IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Microelectronics: Devices to Circuits

High Frequency Response of CS and CE Amplifier

SUDEB DASGUPTA

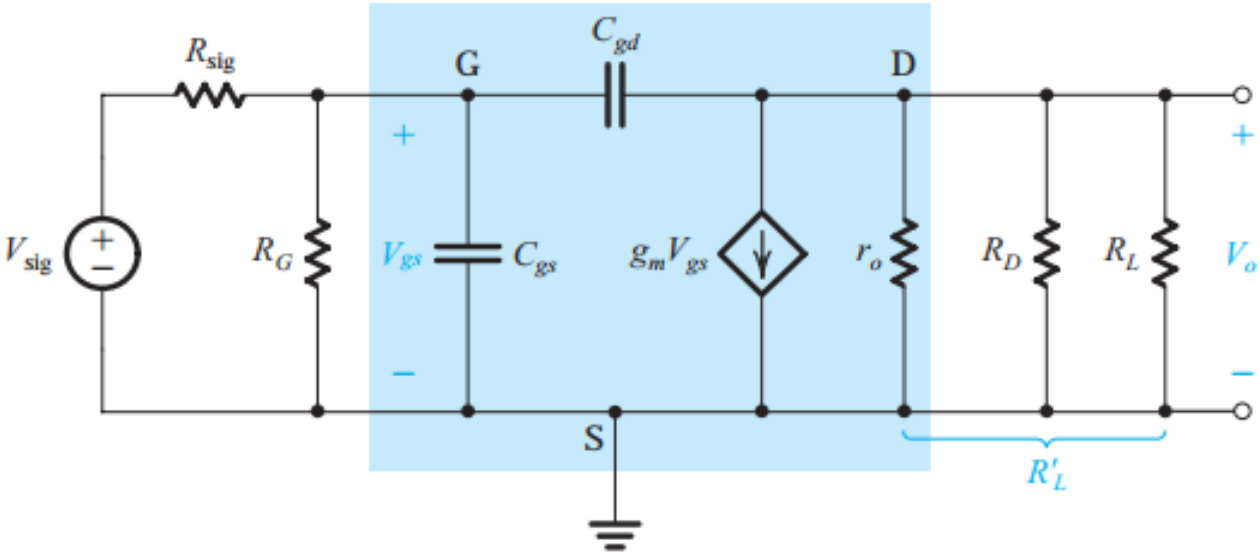
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



Outline

- CS Amplifier
- Common Emitter Amplifier
- Recapitulation

CS Amplifier



$$A_M = \frac{V_o}{V_{Sig}} = -\frac{R_G}{R_G + R_{Sig}}\left(g_m R_L^{'}\right)$$

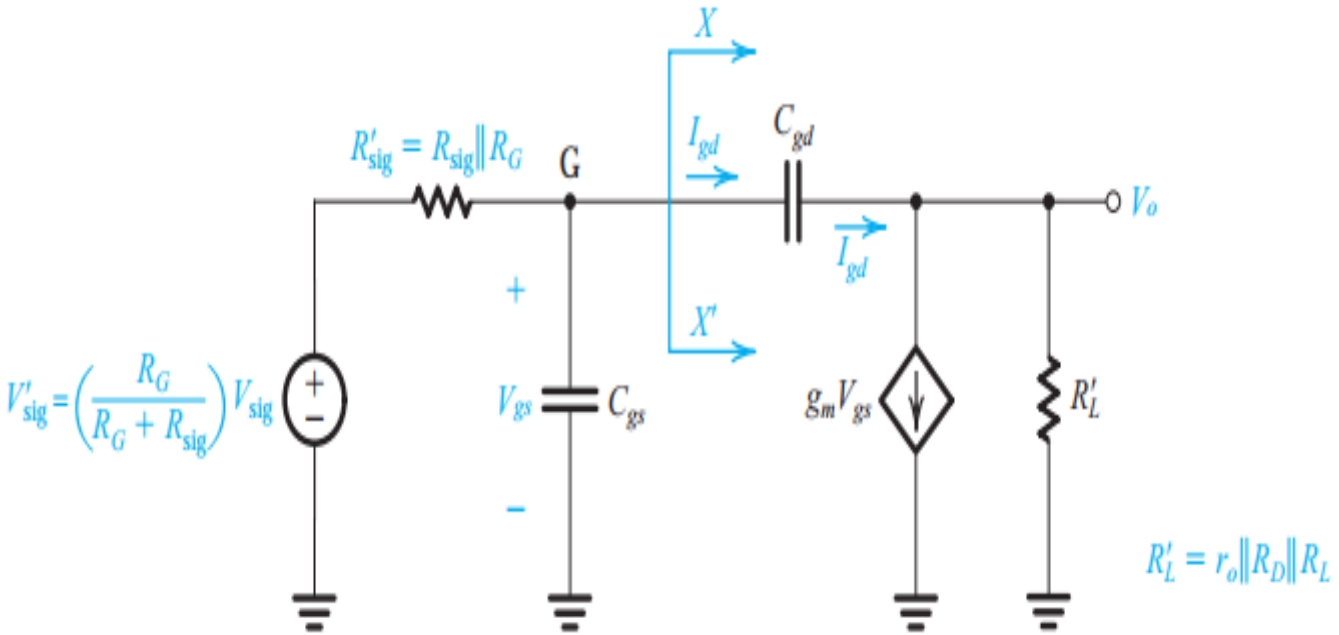
$$V_o = \left(-g_m R_L^{'}\right) V_{gs}$$

$$R_L^{'} = r_o \parallel R_D \parallel R_L$$

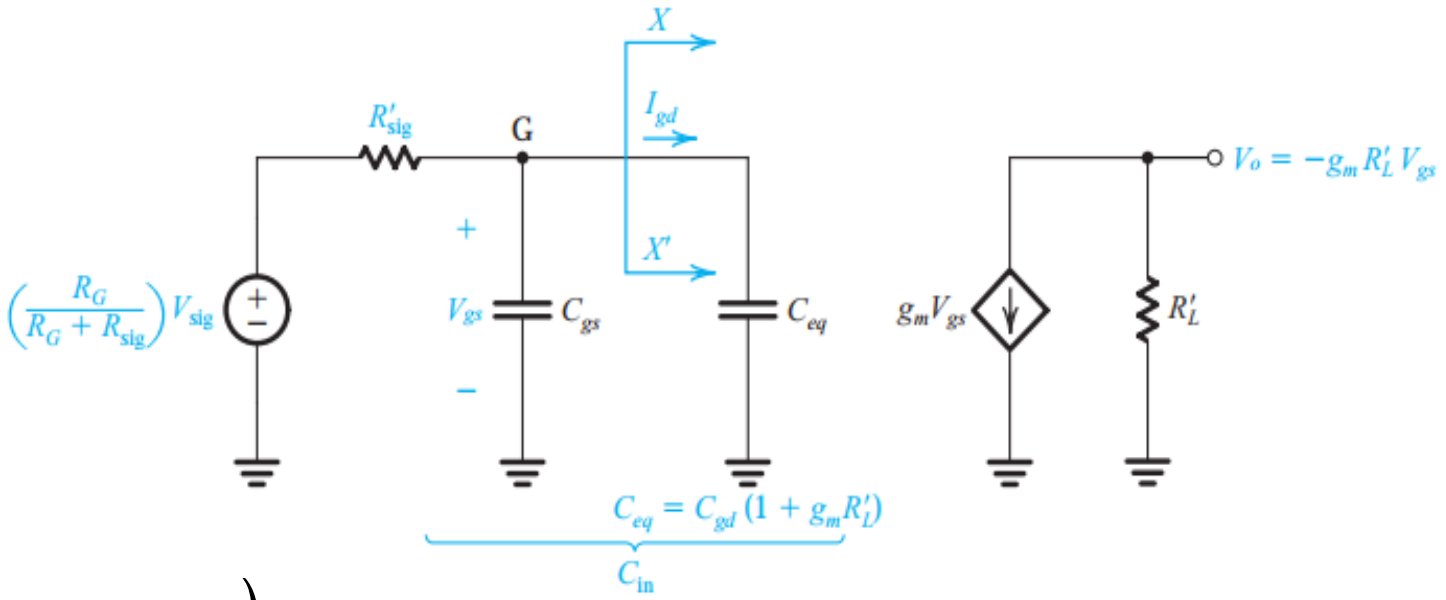
$$I_{gd} = {}^{S}C_{gd}\left(1 + g_m R_L^{'}\right) V_{gs}$$

$$C_{eq} = C_{gd}\left(1 + g_m R_L^{'}\right)$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

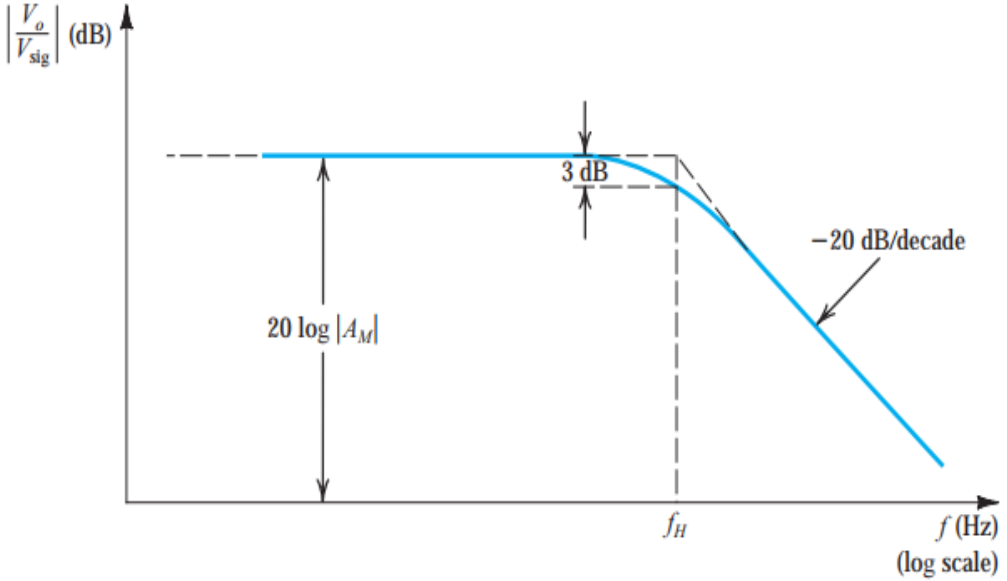


Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$\left(1 + g_m R'_L\right)$ Miller Multiplier

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$$w_0 = \frac{1}{C_{in} R_{sig}} \qquad V_{gs} = \left(\frac{R_G}{R_G + R_{Sig}} V_{Sig}\right) \frac{1}{1 + \frac{S}{w_o}}$$

w_o Pole frequency or corner frequency

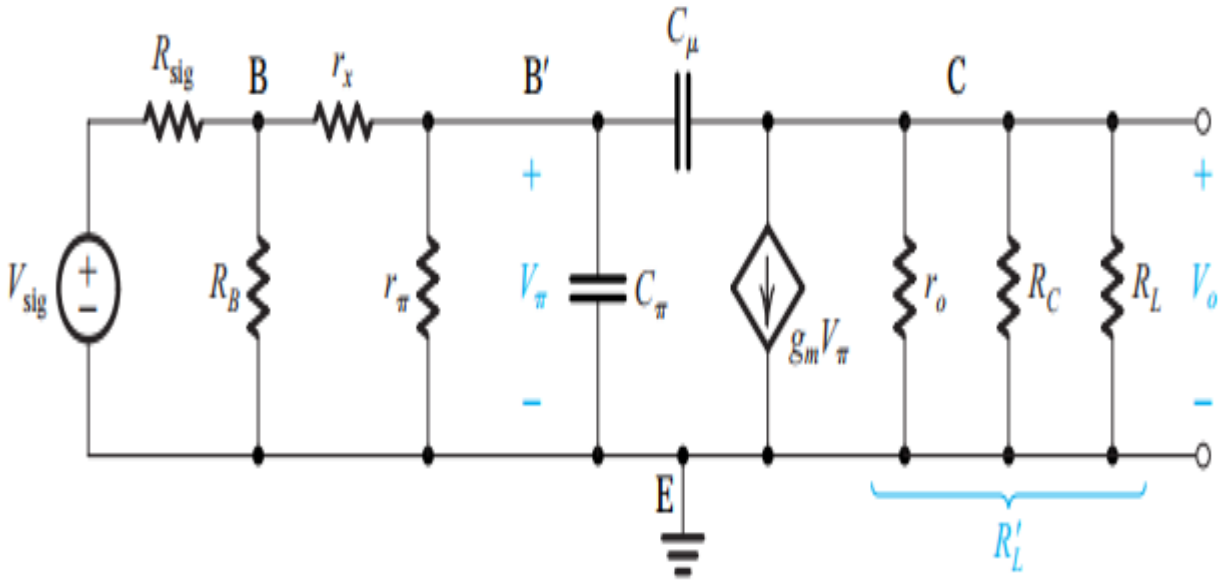
$$\frac{V_0}{V_{sig}} = -\left(\frac{R_G}{R_G + R_{sig}}\right)\left(g_m R_L^{'}\right) \frac{1}{1 + \frac{S}{w_0}}$$

$$w_H = \frac{1}{C_{in} R_{sig}} \qquad \frac{V_0}{V_{sig}} = A_M \frac{1}{1 + \frac{S}{w_H}}$$

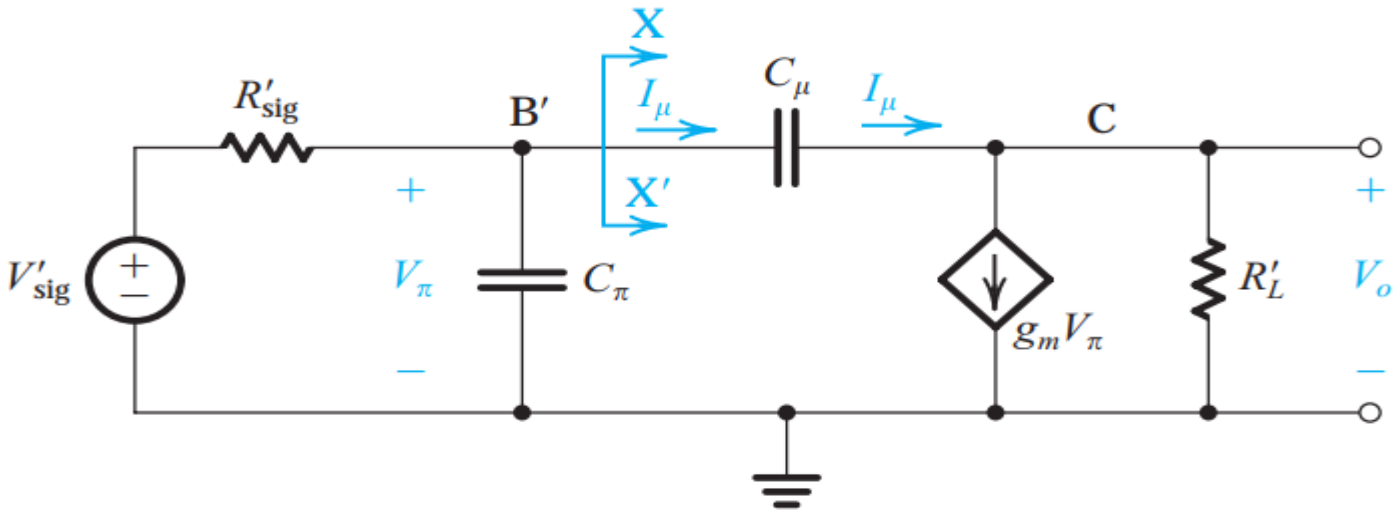
$$C_{in} = C_{gs} + C_{gd}\left(1 + g_m R_L^{'}\right) \qquad R_{sig}^{'} = R_{sig} \parallel R_G \qquad f_H = \frac{1}{2\pi C_{in} R_{sig}}$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Common Emitter Amplifier



Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

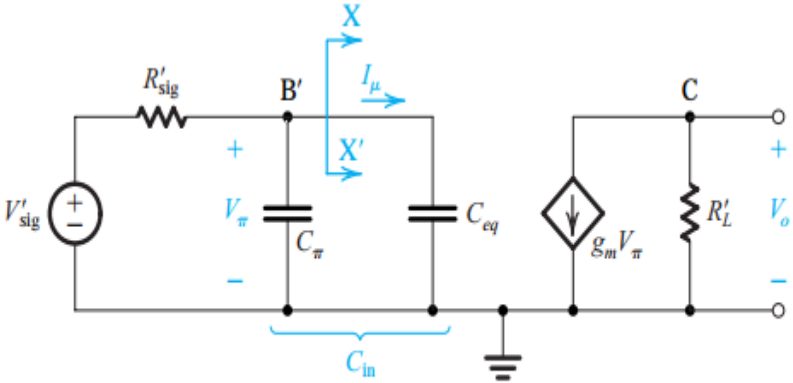


$$V'_{sig} = V_{sig} \frac{R_B}{R_B + R_{sig}} \frac{r_\pi}{r_\pi + r_x + (R_{sig} \| R_B)}$$

$$R'_L = r_o \| R_C \| R_L$$

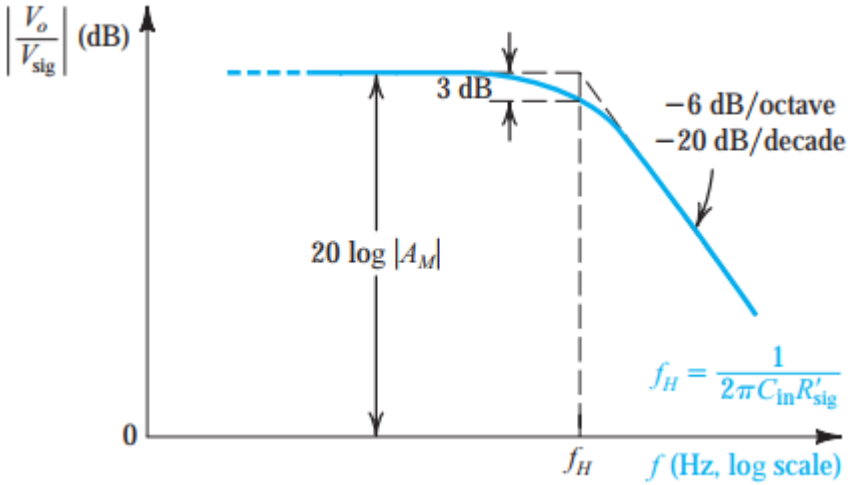
$$R'_{sig} = r_\pi \| [r_x + (R_B \| R_{sig})]$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$$C_{in} = C_\pi + C_{eq}$$
$$= C_\pi + C_\mu(1 + g_m R'_L)$$

$$V_o = -g_m R'_L V_\pi$$



Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

$$A_M = \frac{V_0}{V_{sig}} = -\frac{R_B}{R_B + R_{sig}} \frac{r_\pi}{r_\pi + r_x + (R_{sig} \parallel R_B)} (g_m R_L')$$

$$R_L = r_0 \parallel R_C \parallel R_L$$

$$\frac{V_0}{V_{sig}} = A_M \frac{1}{1 + \frac{S}{w_H}}$$

$$f_H = \frac{1}{2\pi C_{in} R_{sig}}$$

$$C_{in} = C_\pi + C_\mu (1 + g_m R_L)$$

$$R_{sig}' = r_\pi \parallel [r_x + (R_B \parallel R_{sig})]$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- The upper 3-dB frequency is determined by the interaction of $R'_{sig} = R_{sig} \parallel R_G$ and $C_{in} = C_\pi + C_\mu(1 + g_m R_L)$.

- Due to the miller effect, CS amplifier to have a large total input capacitance C_{in} and hence a low f_H.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Thank You