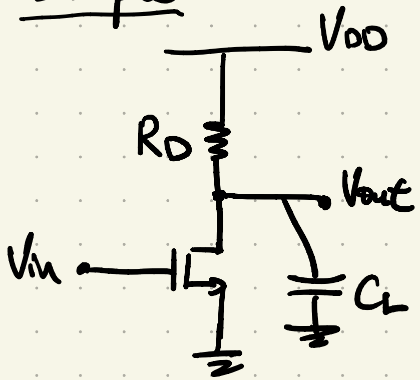
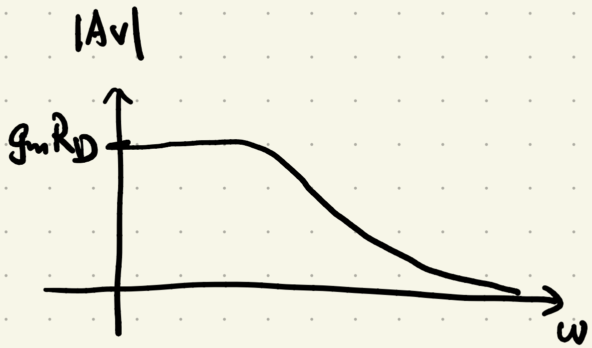
Lec 18

- Useful Frequency Response Concepts
  - Poles & Zeros
  - Bode's Rules
  - Finding Poles by Inspection

- Capacitors generally limit the BW

Example





Poles & Zeros

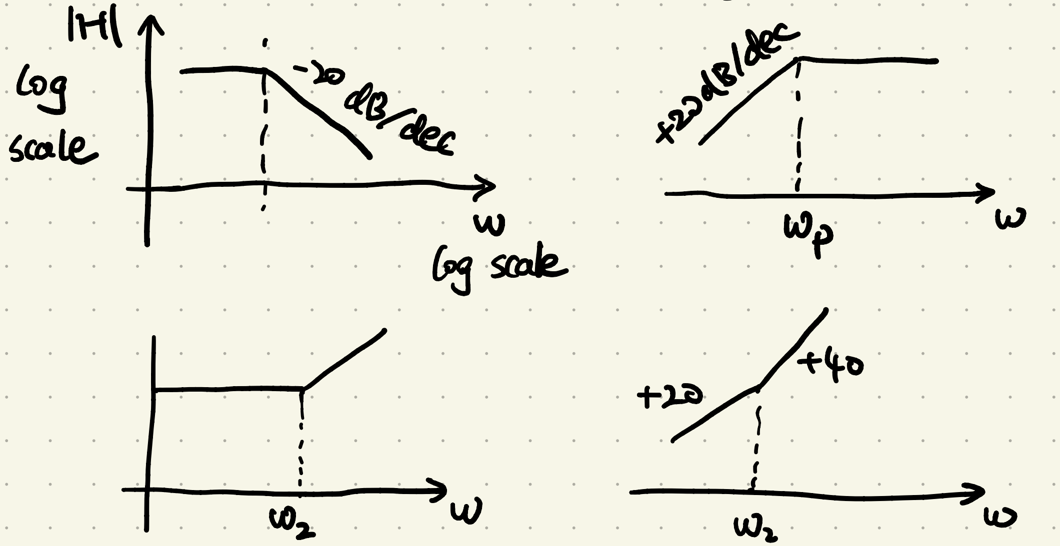
$$H(s) = \frac{N(s)}{D(s)}$$

$N(s) \rightarrow$ zeros

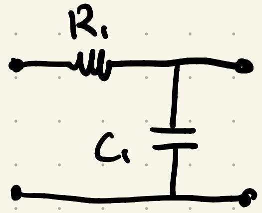
$D(s) \rightarrow$ poles

Bode's Rules

- As ω passes a pole frequency, the slope of $|H|$ decreases by 20 dB/dec

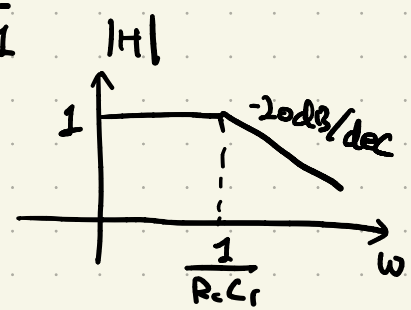


Example



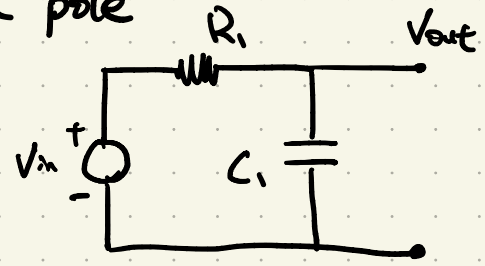
$$H(s) = \frac{1}{R_1C_1s+1}$$

$$\omega_p = -\frac{1}{R_1C_1}$$



Finding Poles by Inspection

We can assume that each node in the signal path contribute a pole



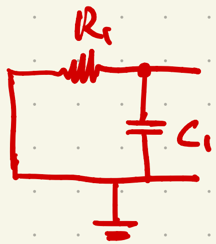
To calculate the pole:

(a) Find the resistance from that pole to ac GND

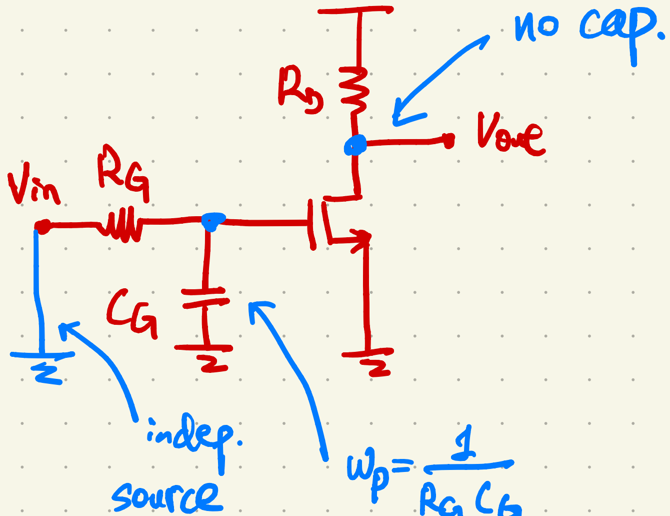
(b) Find the capacitances from that node to ac GND

all indep. sources = 0

$$\omega_p = \frac{1}{RC}$$

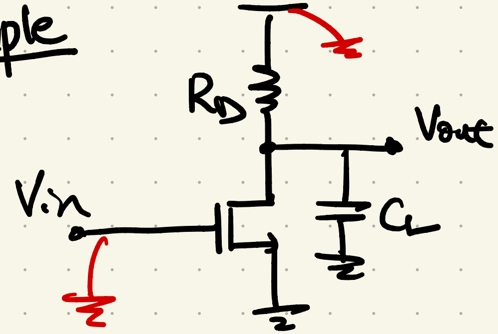


Q:



$$\omega_p = \frac{1}{R_G C_G}$$

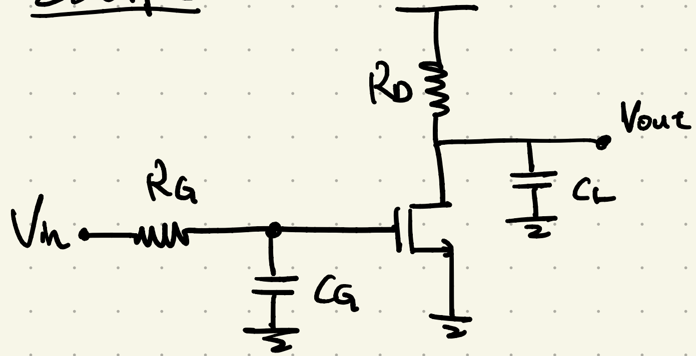
Example



$$\omega_p = \frac{1}{R_D C_L}$$

$$\frac{V_{out}}{V_{in}} = \frac{-g_m R_D}{1 + \frac{s}{\omega_p}} = \frac{-g_m R_D \omega_p}{s + \omega_p}$$

Example

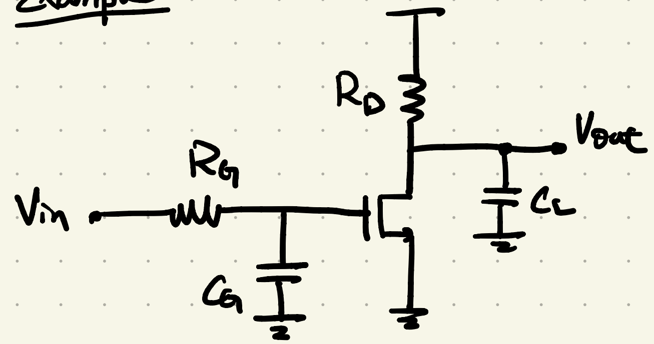


$$\omega_{p_1} = \frac{1}{R_G C_G} \qquad \omega_{p_2} = \frac{1}{R_D C_L}$$

$$\frac{V_{out}}{V_{in}} = \frac{-g_m R_D}{\left(1 + \frac{s}{\omega_{p_1}}\right)\left(1 + \frac{s}{\omega_{p_2}}\right)}$$

$$= \frac{-g_m R_D}{(1 + R_G C_G s)(1 + R_D C_L s)}$$

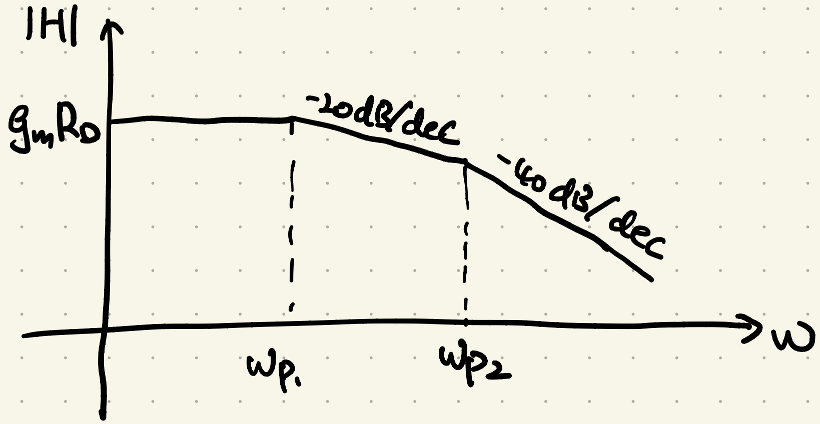
Example



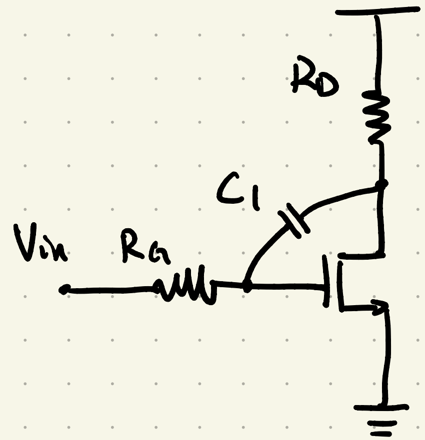
$$\omega_{p1} = \frac{1}{R_G C_G}$$

$$\omega_{p2} = \frac{1}{R_D C_L}$$

Plot the freq response



A Complication



We may handle this by Miller's theorem