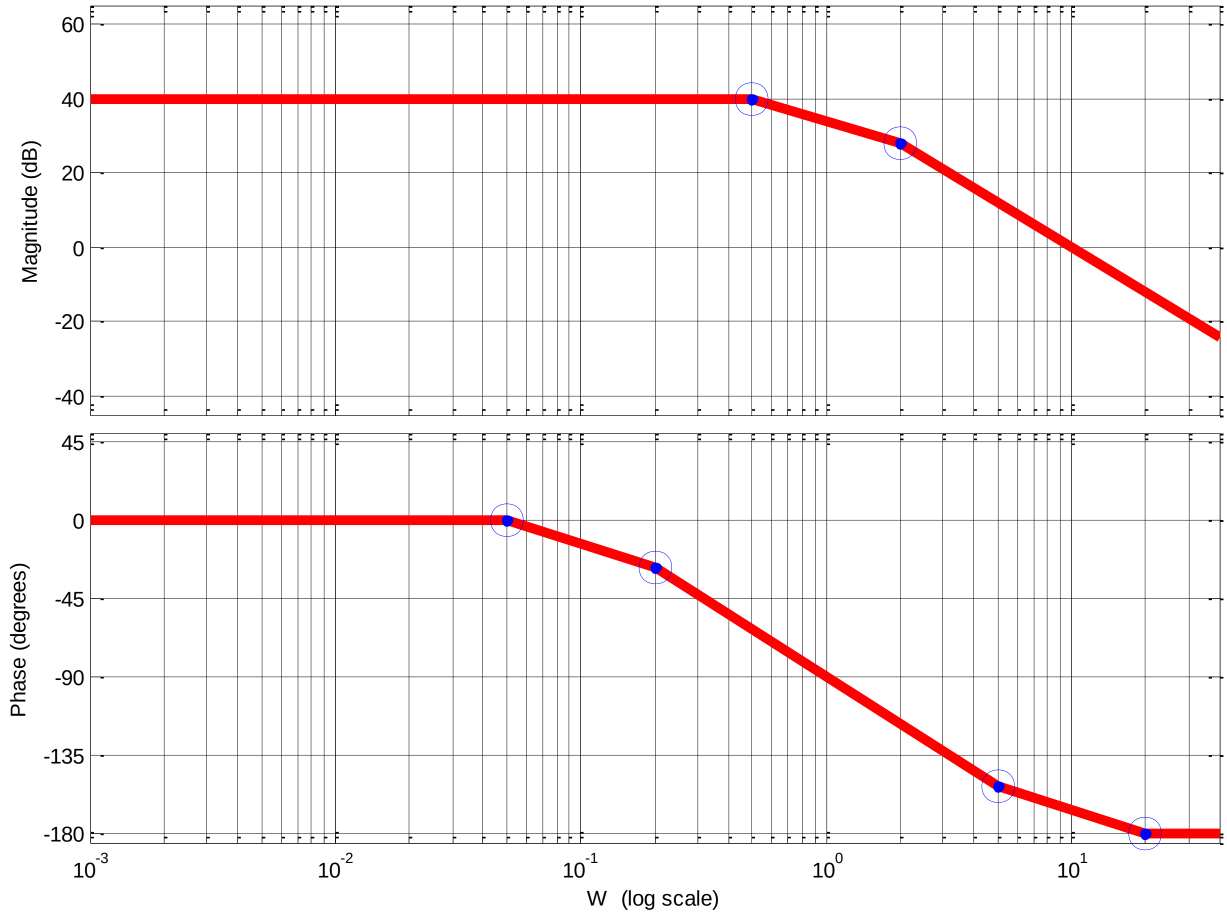
a) $$H(s) = \frac{100}{(s/2+1)\cdot(2s+1)}$$

Approximate Magnitude:

$$\omega << 0.5 \quad : \quad M(\omega) \sim 20 \cdot \log_{10}(100) = 40db$$

$$\omega \in [0.5 \quad , \quad 2] \quad : \quad dM(\omega)/d\omega = -20db/decade$$

$$\omega > 2 \quad : \quad dM(\omega)/d\omega = -40db/decade$$



Approximate Phase:

$$\omega << 0.5/10 \quad : \quad \varphi(\omega) \sim 0^0$$

$$\omega \in [0.5/10 \quad , \quad 2/10] \quad : \quad d\varphi(\omega)/d\omega = -45^0/decade$$

$$\omega \in [2/10 \quad , \quad 0.5 \cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -90^0/decade$$

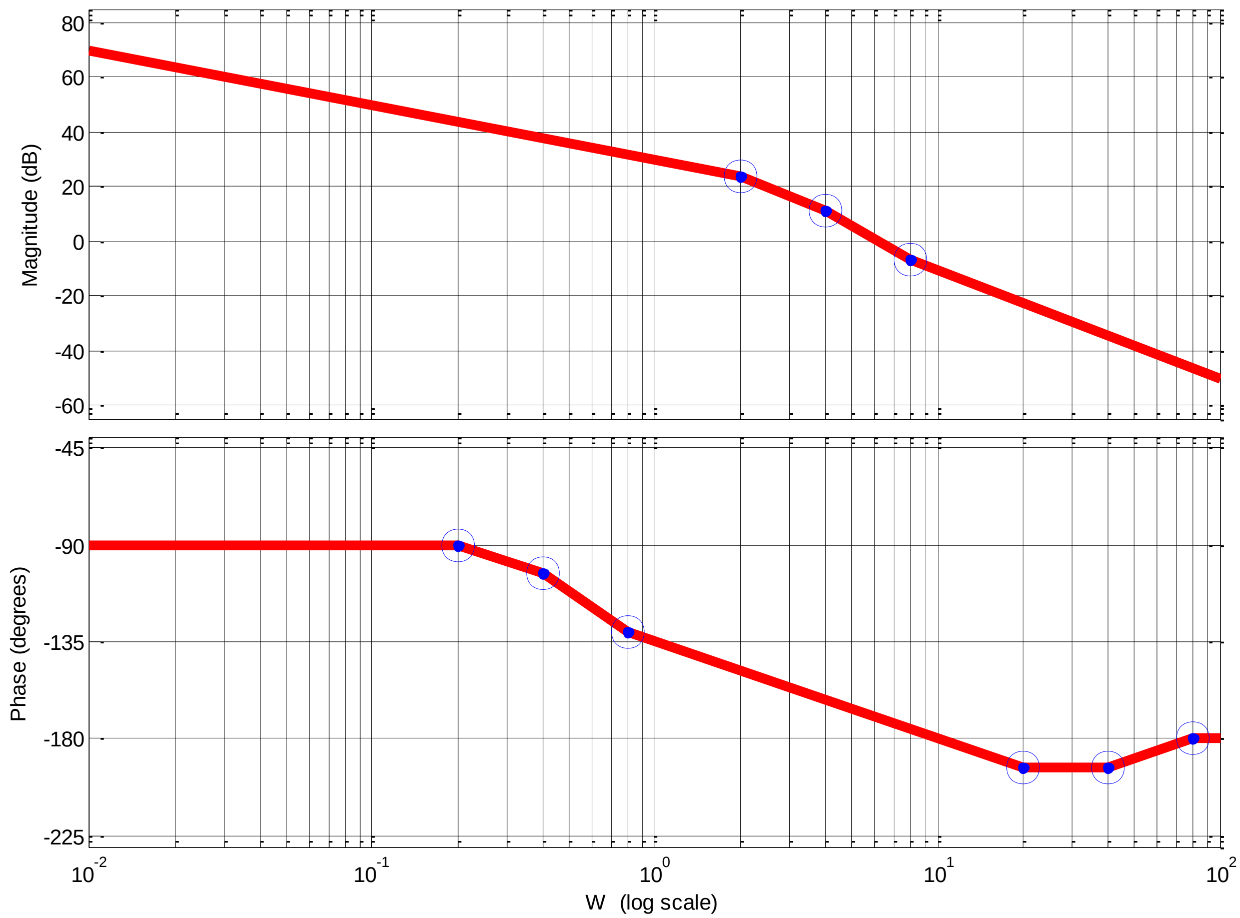
$$\omega \in [0.5 \cdot 10 \quad , \quad 2 \cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -45^0/decade$$

$$\omega > 2 \cdot 10 \quad : \quad d\varphi(\omega)/d\omega = 0^0/decade, \quad \varphi(\omega) \sim -180^0$$

* Gain Margin = INFINITE (The Phase is > -180 for all values of W)
* Phase Margin: Approximately 15 degrees (M(W)~=0dB at W~10 rad/sec, Phase at that W is ~-165 degrees)

b)

$$H(s) = \frac{30 \cdot (s+8)}{s \cdot (s+2) \cdot (s+4)}$$



Approximate Phase:

$\omega << 2/10 \quad : \quad \varphi(\omega) \sim -90^0$ (phase mainly due to pole at 0)

$\omega \in [2/10 \quad , \quad 4/10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \,/\, decade$ (rate mainly due to pole "-2")

$\omega \in [4/10 \quad , \quad 8/10] \quad : \quad d\varphi(\omega)/d\omega = -90^0 \,/\, decade$ (.. to poles "-2,-4")

$\omega \in [8/10 \quad , \quad 2 \cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \,/\, decade$ (.. to poles "-2,-4", zero "-8")

$\omega \in [2 \cdot 10 \quad , \quad 4 \cdot 10] \quad : \quad d\varphi(\omega)/d\omega = 0^0 \,/\, decade$ (.. to pole "-4", zero "-8")

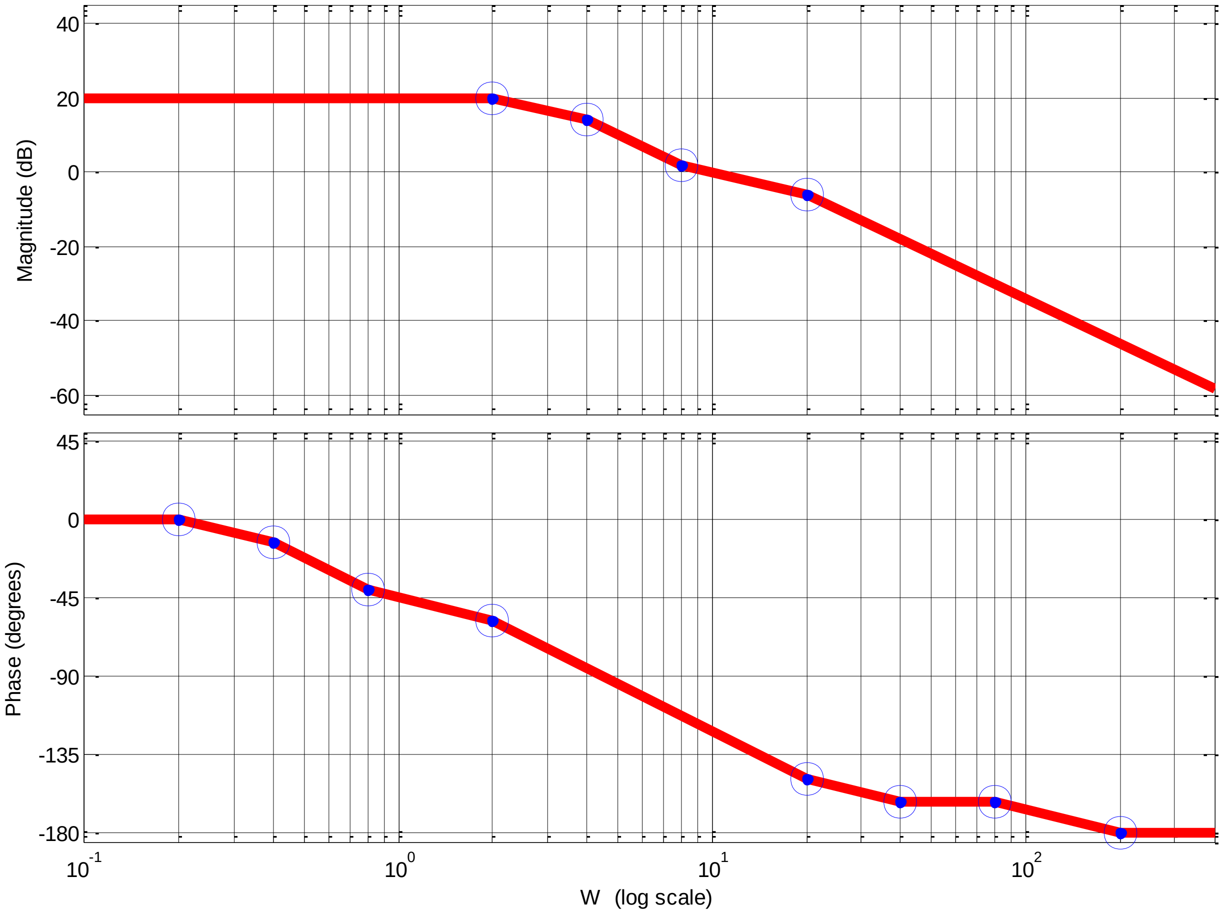
$\omega \in [4 \cdot 10 \quad , \quad 8 \cdot 10] \quad : \quad d\varphi(\omega)/d\omega = +45^0 \,/\, decade$ (zero "-8")

$\omega > 8 \cdot 10 \quad : \quad d\varphi(\omega)/d\omega = 0^0 \,/\, decade, \quad \varphi(\omega) \sim -180^0$

* Gain Margin ~ 10dB (Phase crosses -180 degrees at W ~10 rad/sec, and M(W) ~-10dB.

Phase Margin: Approximately 10 degrees. M(W)~=0dB at W~ 6 rad/sec, where Phase is ~-170 degrees (-170 = -180+10)

c) $$H(s) = \frac{200 \cdot (s+8)}{(s+2)\cdot(s+4)\cdot(s+20)}$$



Approximate Phase:

$$\omega << 2/10 \quad : \quad \varphi(\omega) \sim 0^0$$

$$\omega \in [2/10 \quad , \quad 4/10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \ / \ decade$$

$$\omega \in [4/10 \quad , \quad 8/10] \quad : \quad d\varphi(\omega)/d\omega = -90^0 \ / \ decade$$

$$\omega \in [8/10 \quad , \quad 20/10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \ / \ decade$$

$$\omega \in [20/10 \quad , \quad 2\cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -90^0 \ / \ decade$$

$$\omega \in [2\cdot 10 \quad , \quad 4\cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \ / \ decade$$

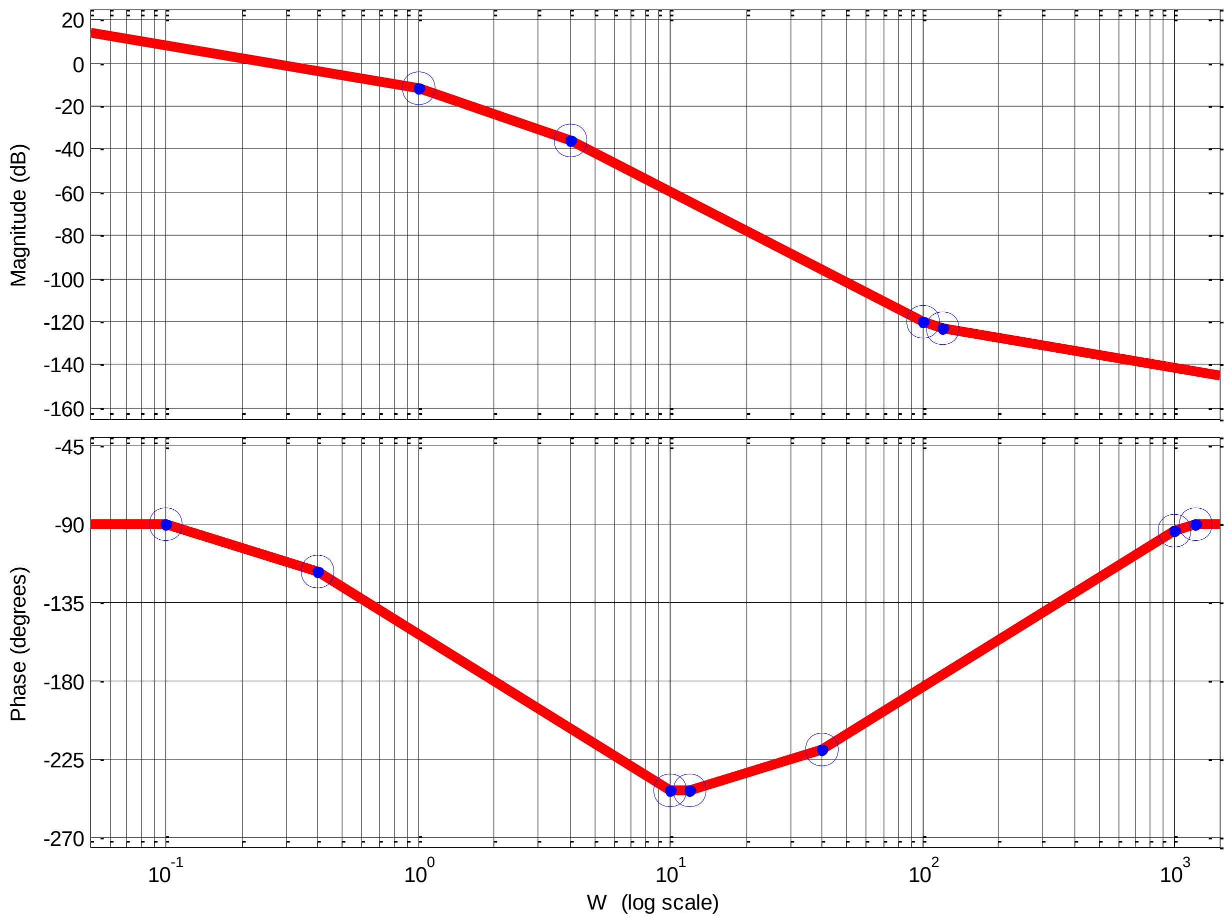
$$\omega \in [4\cdot 10 \quad , \quad 8\cdot 10] \quad : \quad d\varphi(\omega)/d\omega = +0^0 \ / \ decade$$

$$\omega \in [8\cdot 10 \quad , \quad 20\cdot 10] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \ / \ decade$$

$$\omega > 20\cdot 10 \quad : \quad d\varphi(\omega)/d\omega = 0^0 \ / \ decade, \quad \varphi(\omega) \sim -180^0$$

* Gain Margin: INFINITE (there is no W where Phase touches -180 degrees)
* Phase Margin: Approximately 60 degrees. M(W)~=0dB at W~ 10 rad/sec, where Phase is ~-120 degrees (-120 = -180+60)

d) $$H(s)=\frac{(s/100+1)\cdot(s/120+1)}{s\cdot(s+4)\cdot(s+1)}$$



Approximate Phase:

$\omega << 0.1 \quad : \quad \varphi(\omega) \sim -90^0$

$\omega \in [0.1 \quad , \quad 0.4] \quad : \quad d\varphi(\omega)/d\omega = -45^0 \ / \ decade$

$\omega \in [0.4 \quad , \quad 10] \quad : \quad d\varphi(\omega)/d\omega = -90^0 \ / \ decade$

$\omega \in [10 \quad , \quad 12] \quad : \quad d\varphi(\omega)/d\omega = 0^0 \ / \ decade$

$\omega \in [12 \quad , \quad 40] \quad : \quad d\varphi(\omega)/d\omega = +45^0 \ / \ decade$

$\omega \in [40 \quad , \quad 1000] \quad : \quad d\varphi(\omega)/d\omega = +90^0 \ / \ decade$

$\omega \in [1000 \quad , \quad 1200] \quad : \quad d\varphi(\omega)/d\omega = +45^0 \ / \ decade$

$\omega > 1200 \quad : \quad d\varphi(\omega)/d\omega = 0^0 \ / \ decade, \quad \varphi(\omega) \sim -90^0$

* Gain Margin ~ 20dB (Phase touches -180 degrees at W ~2 rad/sec, Magnitude(W) ~-20dB.
* Phase Margin: Approximately 75 degrees. M(W)~=0dB at W~ 0.2 rad/sec, where Phase is ~-105 degrees.

Questions: ask the lecturer; via Moodle Forum or via email.