Discussion Outline

• Offset current (i.e., what happens when we have different input bias currents on each input?)
• Design constraint
Nonideal Op Amps | Input Bias Current

Remember the model for input bias current

- **Nonideal op amp**
- **Ideal op amp**

![Nonideal op amp diagram](image)

- $v^+$
- $v^-$
- $I_{bias}$
- $v_o$
Last week, we found out we could compensate for this bias current—*this only works if the currents are matched*!

\[ R_b = R_1 || R_2 \]

\[ I_{bias,1} = I_{bias,2} \]

\[ R_1 = 10 \, \text{k}\Omega \]

\[ R_2 = 1 \, \text{M}\Omega \]
Now, consider an offset current that is 10% of $I_{bias}$ → What’s the resulting $v_o$ (ignoring any $V_{OS}$)?

- $R_b = R_1 || R_2$
- $R_1 = 10 \, k\Omega$
- $R_2 = 1 \, M\Omega$
- $1.1 \cdot I_{bias,1} = I_{bias,2}$
Now include previous $V_{OS} = 2 \text{ mV}$ & $I_{OS} = 0.1 \cdot I_{bias}$ to find the worst-case dc voltage at the output in this compensated circuit.
Let’s look at how you might be constrained by a COTS (commercial off-the-shelf) part when trying to design a circuit.

- $f_t = 20 \text{ MHz}$
- Slew rate, $\text{SR} = 10 \frac{V}{\mu s}$
- Output saturation, $V_{o,max} = 10 \text{ V}$
Constrained Op Amp Design

Using the noninverting configuration with

- \( A_v = 10 \frac{V}{V} \)
- \( v_i = 0.5 \text{ V} \)

- \( f_t = 20 \text{ MHz} \)
- \( \text{SR} = 10 \frac{V}{\mu s} \)
- \( V_{o,max} = 10 \text{ V} \)

What’s the maximum frequency signal that can be amplified before output distortion occurs?
Constrained Op Amp Design

Using the noninverting configuration with

- \( f = 200 \text{ kHz} \)
- \( f_t = 20 \text{ MHz} \)
- \( \text{SR} = 10 \frac{V}{\mu s} \)
- \( V_{o,max} = 10 \text{ V} \)

What’s the maximum input signal amplitude that can be amplified before output distortion occurs?
Using the noninverting configuration with

- \( f = 50 \text{ kHz} \)
- \( f_t = 20 \text{ MHz} \)
- \( \text{SR} = 10 \frac{V}{\mu s} \)
- \( V_{o,max} = 10 \text{ V} \)

What's the usable input voltage range?