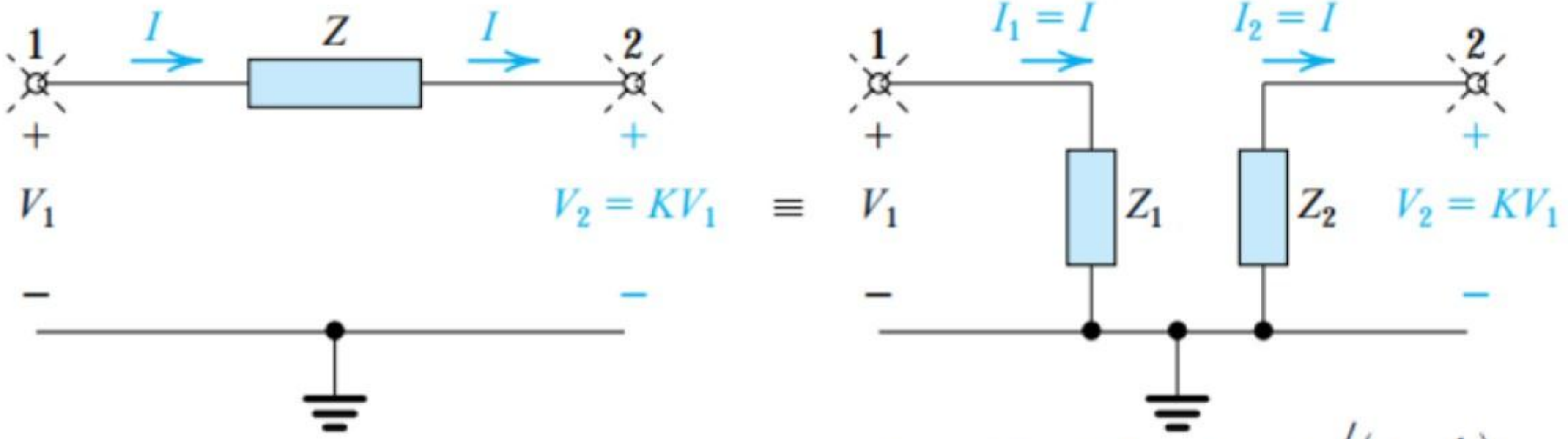
Miller's Theory:



$$Z_1 = Z/(1 - K), \quad Z_2 = Z\Big/\left(1 - \frac{1}{K}\right)$$

(a) (b)

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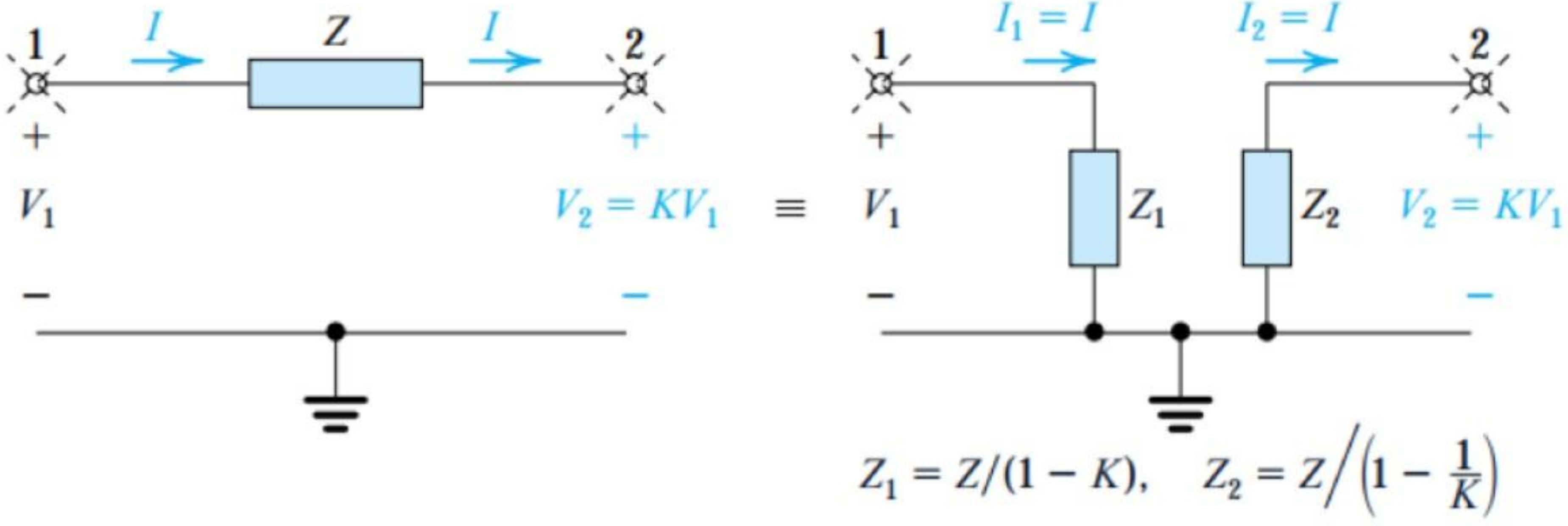
Miller's Theory:



(a) (b)

$C_1 = C(1\text{-}K)$

$C_2 = C(1\text{-}\frac{1}{K})$

Where:

K is calculated at f=0.

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High Frequency Response of Common-Gate Amplifier

- **The key to obtaining wideband operation, that is, high f_H , is to use circuit configurations that do not suffer from the Miller effect. One such configuration is the common-gate circuit.**

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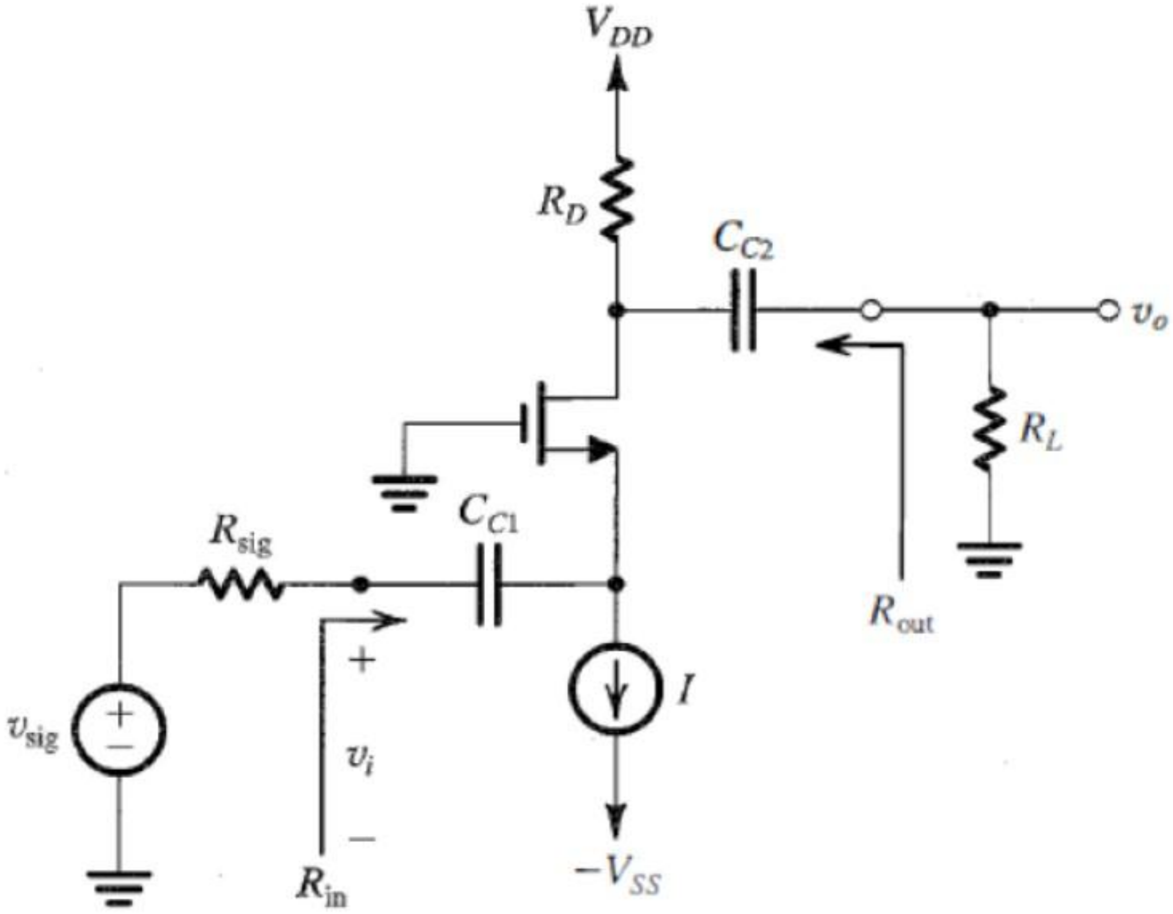
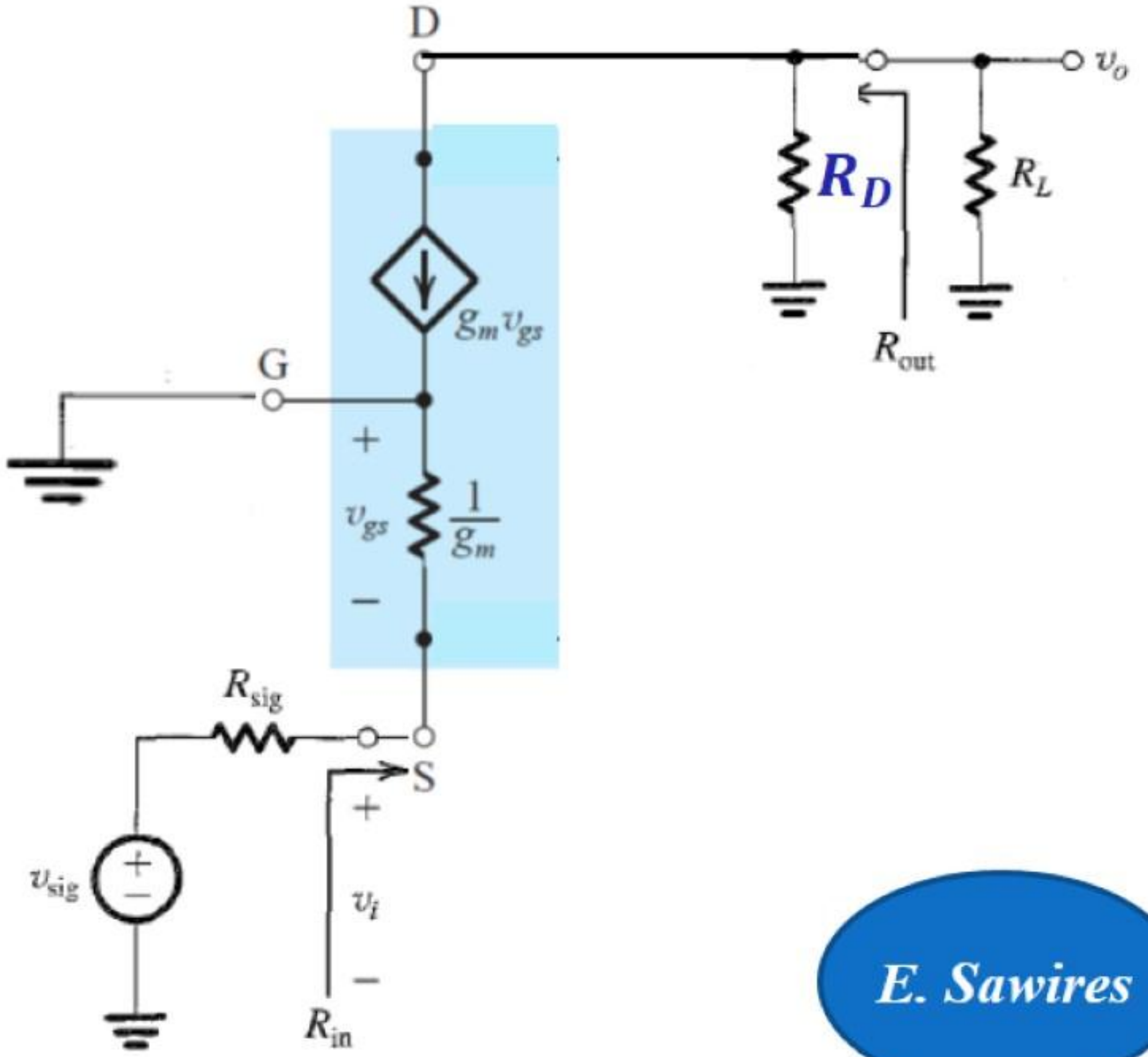
The Common-Gate (CG) amplifier





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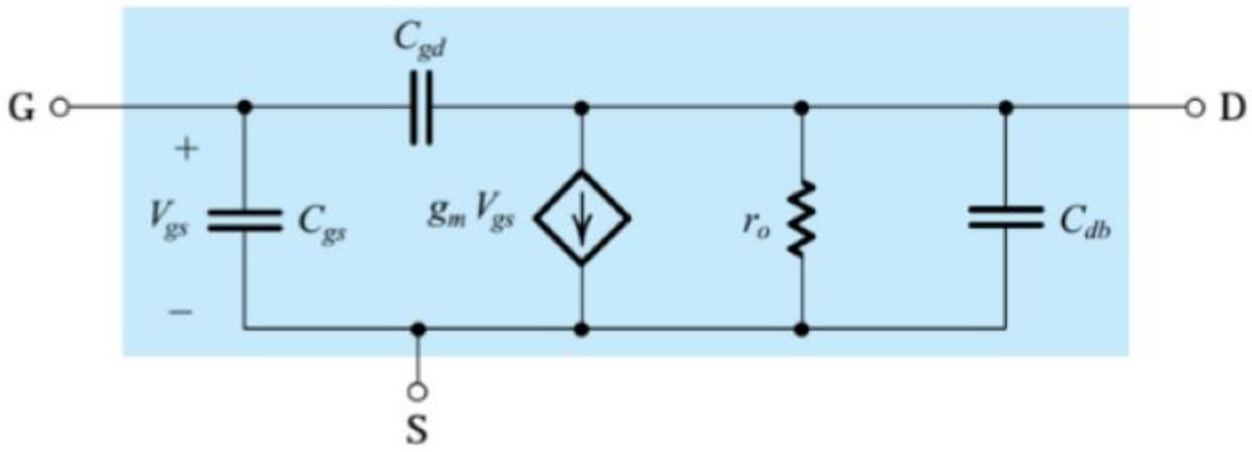
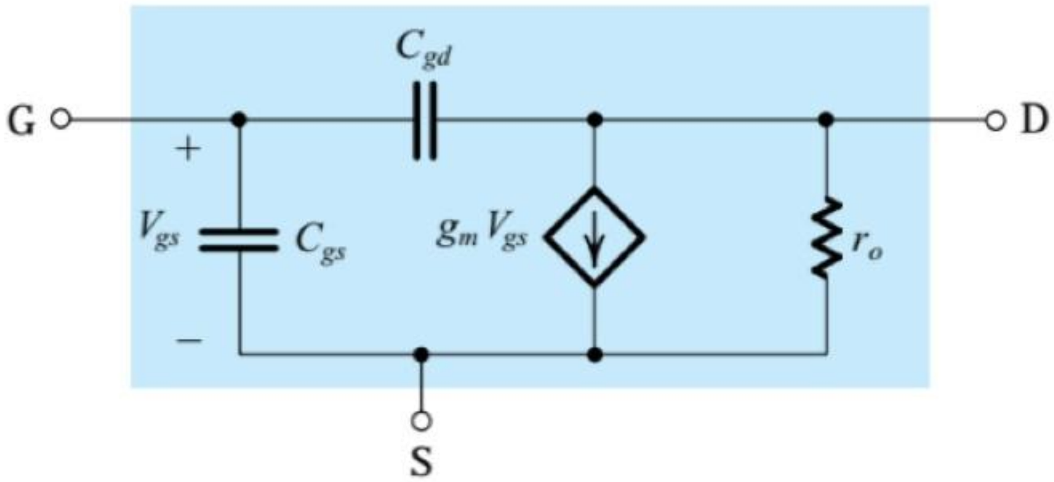


The equivalent circuit for the case in which the source is connected to the substrate (body).



The equivalent-circuit model with Cdb neglected (to simplify analysis).

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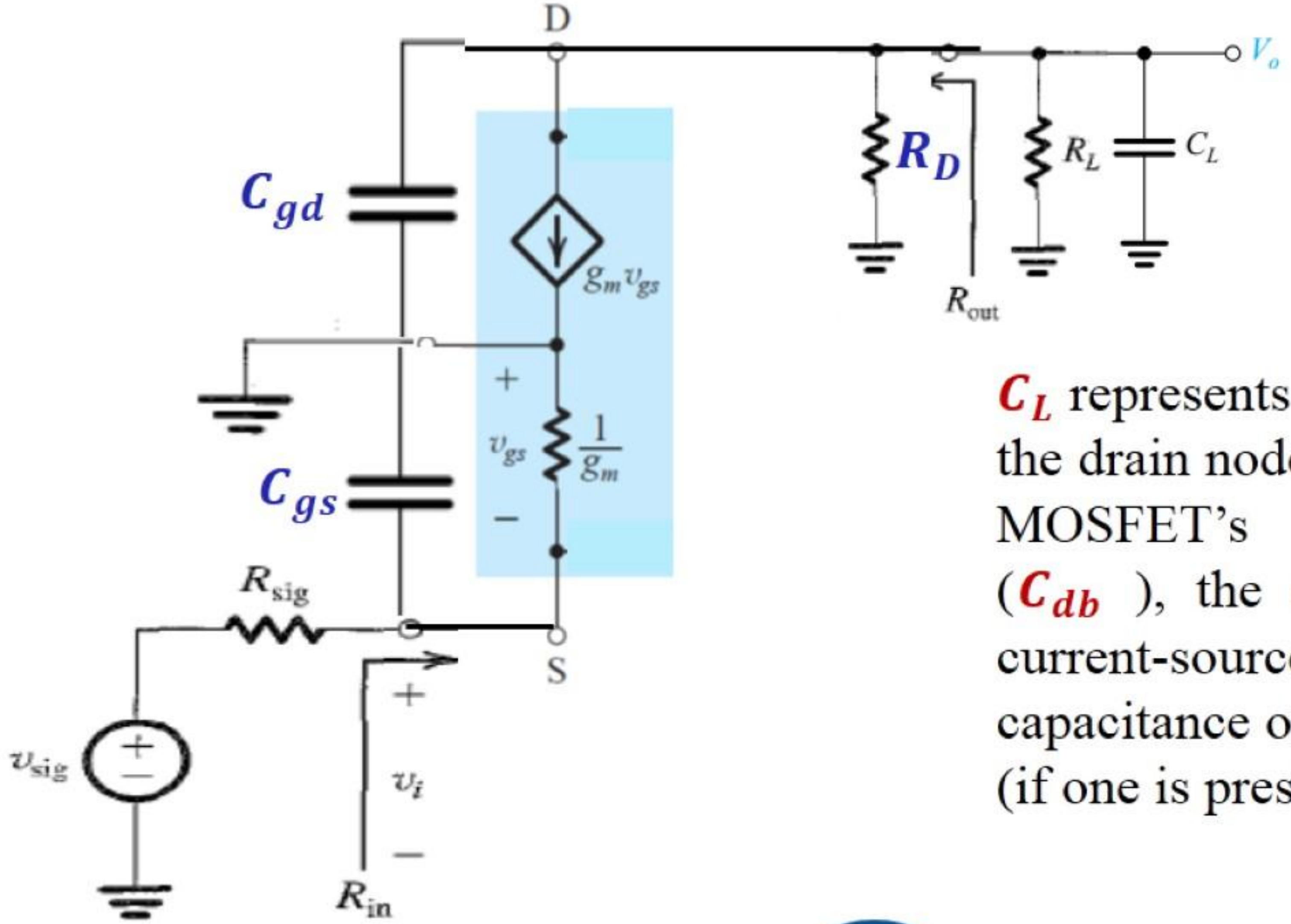
High Frequency Response of Common-Gate Amplifier



C_L represents the total capacitance between the drain node and ground and includes the MOSFET's drain-to-body capacitance (C_{db}), the capacitance introduced by a current-source load, and the input capacitance of a succeeding amplifier stage (if one is present).

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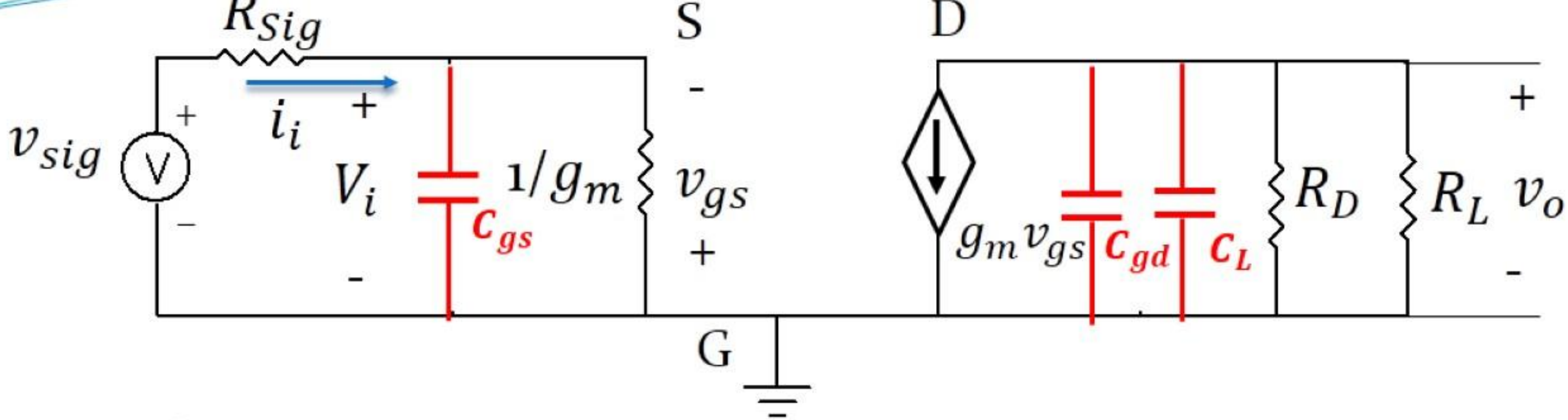

$$f_{P1} = \frac{1}{2\pi C_{gs}\left(R_{\text{sig}} \parallel \frac{1}{g_m}\right)}$$

$$f_{P2} = \frac{1}{2\pi(C_{gd} + C_L)R_L}$$

- The important point to note is that both f_{p1} and f_{p2} are usually much higher than the frequency of the dominant input pole in the CS stage.
- f_{p2} is usually lower than f_{p1}; thus f_{p2} can be dominant.

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High Frequency Response of Amplifier

The general form of amplifiers gain at high frequency can be written as:

$$A(S)=A_M F_H(S) \begin{cases} A_M \text{ is the midband gain} \\ F_H \text{ is a general expression for high frequency} \end{cases}$$

$$F_H(S) = \frac{\overbrace{(1+S/w_{Z1})(1+S/W_{Z2})\ldots.(1+S/W_{Zn})}^{\text{n real zeros}}}{\underbrace{(1+S/w_{P1})(1+S/W_{P2})\ldots.(1+S/W_{Pn})}_{\text{n real poles}}}$$

- This is because the designer needs to estimate the value of the upper 3-dB frequency f_H. In many cases the zeros are either at infinity or such high frequencies as to be of little significance to the determination of f_H. If one of the poles is much smaller than the others, then it will be the dominant pole and other poles can be neglected. In this case $F_H(\mathrm{S}) \approx \frac{1}{(1+\frac{S}{\omega_{P1}})}$,and $\omega_H \approx \omega_{P1}$.

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High Frequency Response of Amplifier

- **As a rule of thumb, a dominant pole exists if the lowest frequency pole is at least two octaves (a factor of 4) away from the nearest pole or zero.**
- If a dominant pole does not exist, the 3-dB frequency can be determined from a plot of $|F_H(jw)|$, and in this case the high cutoff frequency can be written as:

$$w_H = 1/\sqrt{\left(\frac{1}{w_{P1}^2}+\frac{1}{w_{P2}^2}+\cdots\right)-2\left(\frac{1}{w_{Z1}^2}+\frac{1}{w_{Z2}^2}+\cdots\right)}$$

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Example

The high-frequency response of an amplifier is characterized by the transfer function

$$F_H(s) = \frac{1 - s/10^5}{(1 + s/10^4)(1 + s/4 \times 10^4)}$$

Determine the 3-dB frequency approximately and exactly.

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Solution

Noting that the lowest-frequency pole at 10^4 rad/s is two octaves lower than the second pole and a decade lower than the zero, we find that a dominant-pole situation almost exists and $\omega_H \simeq 10^4$ rad/s. A better estimate of ω_H can be obtained using Eq. (9.68), as follows:

$$\omega_H = 1 \Big/ \sqrt{\frac{1}{10^8} + \frac{1}{16 \times 10^8} - \frac{2}{10^{10}}}$$

$$= 9800 \text{ rad/s}$$

The exact value of ω_H can be determined from the given transfer function as 9537 rad/s. Finally, we show in Fig. 9.15 a Bode plot and an exact plot for the given transfer function. Note that this is a plot of the high-frequency response of the amplifier normalized relative to its midband gain. That is, if the midband gain is, say, 100 dB, then the entire plot should be shifted upward by 100 dB.

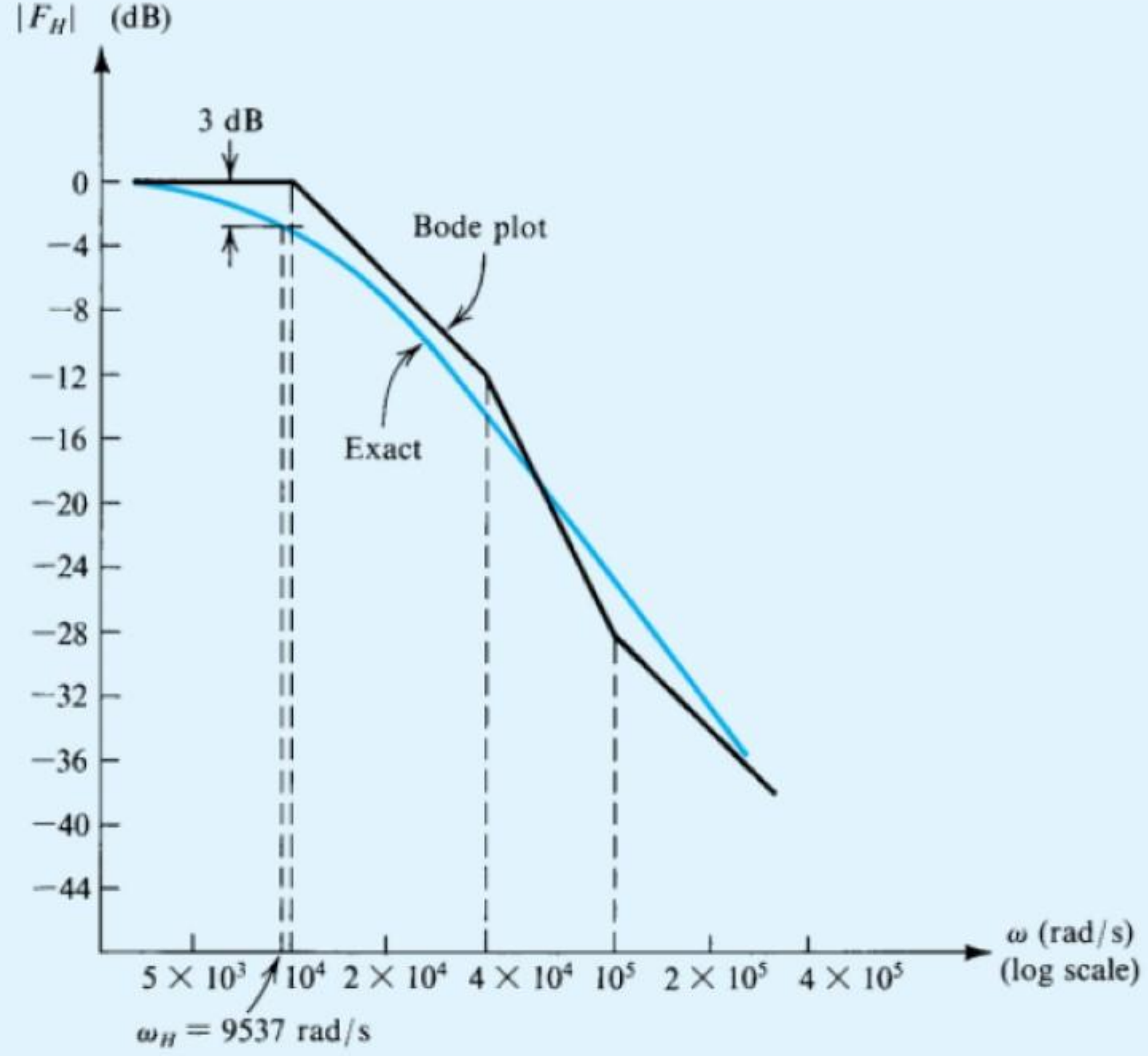

Figure 9.15 Normalized high-frequency response of the amplifier in Example 9.5.

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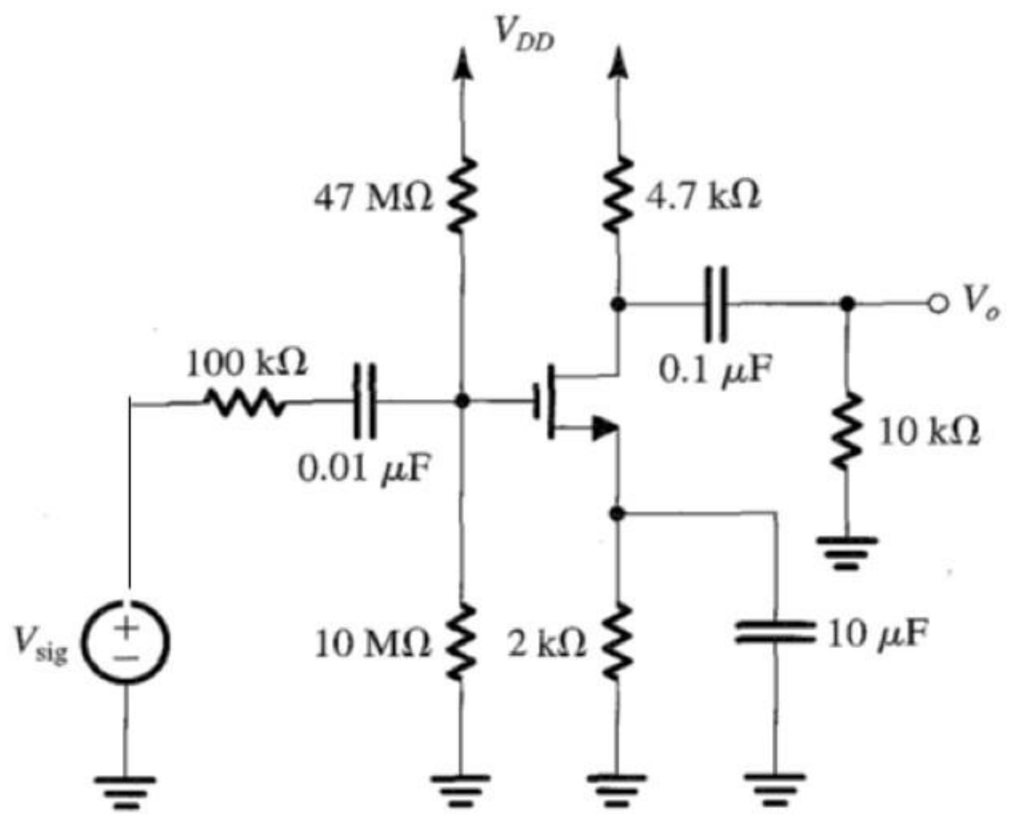
Low Frequency Response of Amplifier



- Proof: Derive the low-frequency band voltage gain for CS without using time-constant method (**Assignment!**)

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Thank You

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Have a Wonderful Semester