Even 3rd Class 4 Domael Esra

Root locus

1. $G(s) = \dfrac{s^2-3s+2}{s^2+7s+12}$

Z : 2, 1

P : -3, -4 $\quad P-Z=\phi$ ← no infinch, no asymptopes

Breakaway:

I) $K = -\dfrac{s^2+7s+12}{s^2-3s+2} \quad \dfrac{dK}{ds} = -\dfrac{(2s+7)(s^2-3s+2)-(s^2+7s+12)(2s-3)}{(s^2-3s+2)^2}$

$\Rightarrow (2s^3 - 6s^2 + 4s + 7s^2 - 21s + 14) - (2s^3 + 14s^2 + 24s - 3s^2 + 21s - 36)$

$= -10s^2 - 20s + 50 \Rightarrow 10s^2+20s-50 = 0$

$s = (1.45, -3.45)$

II) $\dfrac{1}{s+2} + \dfrac{1}{s-1} = \dfrac{1}{s+3} + \dfrac{1}{s+4}$

$1/s-2 + 1/s-1 - 1/s+3 - 1/s+4 = 0$

$(s-1)(s+3)(s+4) + (s-2)(s+3)(s+4) - (s-1)(s-2)(s+4) - (s-1)(s-2)(s+3)$

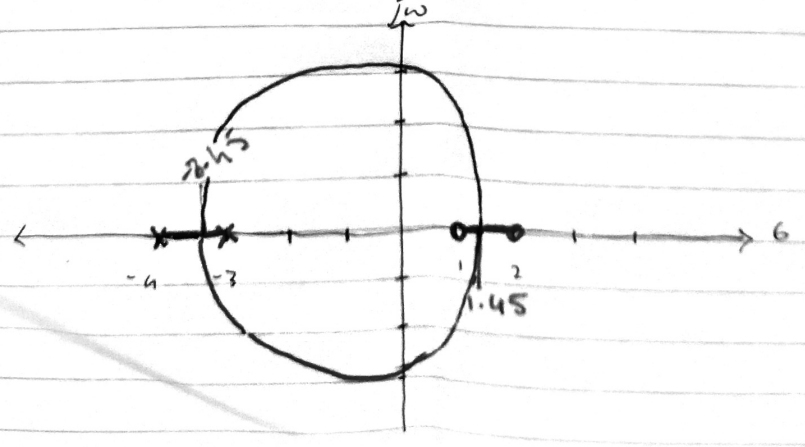
$s^2+7s+12 \quad s^2+7s+12 \quad s^2+2s-8 \quad s^2+s-6$

$\rightarrow s^3+8s^2+19s+12 + s^3+7s^2+14s+12 - s^3-s^2+10s-8 - s^3-2s^2+s+6$

$-s^3$

$= 10s^2+20s-50 = 0 \quad , s = (1.45, -3.45)$

Plot:



2. $G(s) = \frac{s+3}{0.4s^3 + 3s^2 + 5s + 2}$

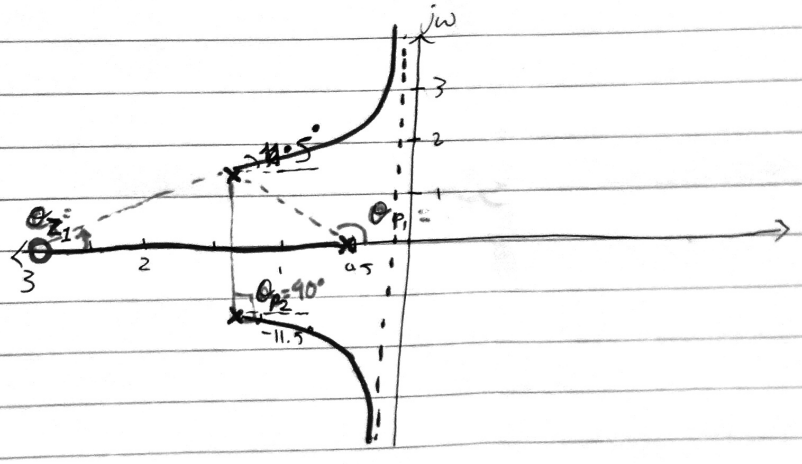
$Z : -3$

$P : -0.55, -1.39 \pm 1.44, \quad P-Z=2$

Assymtopes.

$$\theta_a = \frac{(-0.55 + -1.39 + -1.39)}{2} - (-3) = -0.165$$

$$\theta_a = \frac{(2k+1)\pi}{2}, \quad k=0 \Rightarrow \frac{\pi}{2} = 90°$$



Angles of departure.

$$\theta_D = 180 + \sum \theta_Z - \sum \theta_P \Rightarrow 180 + (\theta_{Z_1}) - (\theta_{P_1} + \theta_{P_2})$$

$$\theta_{Z_1} = (-1.39 + 1.44j - -3) = 2.16 \angle 41.81°$$

$$\theta_{P_1} = (-1.39 + 1.44j - -0.55) = 1.66 \angle 120.25°$$

$$\theta_{P_2} = 90°$$

$$\theta_D = 180 + (41.81) - (90 + 120.25) = \pm 11.55°$$

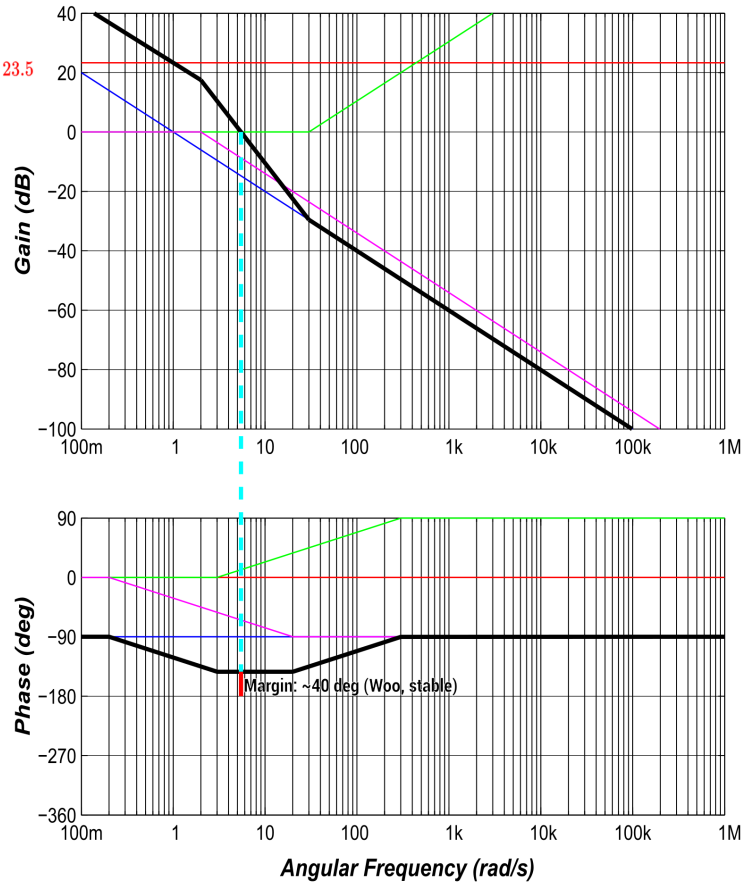
$$G(s) = \frac{s+30}{s(s+2)} = \frac{30\left(\frac{s}{30}+1\right)}{2s\left(\frac{s}{2}+1\right)} = 15 \cdot \frac{1}{s} \cdot \left(\frac{s}{30}+1\right) \cdot \frac{1}{\left(\frac{s}{2}+1\right)}$$

$20 \cdot \log(15) = 23.5$

$\frac{1}{s}$

$\left(\frac{s}{30}+1\right)$

$\frac{1}{\left(\frac{s}{2}+1\right)}$

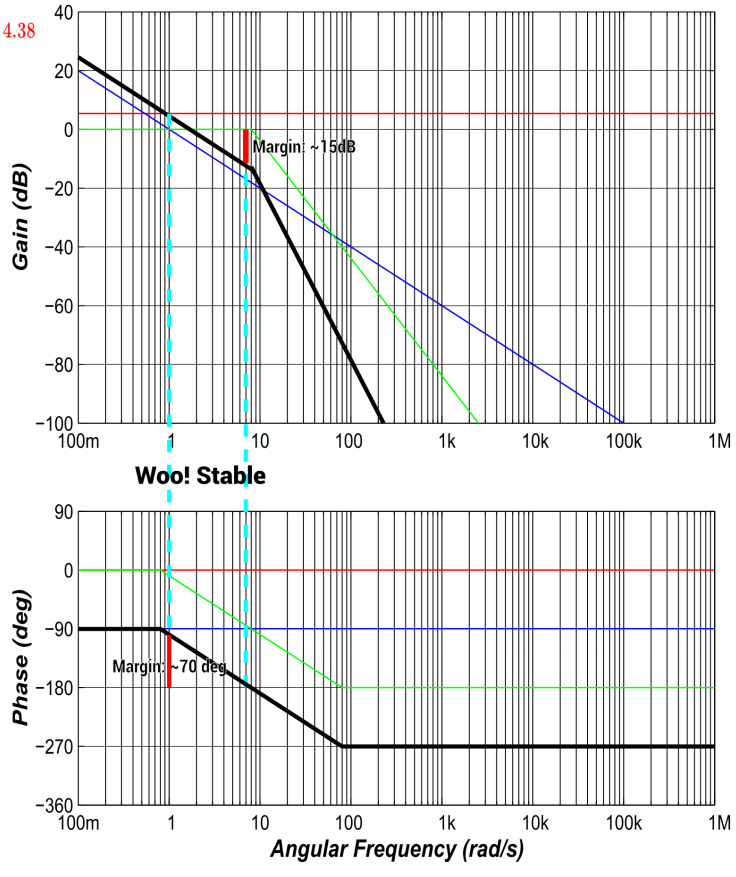


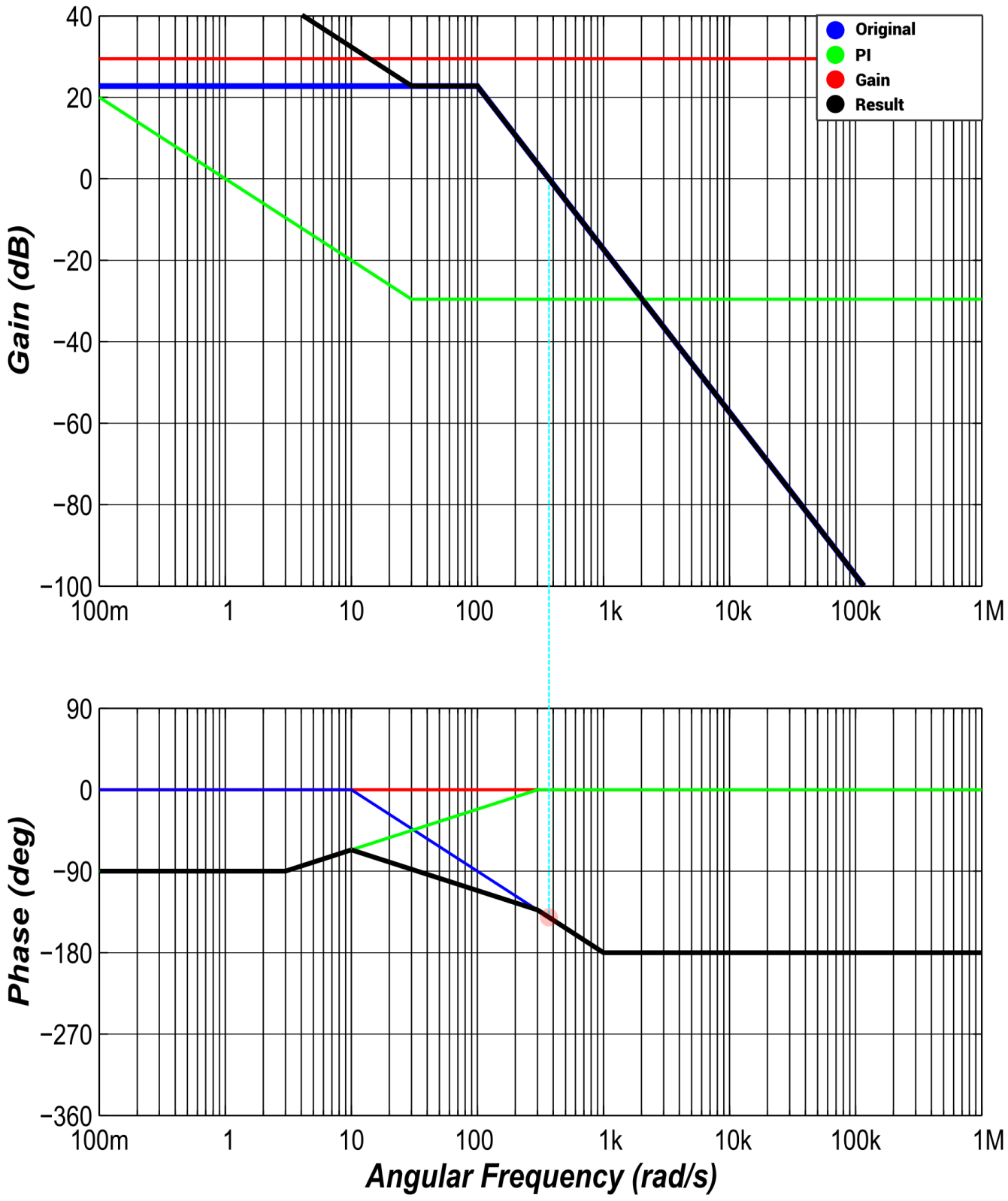
$$G(s) = \frac{106}{s^3+16s^2+64s} = \frac{106}{64} \cdot \frac{1}{s\left(\frac{s}{8}+1\right)^2} = \frac{106}{64} \cdot \frac{1}{s} \cdot \frac{1}{\left(\frac{s}{8}+1\right)^2}$$

$20 \cdot \log\left(\frac{106}{64}\right) = 4.38$

$\frac{1}{s}$

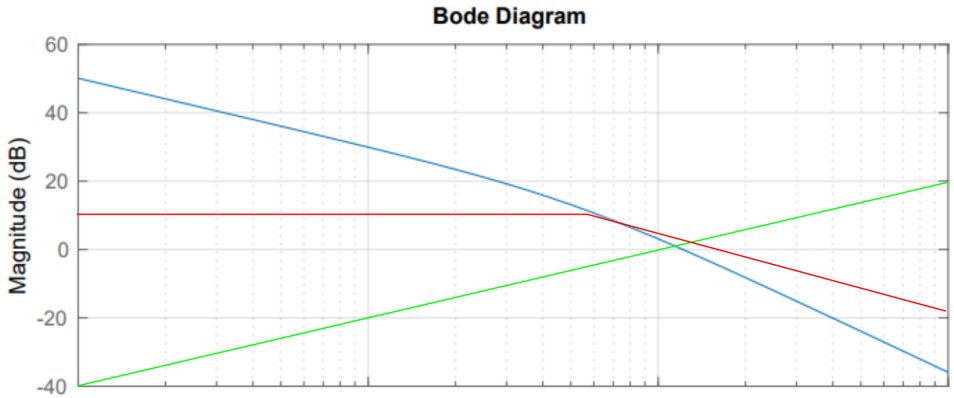
$\frac{1}{\left(\frac{s}{8}+1\right)^2}$




Original
PI
Gain
Result
Gain (dB)
40
20
0
−20
−40
−60
−80
−100
Phase (deg)
90
0
−90
−180
−270
−360
100m
1
10
100
1k
10k
100k
1M
Angular Frequency (rad/s)

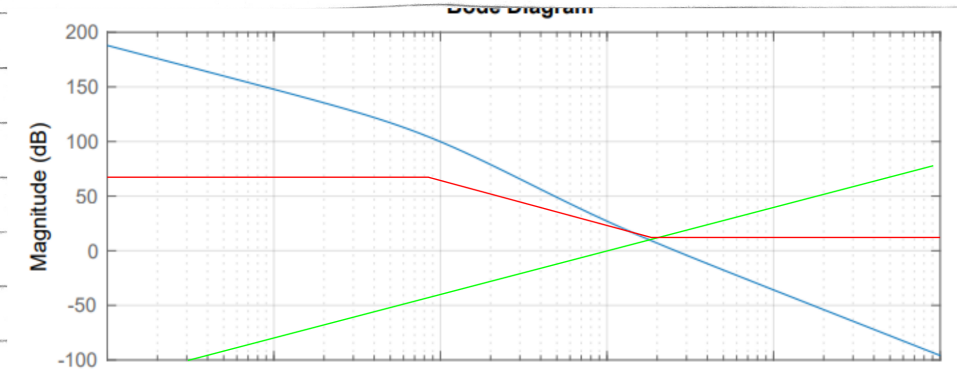
4. F) Type 1.

- Step : Zero error
- Parabolic : Infinite error
- Ramp : $\frac{1}{K_V}$, 10 dB → 3.16 ⇒ 0.316



II. Type 2.

- Step & Ramp : Zero error
- Parabolic : $\frac{1}{K_a}$, 70dB → 3.16×10^{-4}



III. Type 0.

- Ramp & Parabolic : Infinite.
- Step : $\frac{1}{1+K_p}$, read 14 dB → $K_p = 10^{\frac{14}{20}} = 5.01$

$\frac{1}{1+5} = \frac{1}{6}$ = steady state error.