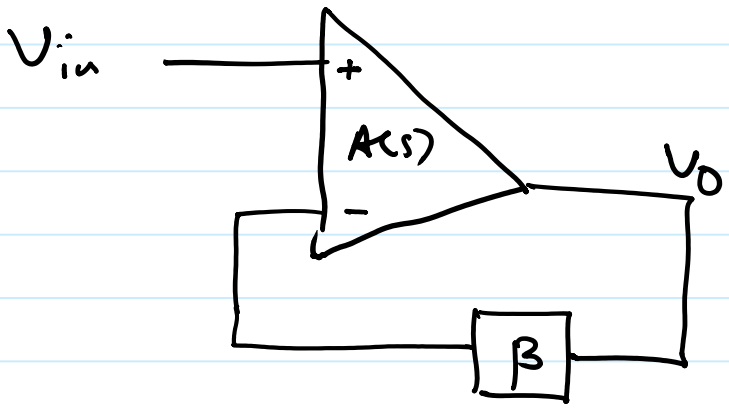
Two stage or 2nd order system

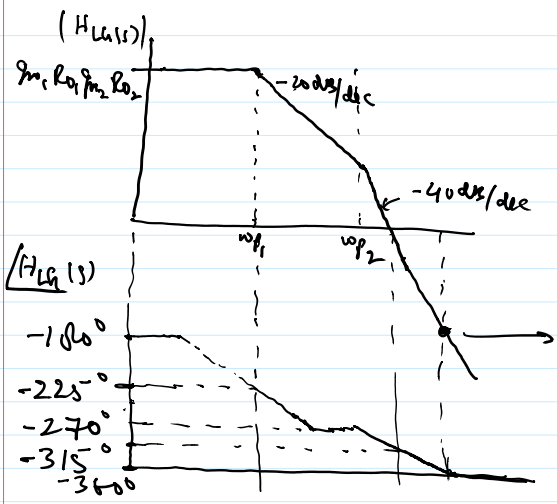


$$H_{LG}(s) = \beta A(s)$$

$$A(s) = \frac{g_{m_1} R_{o_1} g_{m_2} R_{o_2}}{(1 + s/\omega_{p_1})(1 + s/\omega_{p_2})}$$

$$\omega_{p_1} = \frac{1}{R_{o_1} C_{o_1}} \quad \& \quad \omega_{p_2} = \frac{1}{R_{o_2} C_{o_2}}$$

Assume $\omega_{p_1} < \omega_{p_2}$



→ if $|H_{LG}(s)| > 1$ when $\angle H_{LG}(s) = -360°$ then system will become unstable.

$g_{m_1} R_{O_1} = 100, \quad g_{m_2} R_{O_2} = 10$

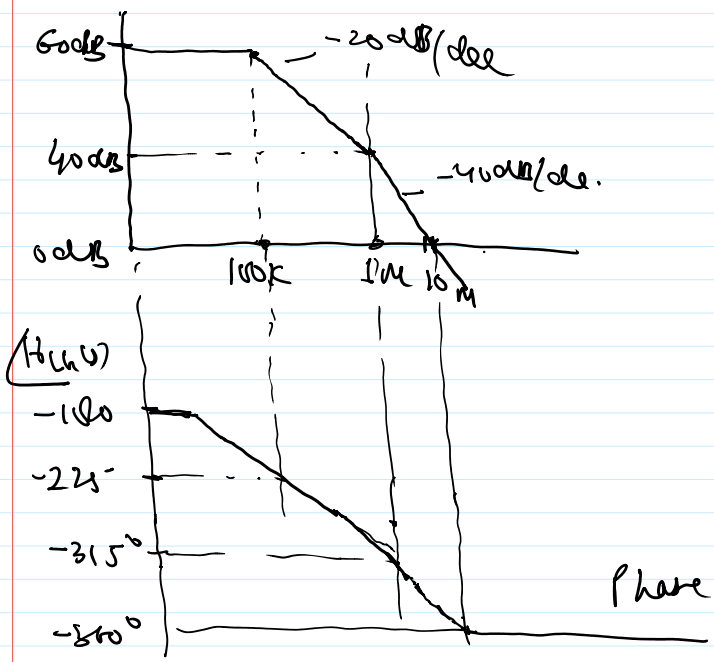
$R_O = 1000 = 60dB$

$R_{O_1} = 1 M\Omega$ & $R_{O_2} = 100 K$

$C_{O_1} = C_{O_2} = 10pF$

$$\omega_{p_1} = \frac{1}{R_{O_1} C_{O_1}} = \frac{1}{10^6 \times 10^{-11}} = 10^5 = 100K \text{ rad/sec}$$

$\omega_{p_2} = 1M \text{ rad/sec}$



Phase margin = 0

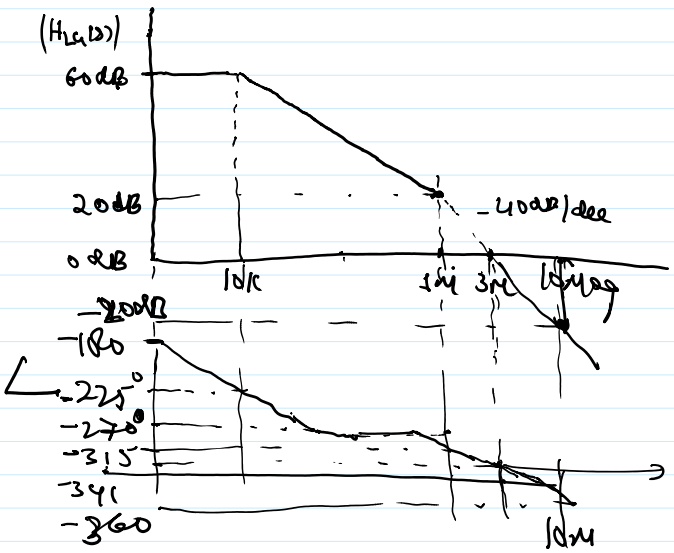
In order to increase the phase margin or make the system stable, loop needs to be compensated.

we can move ω_{p_1} at lower frequency by increasing the capacitor at the o/p of 1st stage.

Let's say we add more cap at the o/p of 1stage to increase it by 10x

$$\omega_{p_1} \rightarrow \frac{1}{10} \cdot 100K = 10 \text{ Krad/sec}$$

$$\omega_{p_2} = 1M \text{ rad/sec}$$

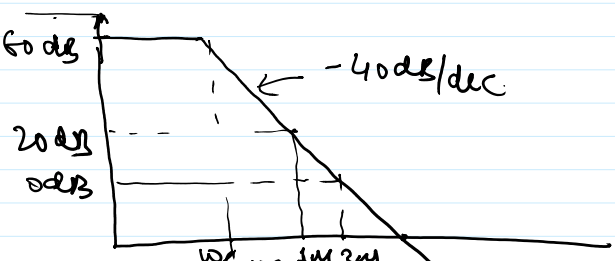


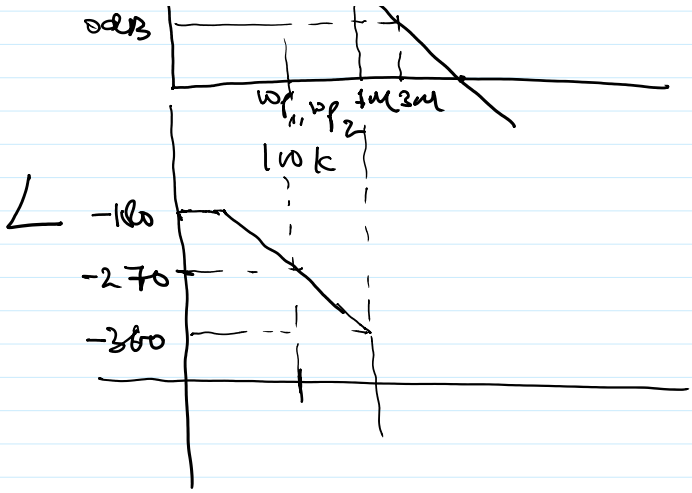
Gain Margin = -20 dB

PM ≈ 19°

The gain at 180° phase is defined as gain margin

$\omega_{p_1} = 100K$, $\omega_{p_2} = 100K$





Moving two poles apart improves phase margin

In order to get phase margin $> 45^0$

2nd pole must be outside ω_{ugb} → unity gain BW (0dB)