# ECE 342
# Electronic Circuits

# Lecture 24
# CS Frequency Response

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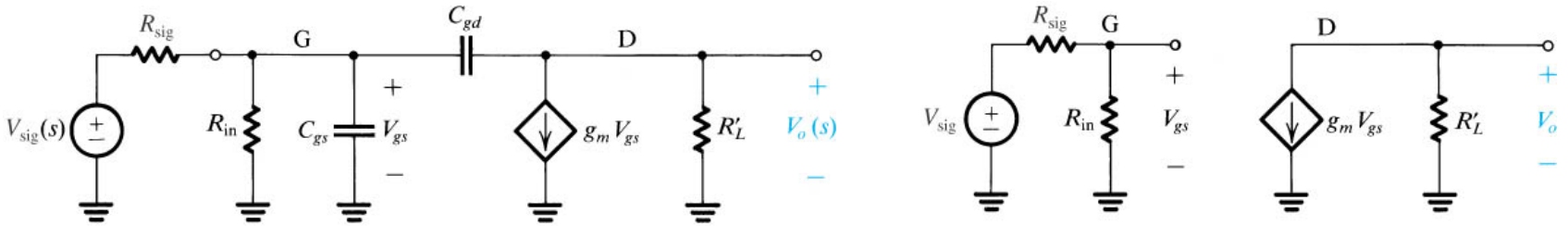
# MOSFET Amp Bandwidth

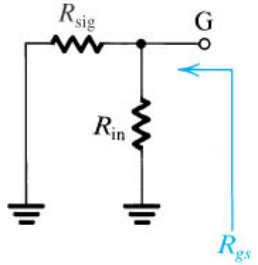
MOSFET amplifier has $R_{sig}$= 100 kΩ, $C_{gs}$=$C_{gd}$= 1 pF, $g_m$ = 4 mA/V and $R_L$' =3.33 kΩ. Find midband voltage gain and 3-dB frequency.




$$A_M = \frac{V_o}{V_{sig}} = -\frac{R_{in}}{R_{in}+R_{sig}}\left(g_m R_L^{'}\right) = -\frac{420}{420+100}\times 4 \times 3.33 = -10.8$$

# MOSFET Amp Analysis

To determine the 3-dB frequency, we first evaluate the time constant associated with $C_{gs}$. First, we determine the resistance $R_{gs}$ seen by $C_{gs}$. The capacitance $C_{gd}$ is removed and $V_{sig}$ is short-circuited



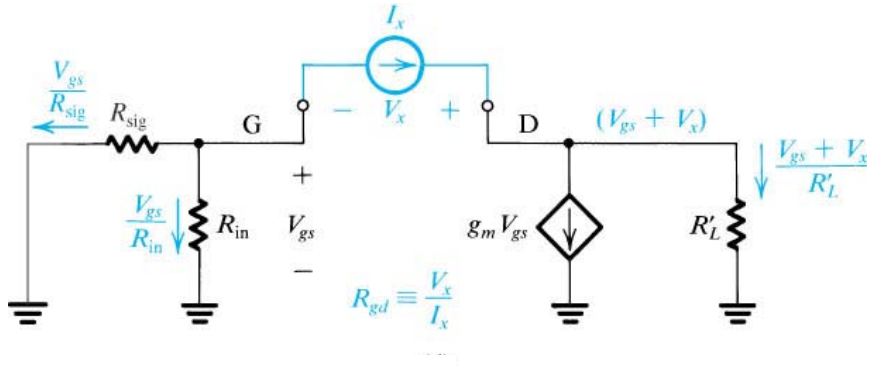

$$R_{gs} = R_{in} \,||\, R_{sig} = 420\ k\Omega \,||\, 100\ k\Omega = 80.8\ k\Omega$$

The time constant associated with $C_{gs}$ is

$$\tau_{gs} = C_{gs} R_{gs} = 1 \times 10^{-12} \times 80.8 \times 10^{3} = 80.8\ ns$$

# MOSFET Amp Analysis

The resistance $R_{gd}$ seen by $C_{gd}$ is found by setting $C_{gs}$ = 0 and short-circuiting $V_{sig}$




$$I_x = -\frac{V_{gs}}{R_{in}} - \frac{V_{gs}}{R_{sig}} \qquad V_{gs} = -I_x R' \qquad R' = R_{in} \,||\, R_{sig}$$

$$I_x = g_m V_{gs} + \frac{V_{gs} + V_x}{R'_L} \qquad R_{gd} = \frac{V_x}{I_x} = R' + R'_L + g_m R'_L R'$$

# MOSFET Amp Analysis

The open-circuit time constant of $C_{gd}$ is

$$\tau_{gd} = C_{gd} R_{gd} = 1 \times 10^{-12} \times 1.16 \times 10^{6} = 1160\ ns$$

The upper 3-dB frequency $\omega_H$ can now be determined from

$$\omega_H = \frac{1}{\tau_{gs} + \tau_{gd}} = \frac{1}{(80.8 + 1160) \times 10^{-9}} = 806\ krad/s$$

$$f_H = \frac{\omega_H}{2\pi} = 128.3\ kHz$$