Frequency Response (2)

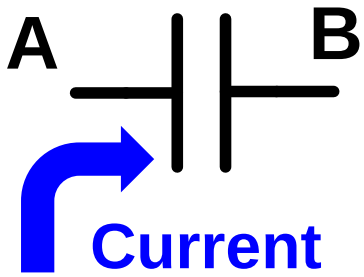
Hanwool Jeong

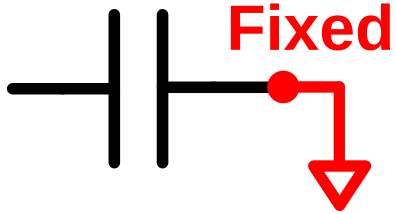
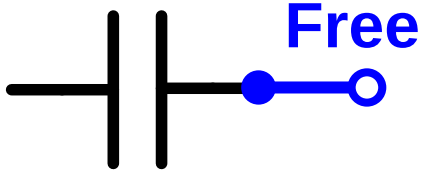
hwjeong@kw.ac.kr

Capacitance in Circuit

- Capacitance is charge-to-voltage ratio

➔Cap ↑ : Voltage difference cannot change easily.



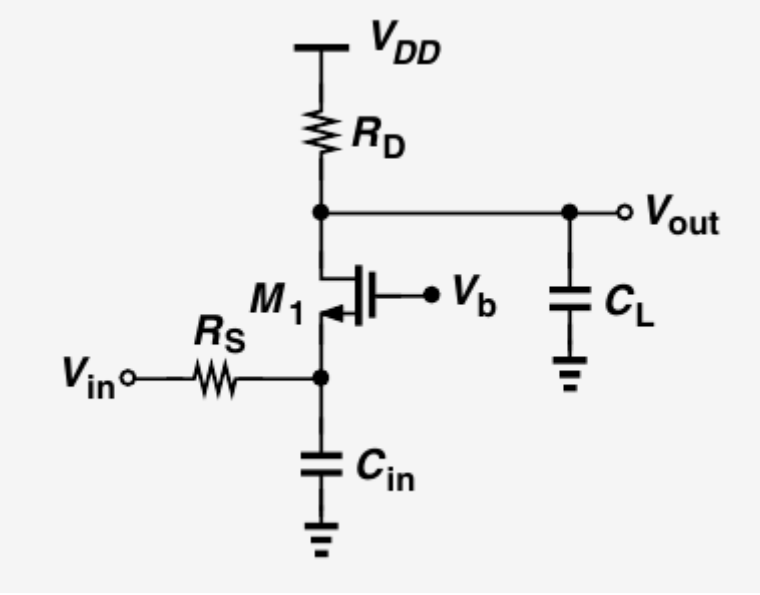
Fixed Node B	Free Node B
	

➔ **V_A will increase**

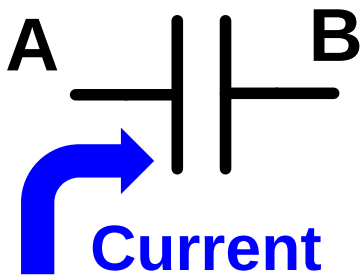
➔ As the cap disturbs the voltage difference between it, it limits the circuit operation.

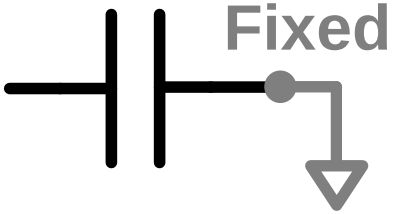
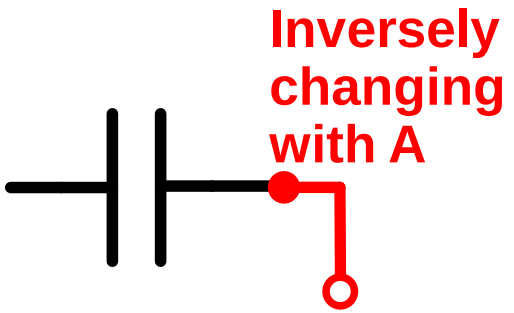
Revisit the Grounded Cap Effect

- How is the pole determined? How does the grounded cap affect?



How About This?



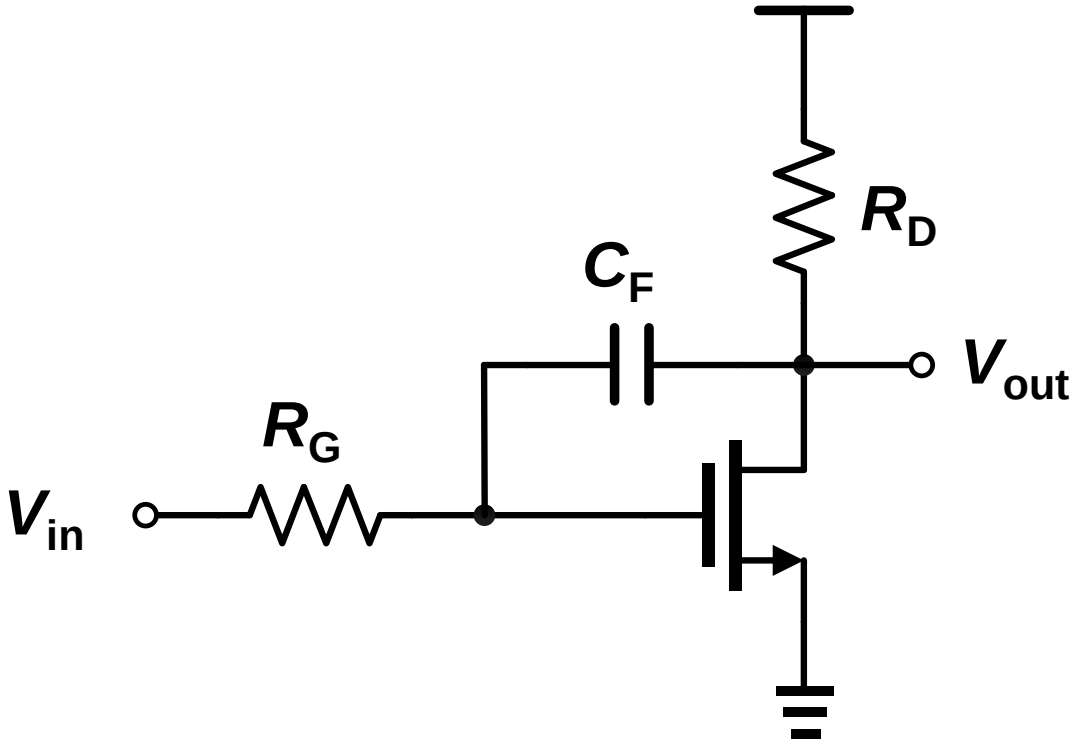
Fixed Node B	Inverse Node B
	

➔ V_A will increase

- Can you approximate the right-side cap with simpler one?
- What if the node B changes inversely to A more severely, like $V_B = -2V_A$ or $V_B = -3V_A$?

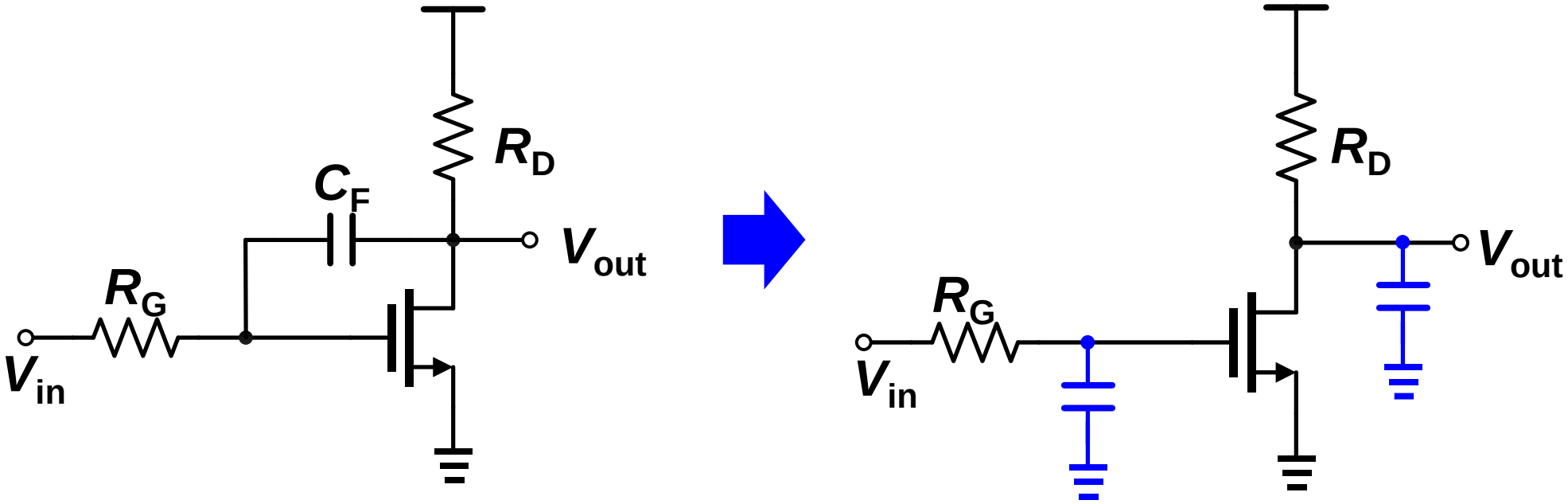
Can You Determine the Pole When Floating Capacitor Exists?

- Let's establish a systemized method.

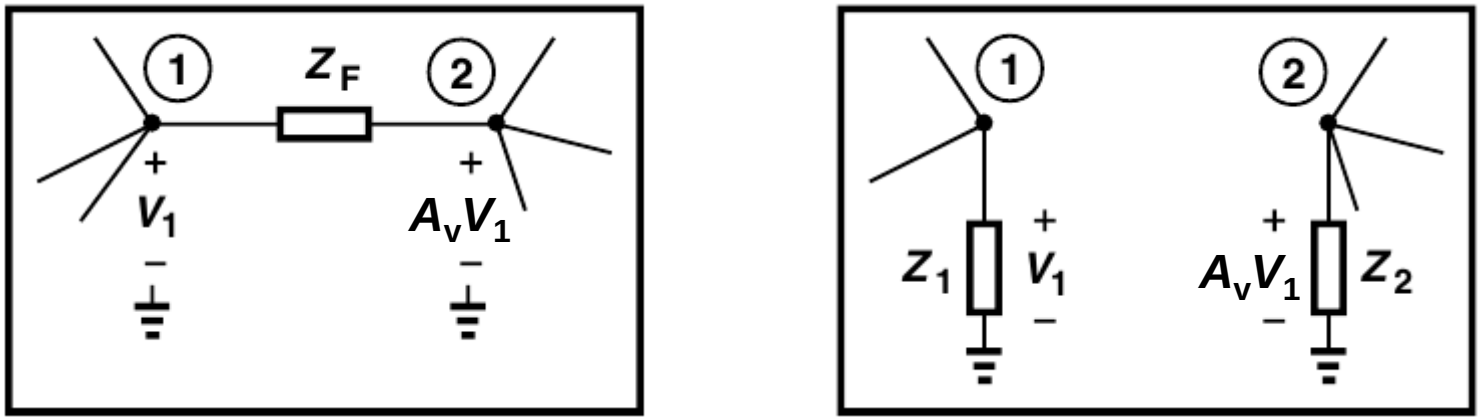


Our Goal

- Floating cap into Grounded cap ➔ Can you guess how?



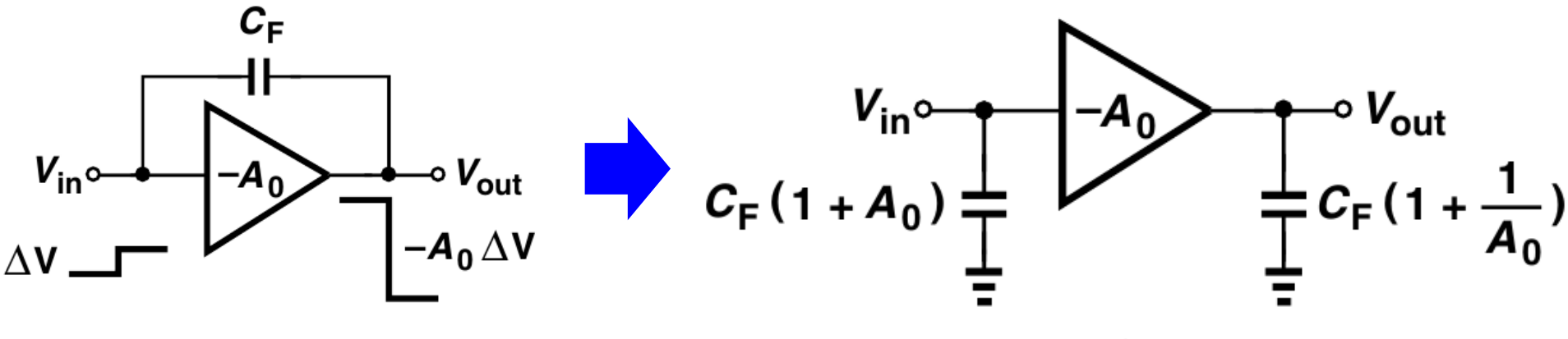
Miller's Theorem



$$\frac{V_1 - A_v V_1}{Z_F} = \frac{V_1}{Z_1} \qquad \frac{V_1 - A_v V_1}{Z_F} = -\frac{A_v V_1}{Z_1}$$

$$Z_1 = \frac{Z_F}{1 - A_v} \qquad Z_2 = \frac{Z_F}{1 - 1/A_v}$$

Applying to Floating Cap w/ Inverting Circuit

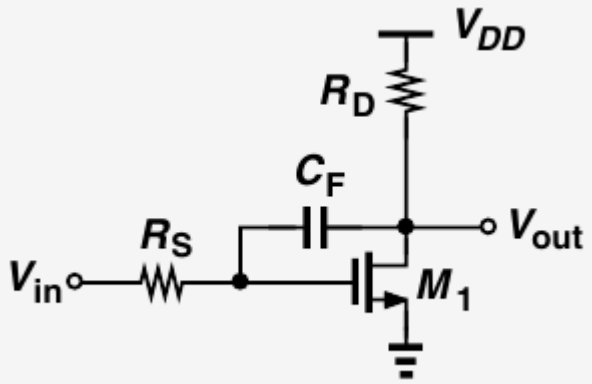


$$Z_1 = \frac{Z_F}{1 - A_v} \qquad Z_2 = \frac{Z_F}{1 - \frac{1}{A_v}}$$

$$= \frac{1}{(1 + A_0)C_F s} \qquad = \frac{1}{\left(1 + \frac{1}{A_0}\right)C_F s}$$

Example 11.10

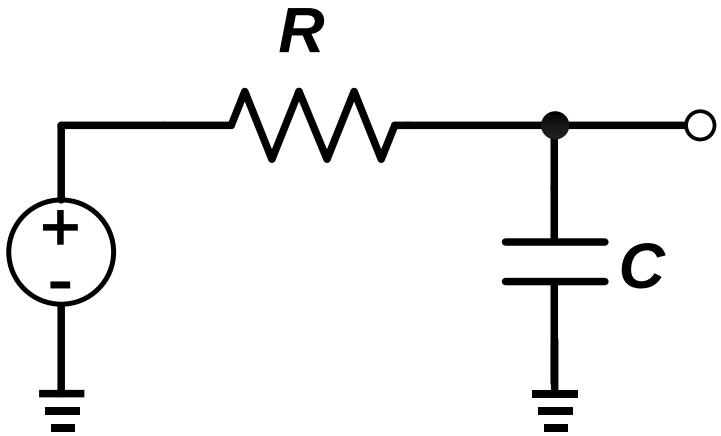
Estimate the pole of the circuit shown in Fig. 11.15(a). Assume $\lambda = 0$.

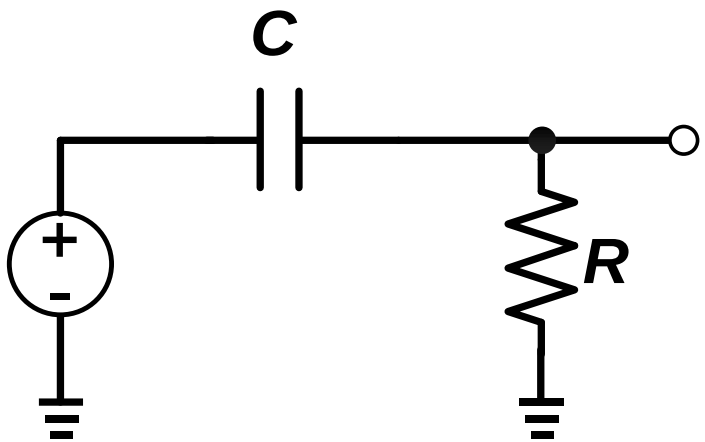


To Note

- Miller's theorem requires that the floating impedance and the voltage gain be computed at the same frequency.
- However, the low-frequency gain, $g_m R_D$, is used even for the purpose of finding high-frequency poles.
- After all, we know that the existence of CF lowers the voltage gain from the gate of M1 to the output at high frequencies.
- That is why we call this procedure "Miller approximation."

Can We Say Low Frequency is Always Well Propagated?



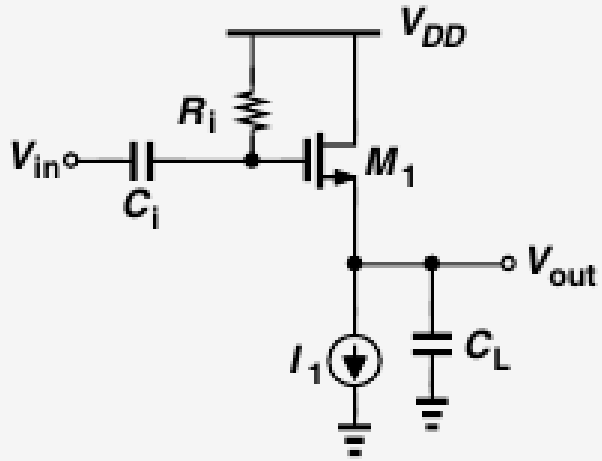


$$\frac{V_{out}}{V_{in}}(s) = \frac{R_1}{R_1 + \frac{1}{C_1 s}} = \frac{R_1 C_1 s}{R_1 C_1 s + 1}.$$

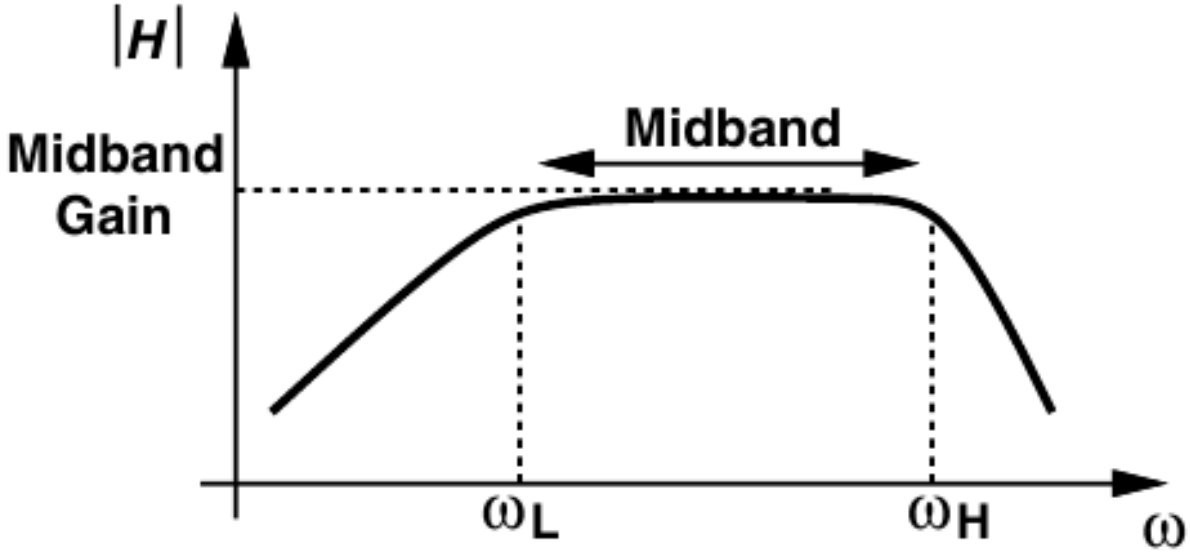
$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{R_1 C_1 \omega}{\sqrt{R_1^2 C_1^2 \omega_1^2 + 1}}.$$

Example 11.11

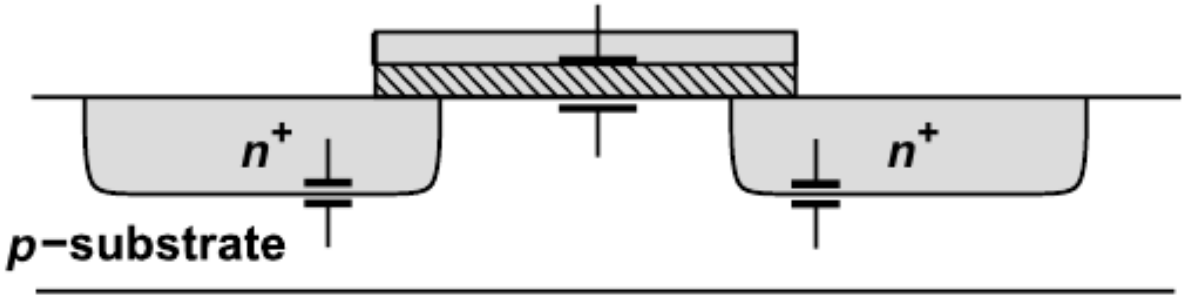
Figure 11.17 depicts a source follower used in a high-quality audio amplifier. Here, R_i establishes a gate bias voltage equal to V_{DD} for M_1, and I_1 defines the drain bias current. Assume $\lambda = 0$, $g_m = 1/(200\,\Omega)$, and $R_1 = 100$ kΩ. Determine the minimum required value of C_1 and the maximum tolerable value of C_L. Assume that the audio frequency range is 20Hz ~ 20kHz.

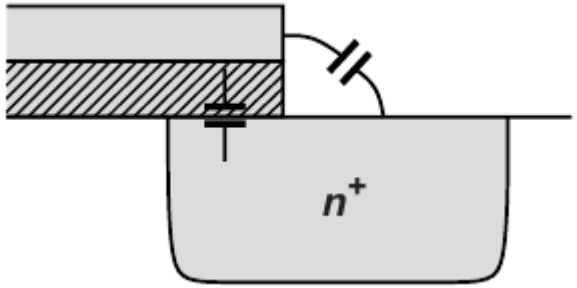


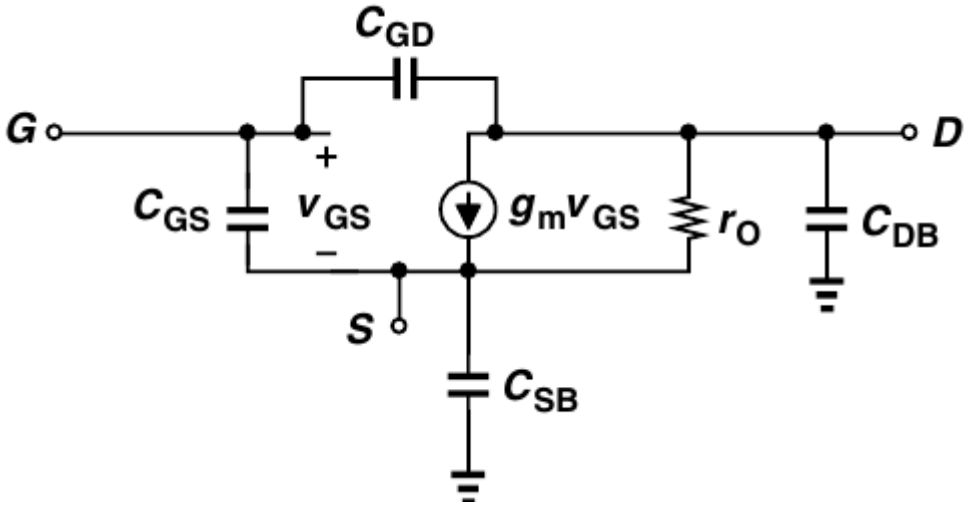
Typical Response

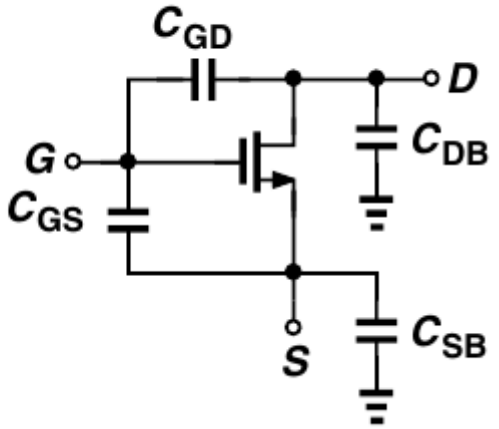


Capacitor Components in MOSFET









Example 11.13

Identify all of the capacitances in the circuit of Fig. 11.26(a).

