Lead Form $K(s) = K_0 \dfrac{s_p \,(s - s_z)}{s_z \,(s - s_p)}$ $|s_p| > |s_z|$

Decomp $K(s) = \left(K_0\right)\left(\dfrac{-s_p}{s - s_p}\right)\left(\dfrac{s - s_z}{-s_z}\right)$

$K(j\omega)$

Im(s)

$j\omega$

$|j\omega - s_p|$ $|j\omega - s_z|$ $\sphericalangle (j\omega - s_z)$

$\sphericalangle (j\omega - s_p)$

Re(s)

$s_p < 0$ $s_z < 0$

$\sphericalangle K(j\omega)$ $90°$ $45°$ 0

$\omega = 0.1|s_p|$ $\omega = |s_z|$ $\omega = |s_p|$

if $|s_p| > 19|s_z|$

$20\log_{10}|K(j\omega)|$ $\frac{s_p}{s_z}K_0$ K_0

Prop Arm

$$H(s) = \frac{-\beta\gamma}{s^2(s-\beta)}$$

$\angle H(j\omega)$

-180

-225

-270

0.1β

10β

$\omega = |\beta$
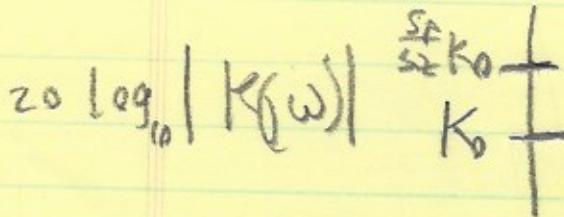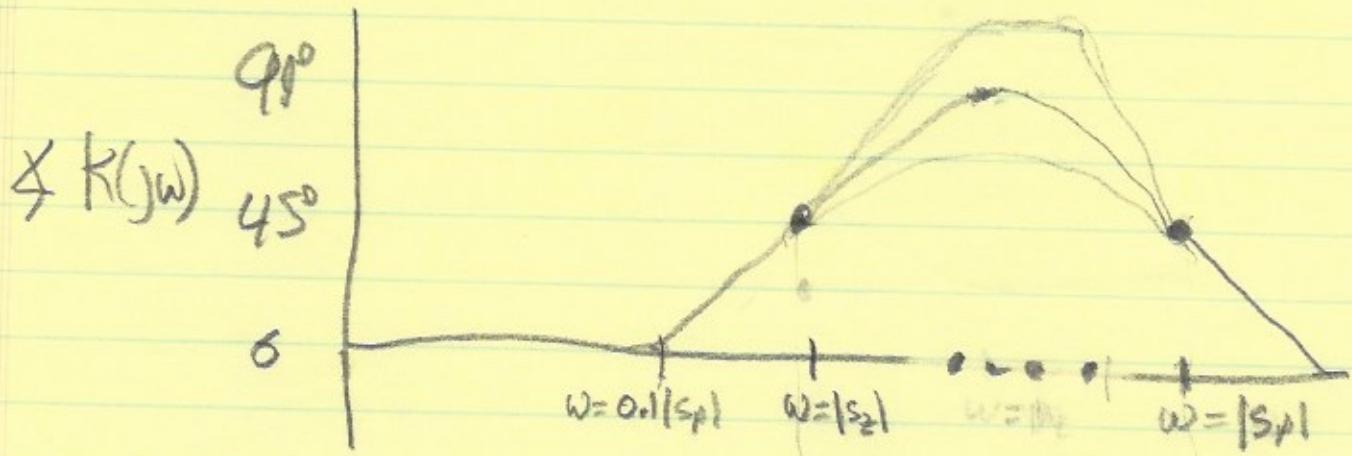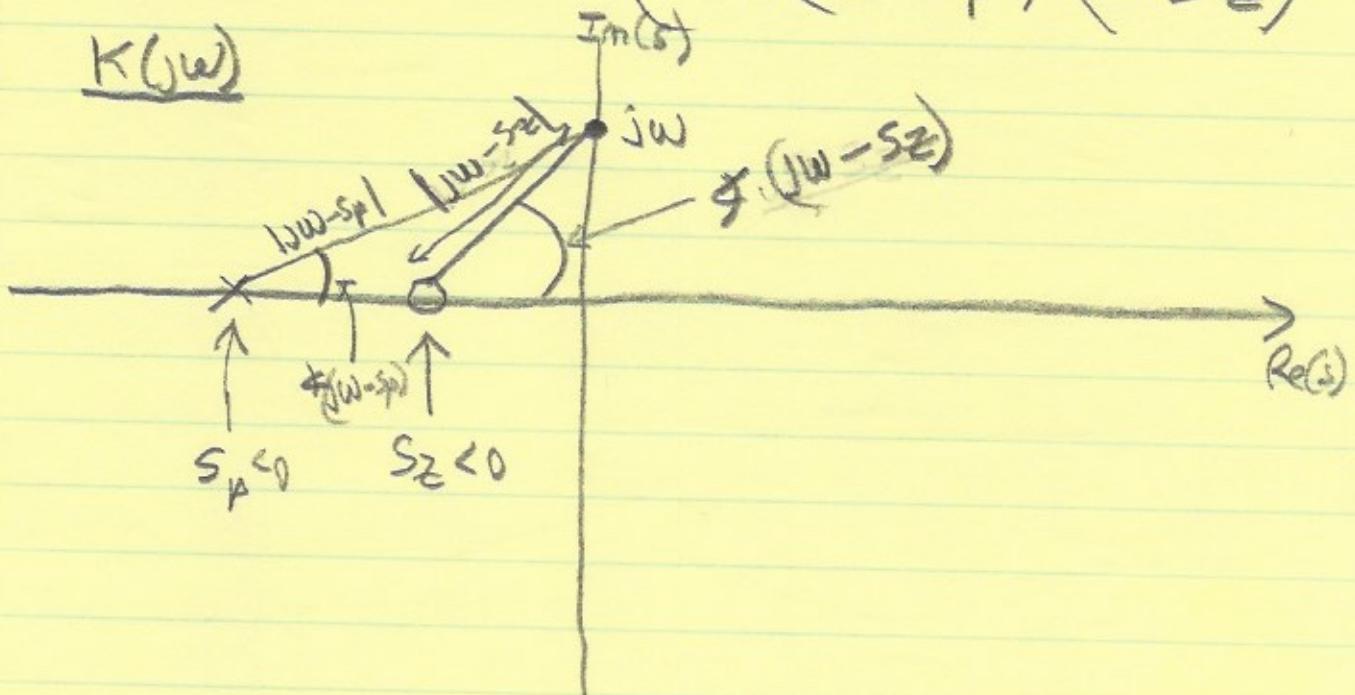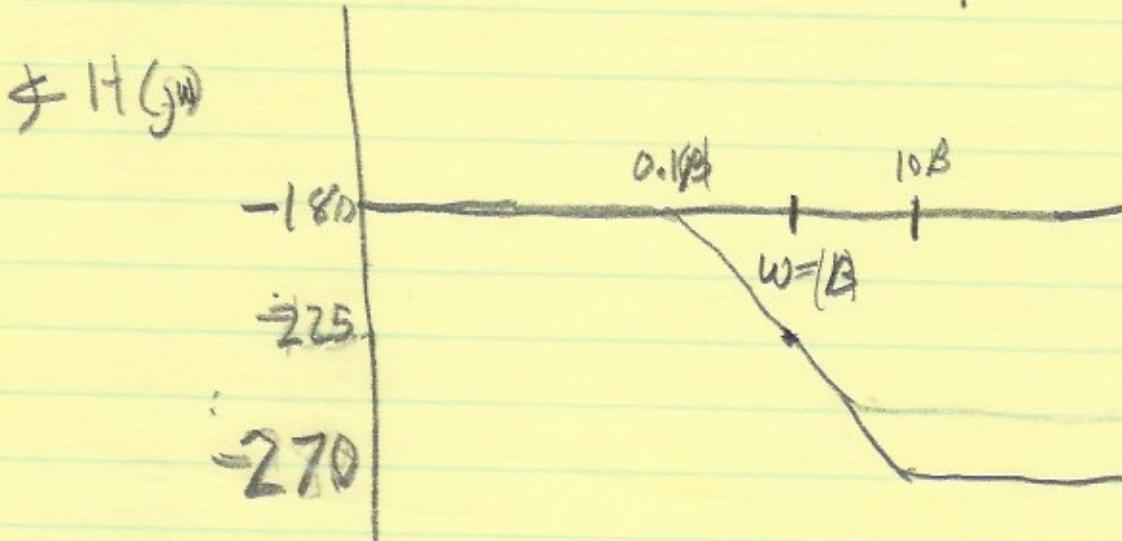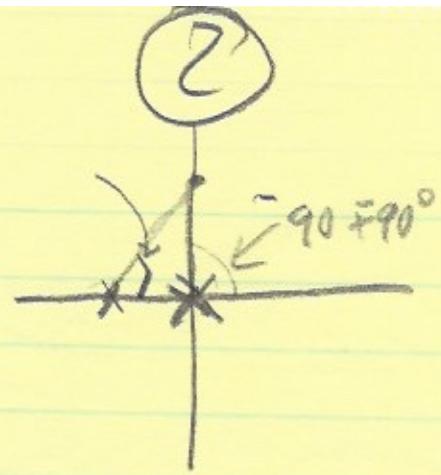
$20 \log_{10} |H|$

$\omega = \beta$
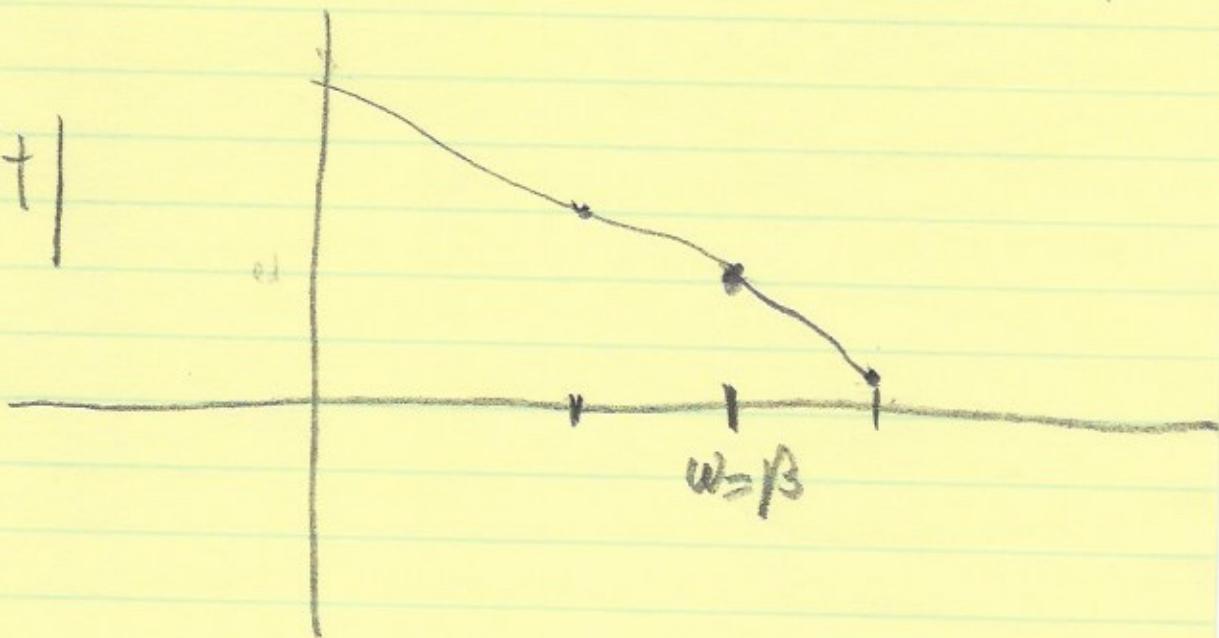
Goal

when $|K(j\omega)H(j\omega)| = 1$

$\angle K(j\omega) H(j\omega)$ is as far above -180 as possible

```matlab
>> Gamma = 90; Beta = -13; Hs = -(Gamma*Beta)/(s^2*(s-Beta));
>> K0 = 1; sz = -1000; sp = -100000; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 1; sz = -3; sp = -30; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 1; sz = -10; sp = -100; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 1; sz = -6; sp = -60; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 1; sz = -6; sp = -600; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 1; sz = -6000; sp = -600000; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 10; sz = -6000; sp = -600000; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 10; sz = -4; sp = -40; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 10; sz = -8; sp = -80; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 10; sz = -6; sp = -60; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 10; sz = -10; sp = -100; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks); hold on; margin(Hs); margin(Ks*Hs); figure(2); step(feedback(Ks*Hs,1),5);
>> K0 = 3.3; sz = -10; sp = -100; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks*Ks); hold on; margin(Hs); margin(Ks*Ks*Hs); figure(2); step(feedback(Ks*Ks*Hs,1),5);
>> K0 = 3.3; sz = -20; sp = -200; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks*Ks); hold on; margin(Hs); margin(Ks*Ks*Hs); figure(2); step(feedback(Ks*Ks*Hs,1),5);
>> K0 = 3.3; sz = -40; sp = -400; Ks = K0*(sp/sz)*(s-sz)/(s-sp); figure(1); hold off; margin(Ks*Ks); hold on; margin(Hs); margin(Ks*Ks*Hs); figure(2); step(feedback(Ks*Ks*Hs,1),5);
>>
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