $\sigma_A < -14$

$z > p > 28$



$28 < z < p$

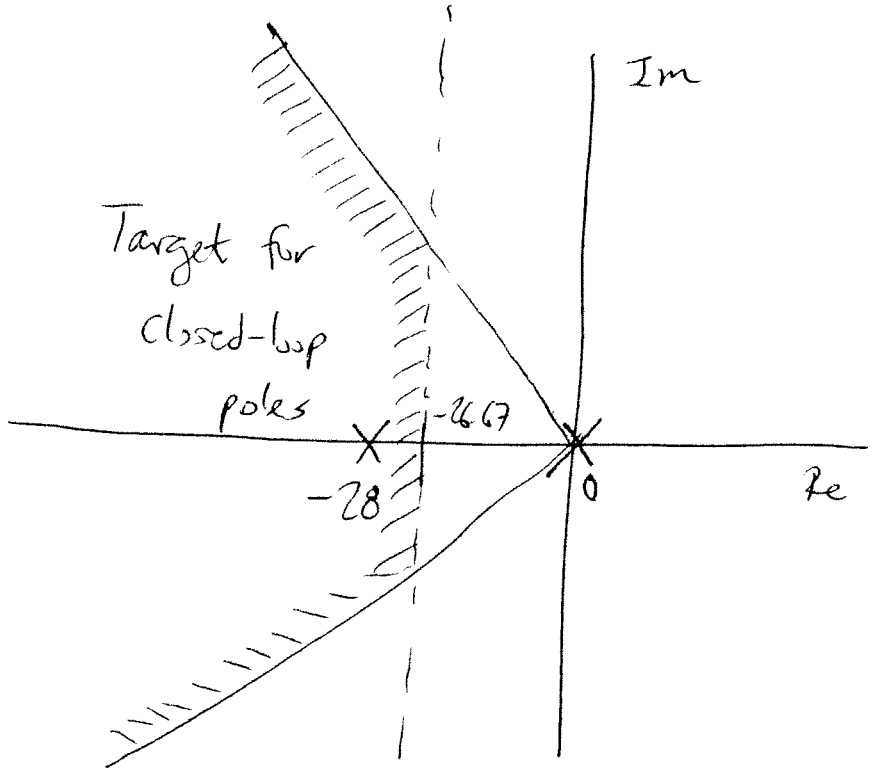


(faster)

4. It's better to choose $p > z > 28$.

For $PO < 10\%$: $\zeta > 0.6$ $(\beta < 53^\circ)$

For $T_{set} < 0.15s$: $\frac{4}{\zeta \omega_n} < 0.15 \rightarrow \zeta \omega_n > 26.67$



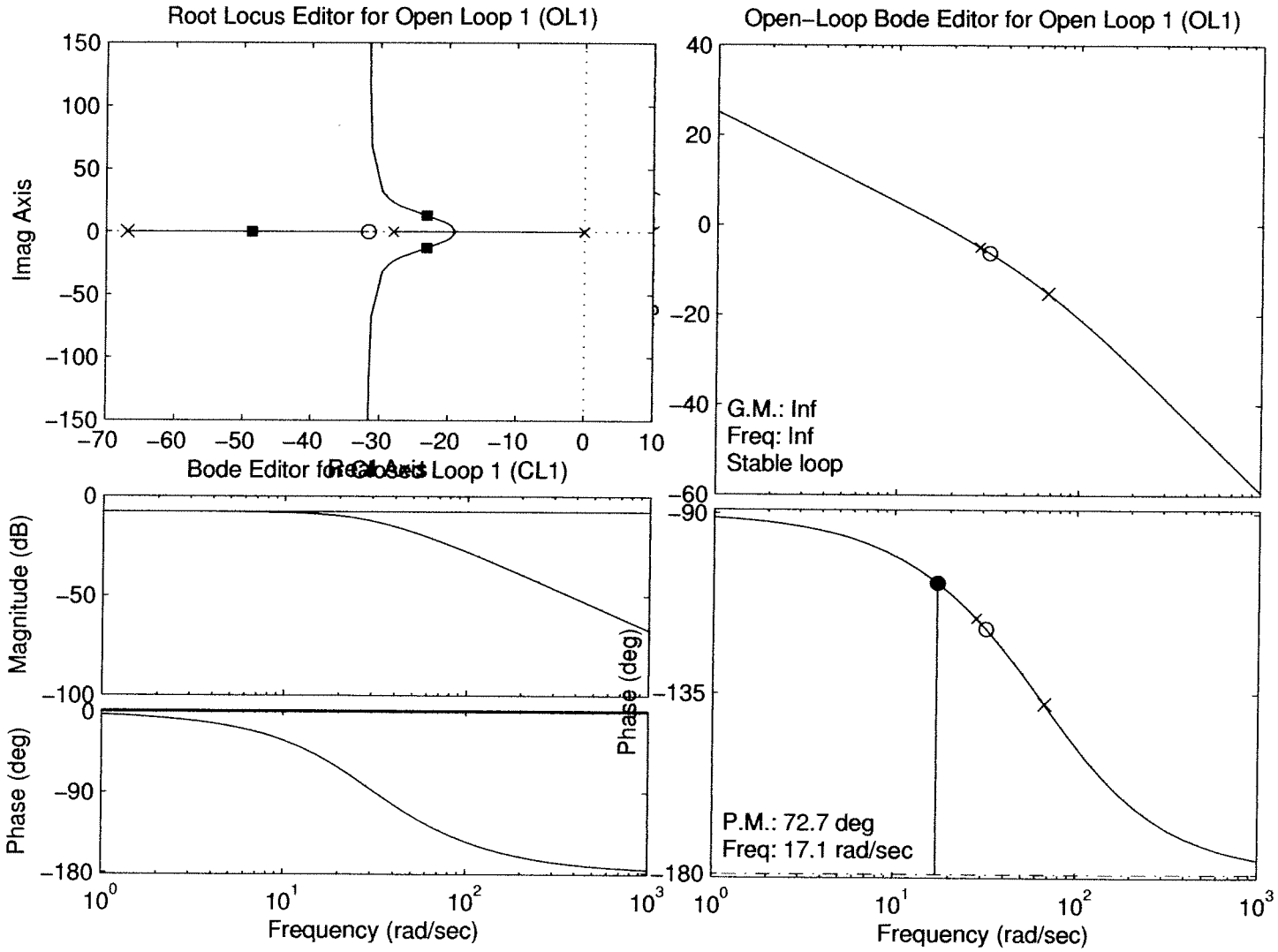
SISOtool tuning:

Initially, the control voltage (green line) starts at 0.4050 V. This is because the system is initially configured with proportional control with $K = 1$

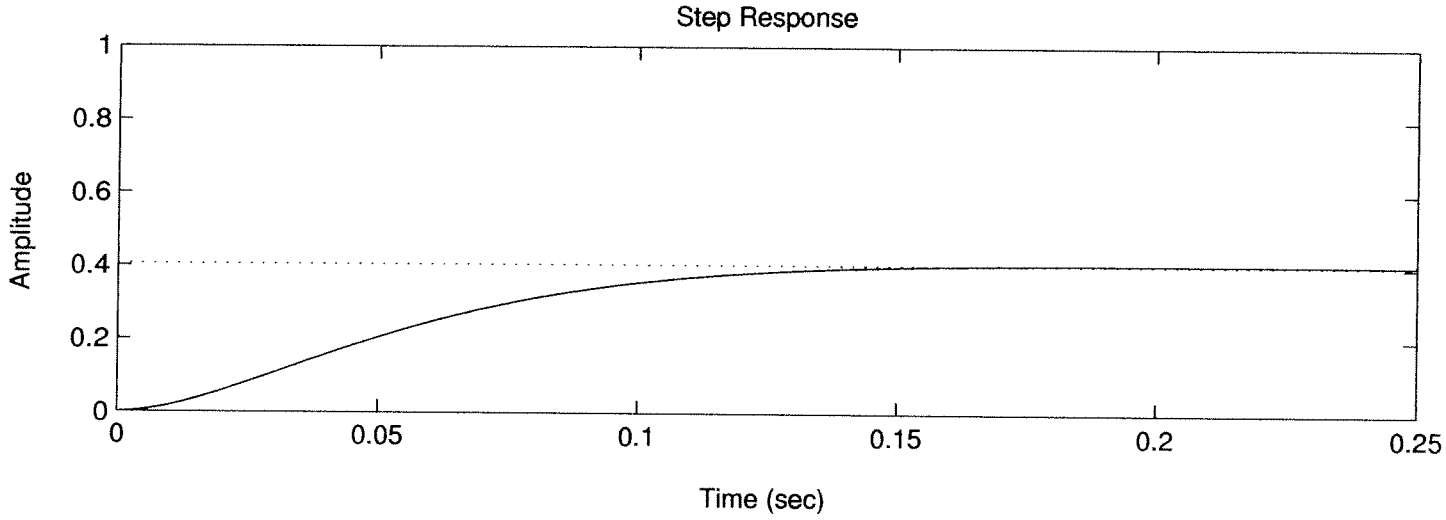
$$u = Ke = 1(0.4050 - y(0)) = 0.4050$$

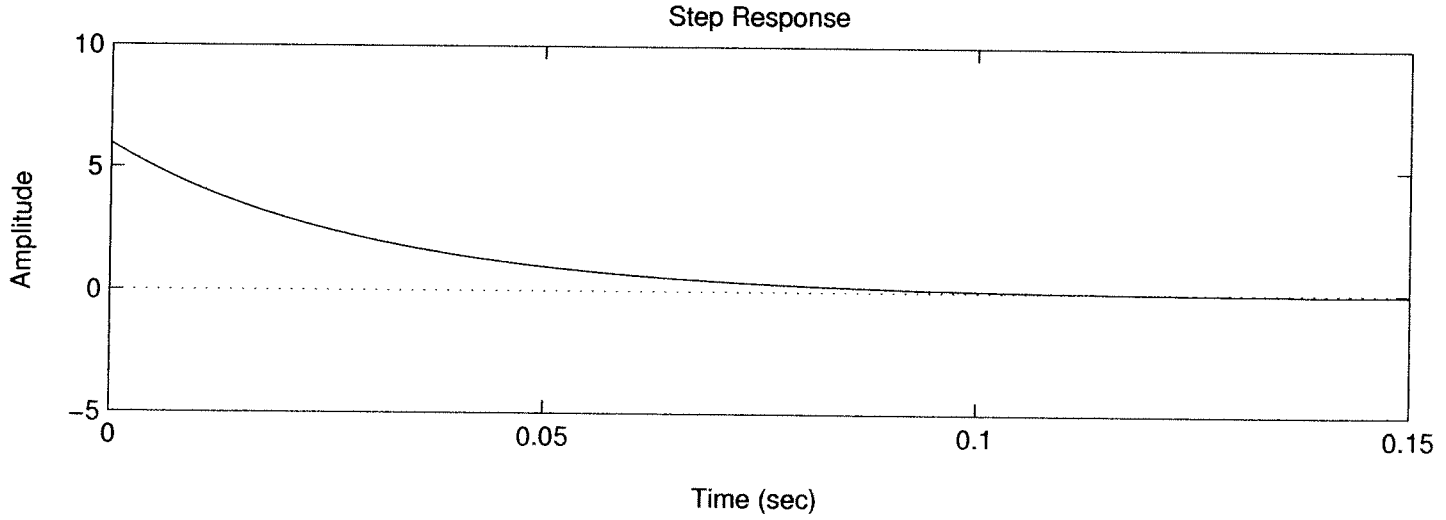
↑ zero

sisotool final tuning



From sisotool





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>> C
```
(exported controller)

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Zero/pole/gain from input "Input" to output "Output":
14.746 (s+31.62)
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    (s+66.9)

>> sysGK=series(C,sysG)

Zero/pole/gain from input "Input" to output:
1076.4602 (s+31.62)
-------------------
 s (s+28) (s+66.9)

>> sysT=feedback(sysGK,1)

Zero/pole/gain from input "Input" to output:
      1076.4602 (s+31.62)
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(s+48.65) (s^2 + 46.25s + 699.6)

>> step(0.4050*sysT)
>>
```

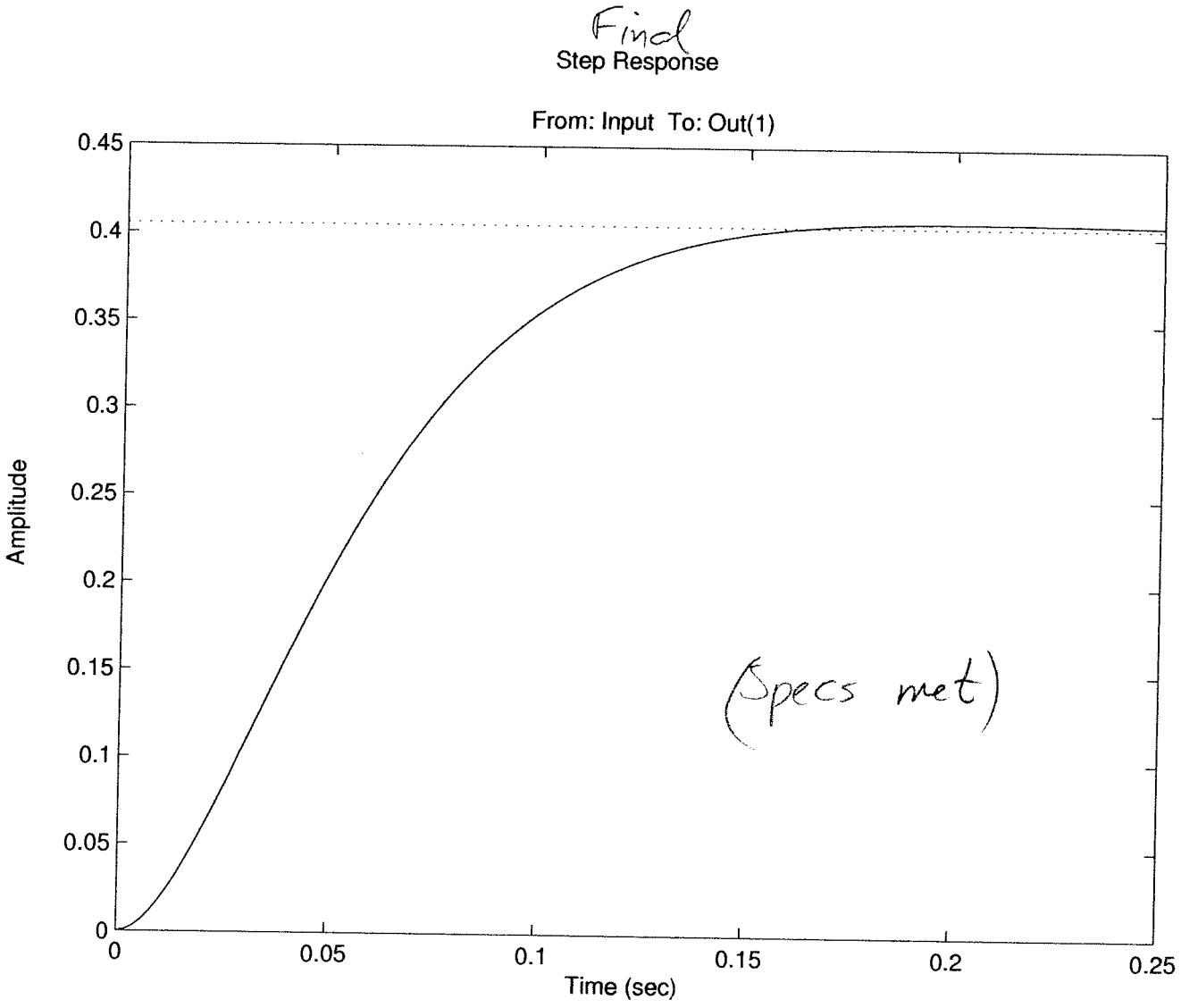
$z = -31.62$

$p = -66.9$

$K = 14.75$

} loop TF (GK)

} closed-loop TF (T(s))


Find
Step Response
From: Input To: Out(1)
Amplitude
Time (sec)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
(Specs met)