IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

MICRORLECTRONICS: DEVICES TO CIRCUITS

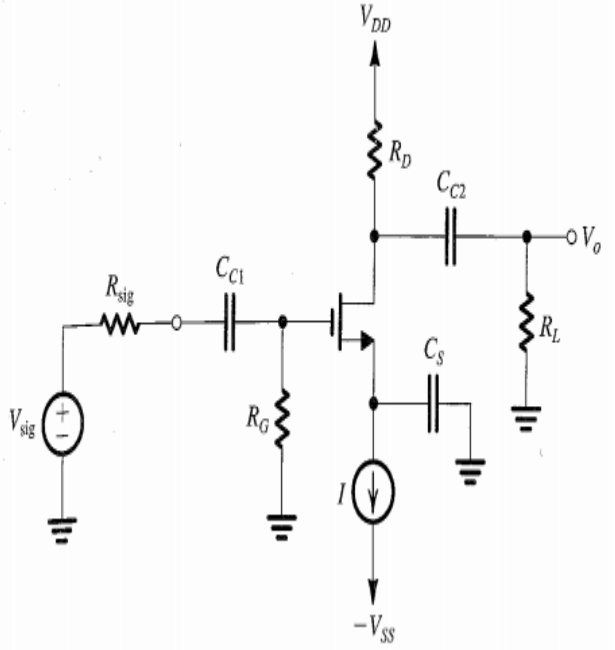
Internal Cap models and High frequency Modeling

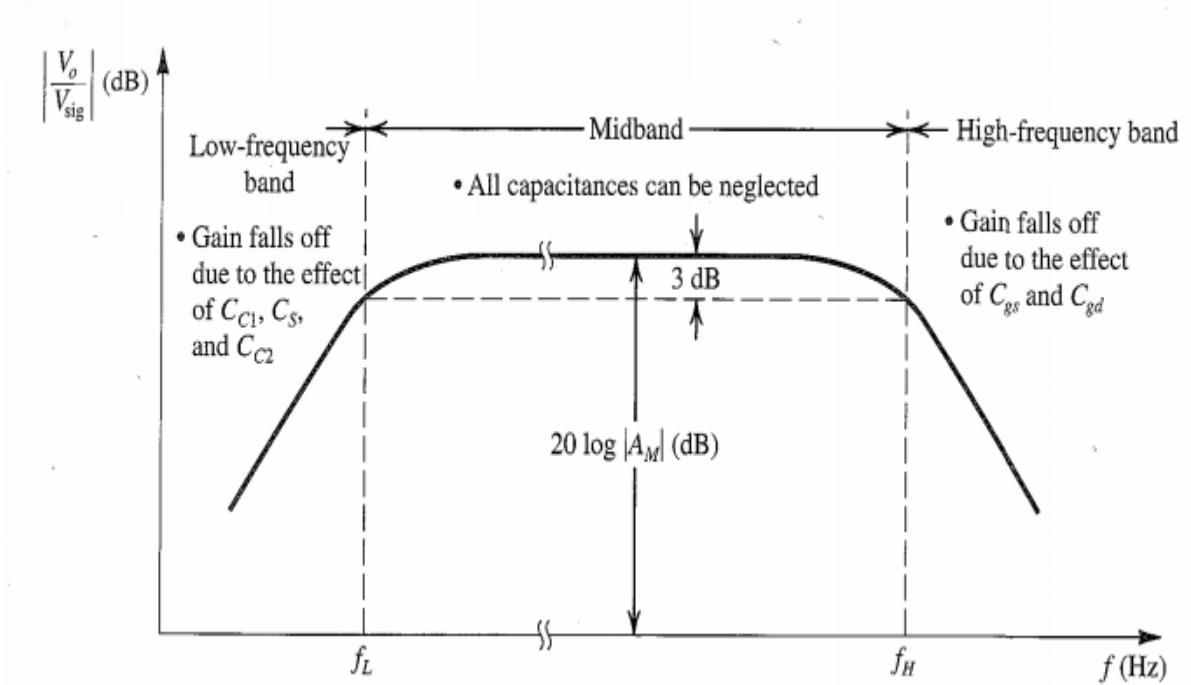
SUDEB DASGUPTA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



Frequency response of CS Amplifier





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

- The gain is almost constant over a wide frequency band called the **midband**.

Midband gain $A_M = \frac{V_o}{V_{sig}} = -\frac{R_G}{R_G + R_{sig}} g_m \left(g_m \| R_D \| R_L\right)$

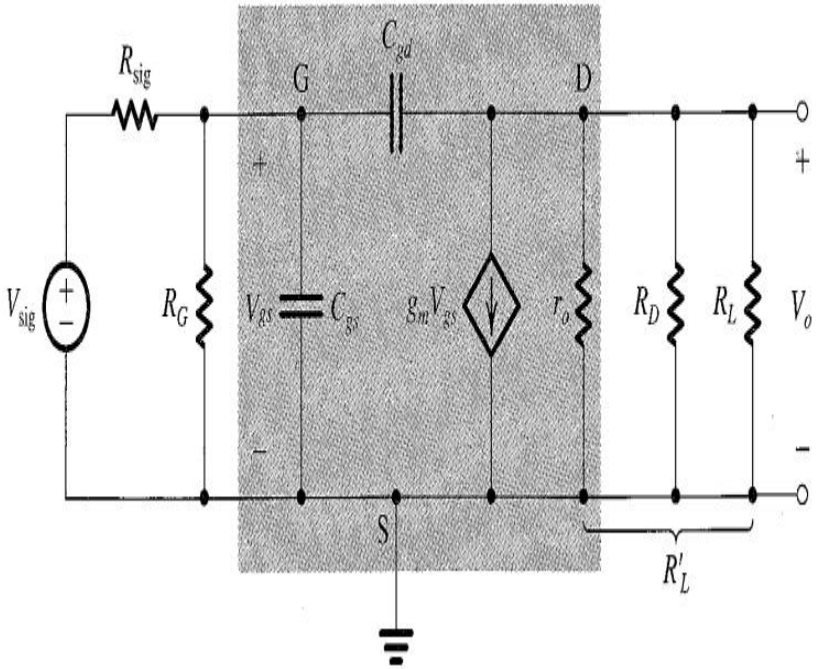
3dB bandwidth is $BW = f_H - f_L$

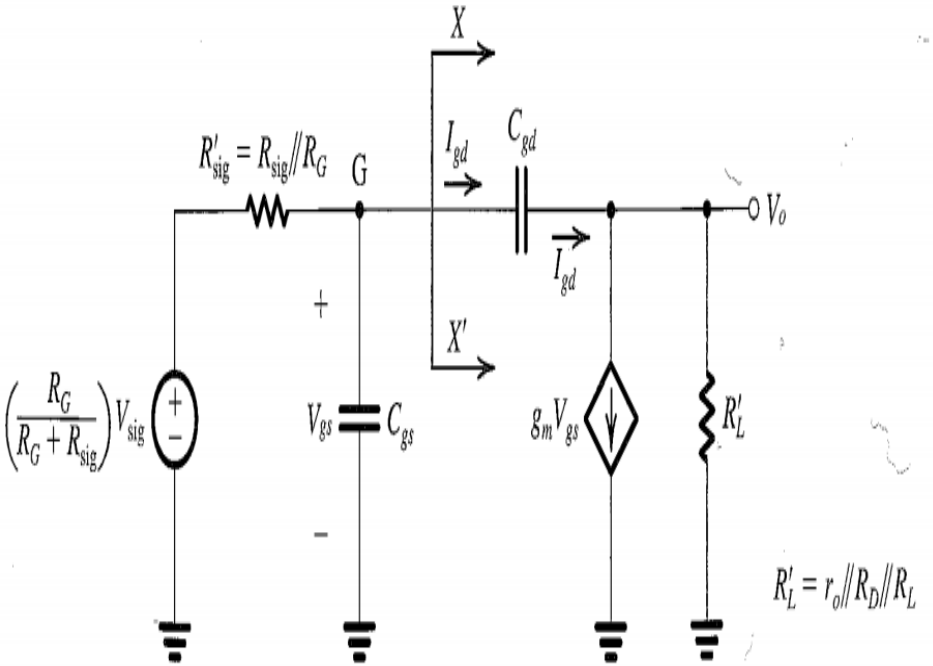
If $f_H >> f_L$ Than bandwidth $BW = f_H$

- A figure of merit for the amplifier is its gain –bandwidth product .

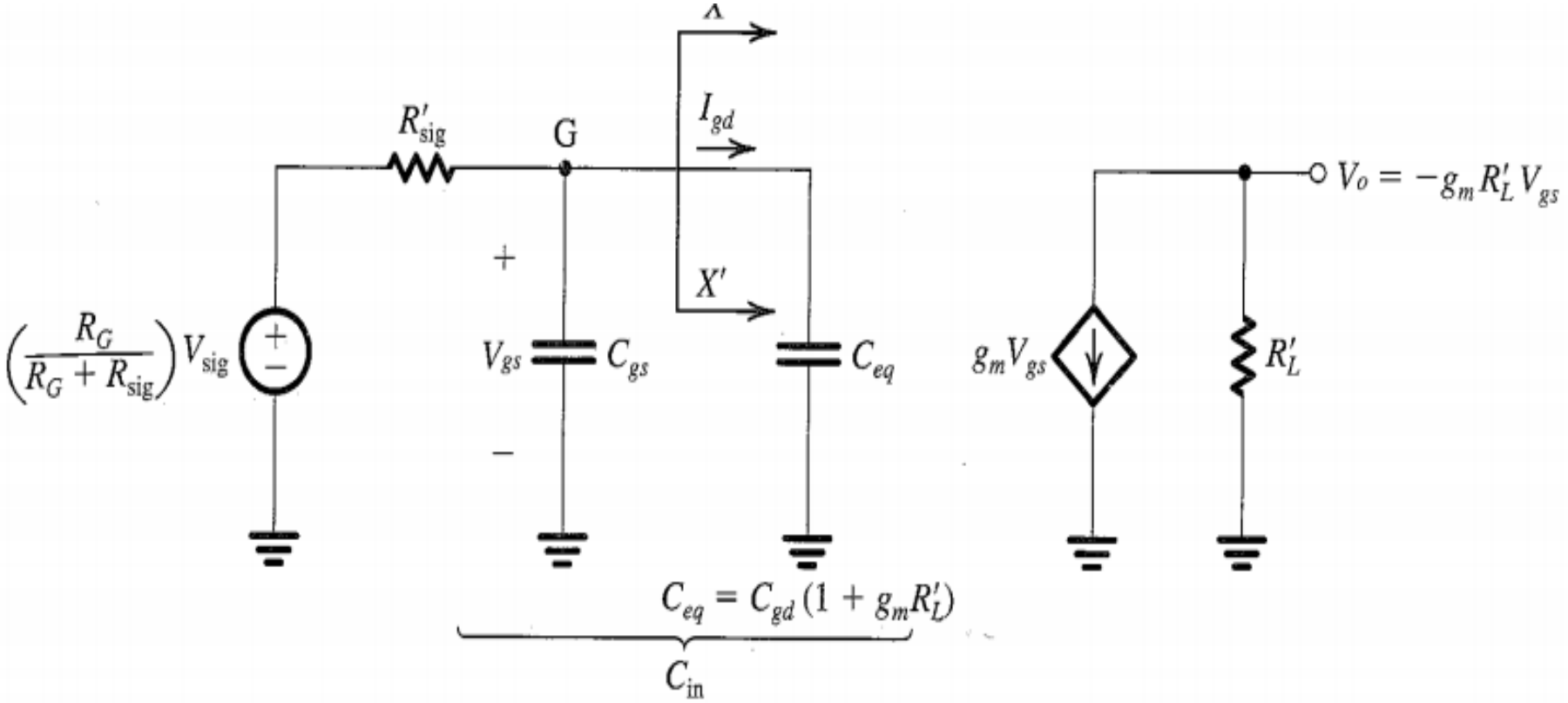
$$GB = \left|A_M\right| BW$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

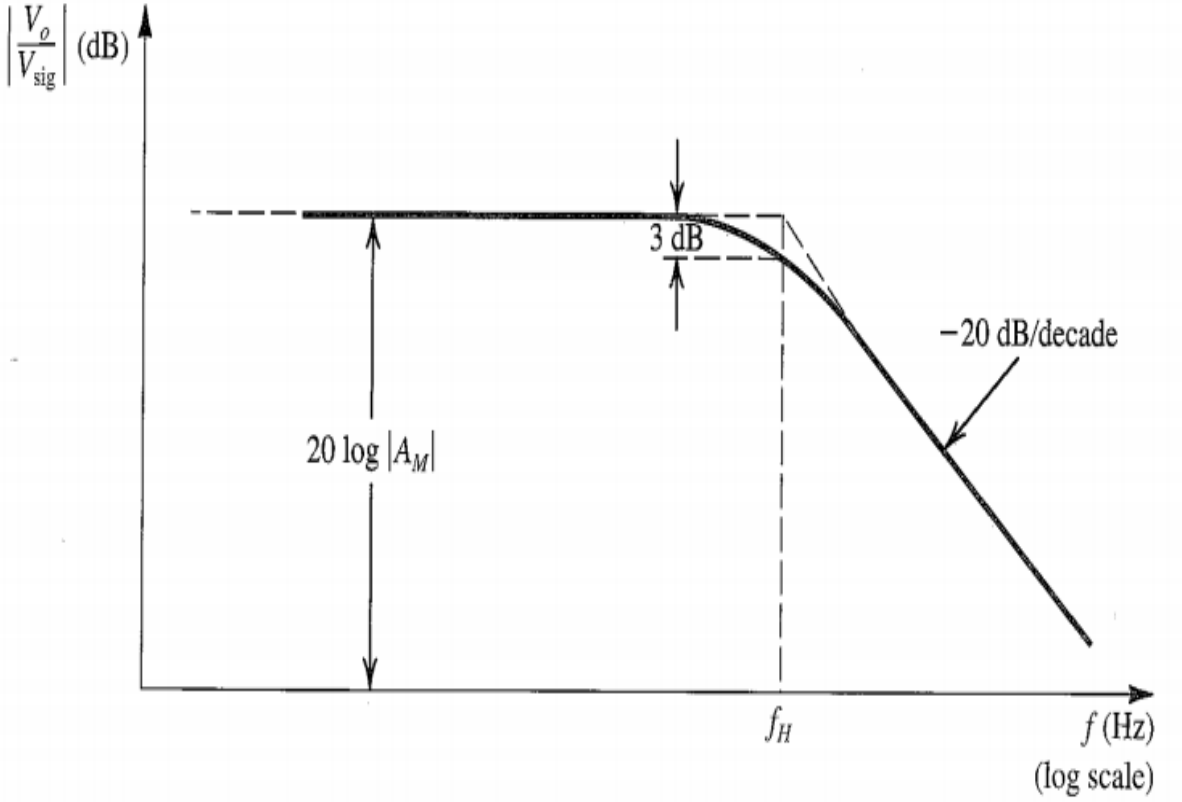




Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



Source: Microelectronics Circuits, Sedra and Smith, Fifth edition



$$\frac{V_o}{V_{sig}} = \frac{A_M}{1 + \frac{s}{\omega_H}}$$

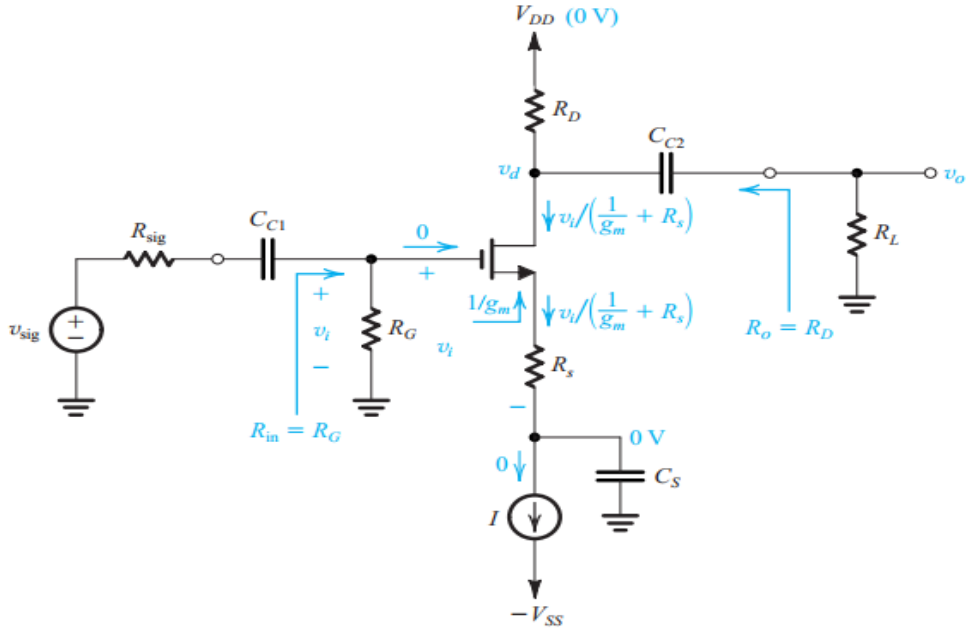
$$f_H = \frac{1}{2\pi C_{in} R'_{sig}}$$

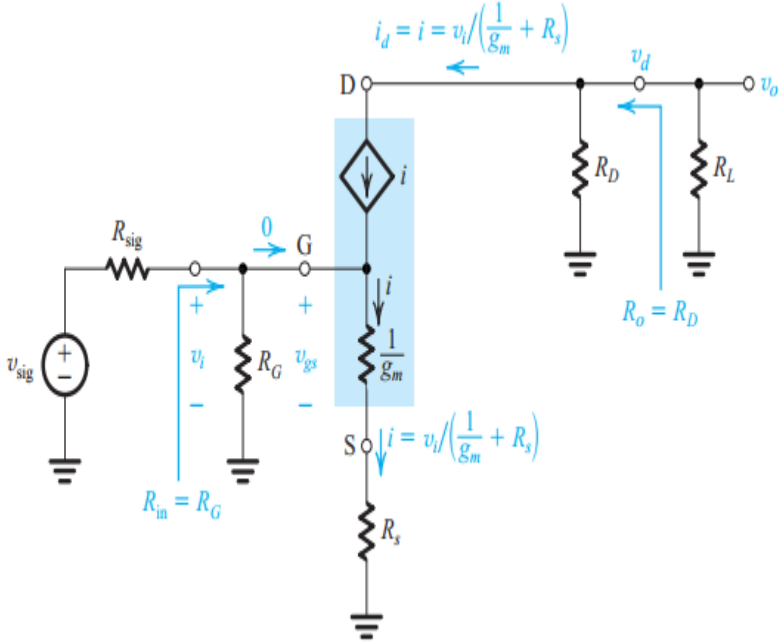
$$C_{in} = C_{gs} + C_{gd}\left(1 + g_m R'_L\right)$$

$$R'_{sig} = R_{sig} \parallel R_G$$

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

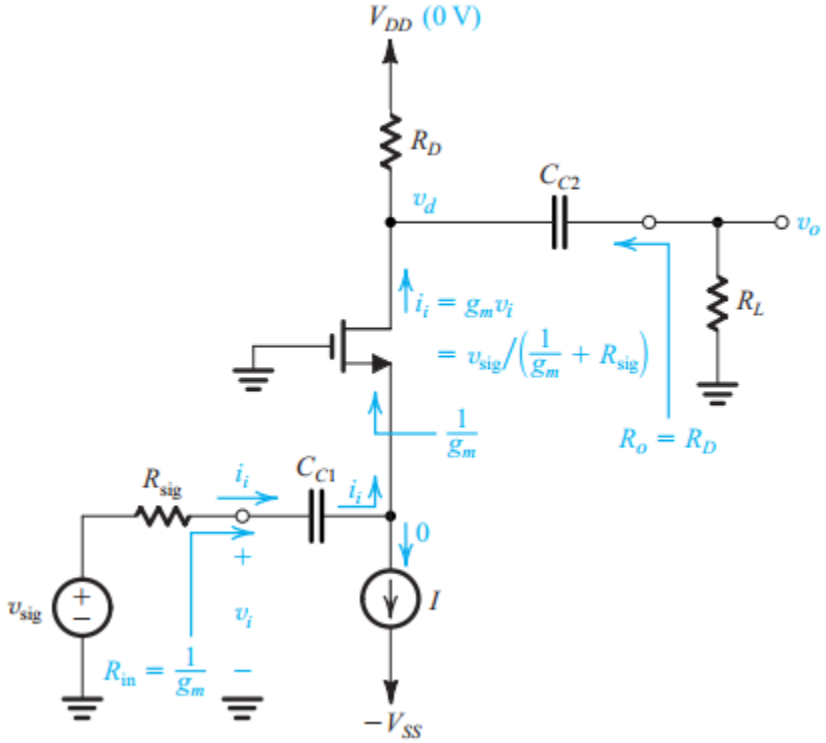
High frequency model of CS Amplifier with source resistance

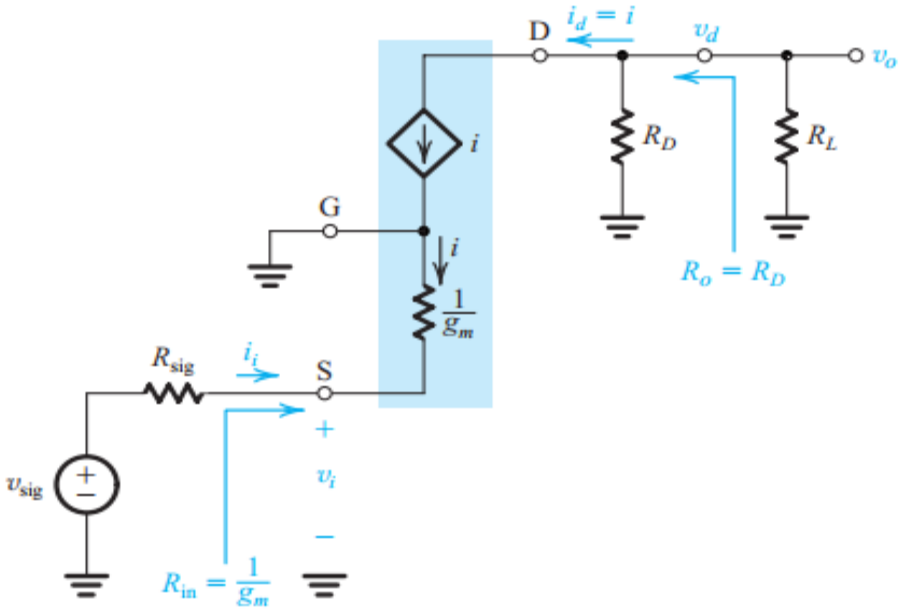




Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

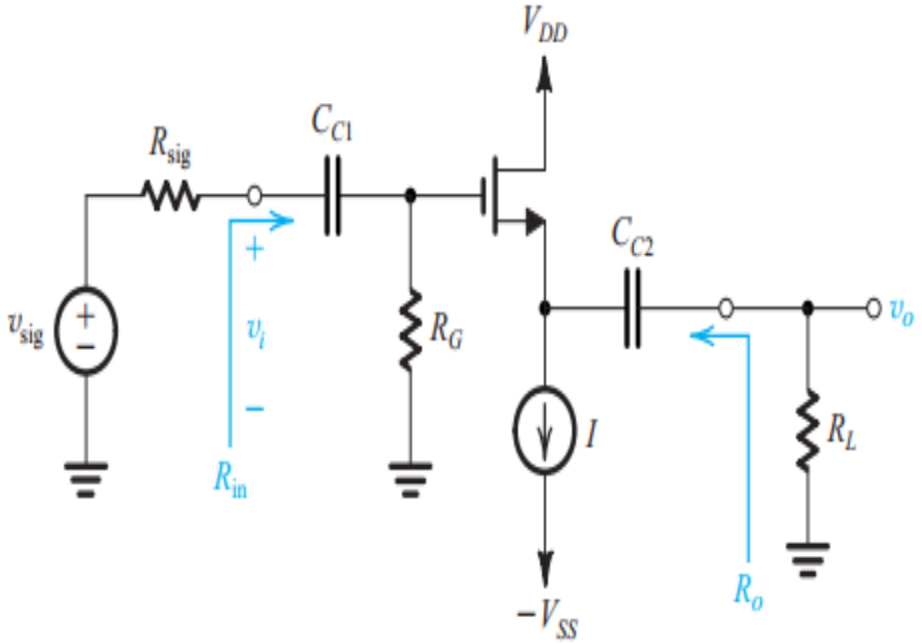
High frequency model of CG Amplifier

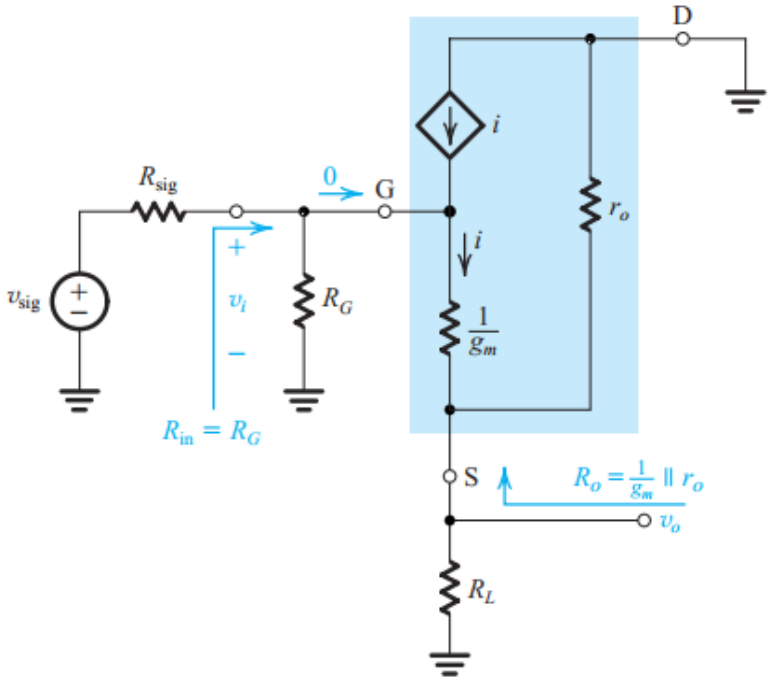




Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

High frequency model of SF(CD) Amplifier





Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Recapitulation

- A figure of merit for the high –frequency operation of the MOSFET as an amplifier is the unity gain frequency f_T.
- f_T is proportional to g_m and inversely proportional to the FET internal capacitance.
- The higher the value of f_T, the more effective the FET becomes as an amplifier.
- Miller –effect occur due to gate to drain capacitance.
- The midband is the useful frequency band of the amplifier.
- f_H and f_L are the frequencies at which the gain drops by 3dB below its value at midband.

Source: Microelectronics Circuits, Sedra and Smith, Fifth edition

Thank You