

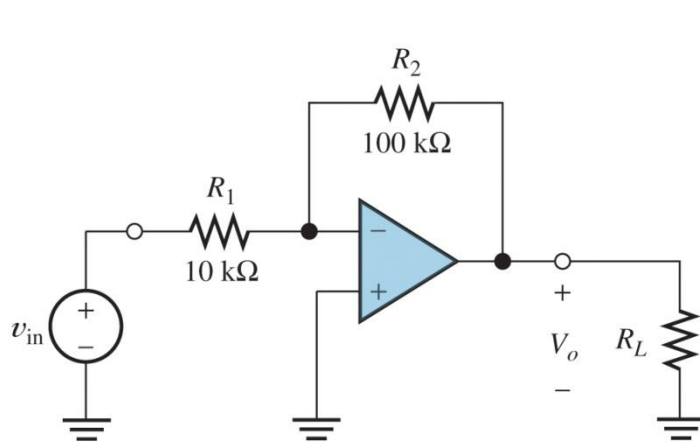
EELE 250: Circuits, Devices, and Motors

Op Amps (cont.)

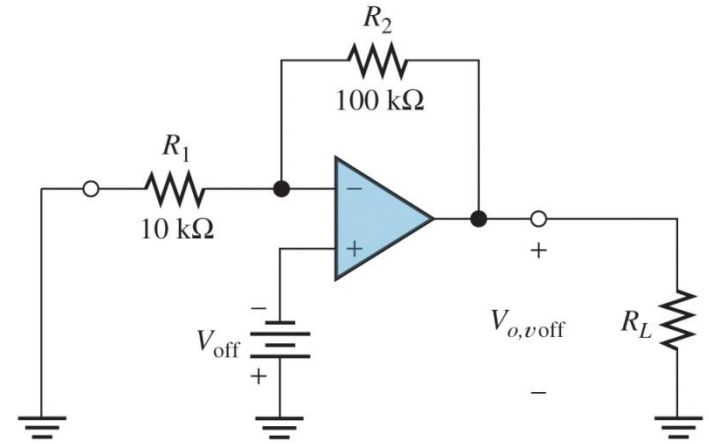
Assignment Reminder

- Read 14.4 - 14.7
- Practice Problems:
 - P14.18, P14.20, P14.21, P14.23, P14.36, P14.38
- Lab #6 this week. Keep your circuits on your breadboard for use again next week in Lab #7.
- D2L Quiz #8 by 11AM on Monday 31 Oct.
- Exam #3: Wednesday 9 Nov.

Modeling real op amps



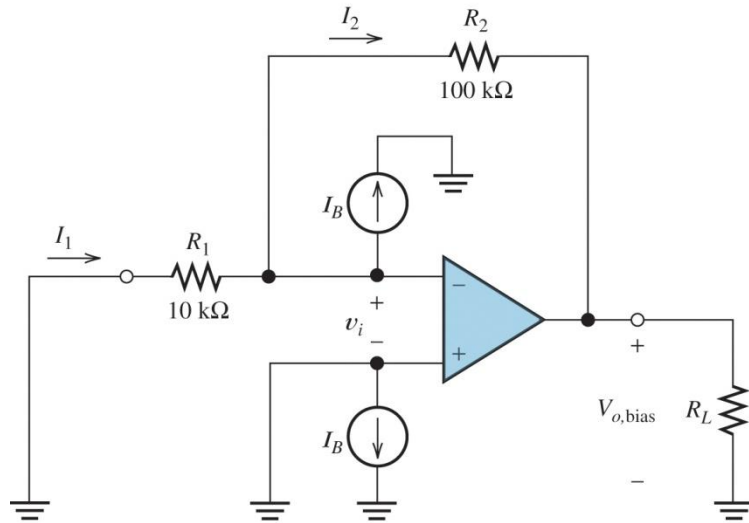
(a) Original circuit



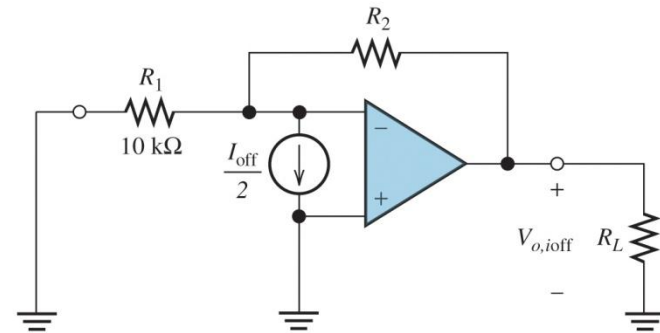
(b) Circuit with $v_{in} = 0$ showing the input offset voltage source

Input offset voltage: output may not be exactly zero volts even if input is zero

Modeling real op amps (cont.)



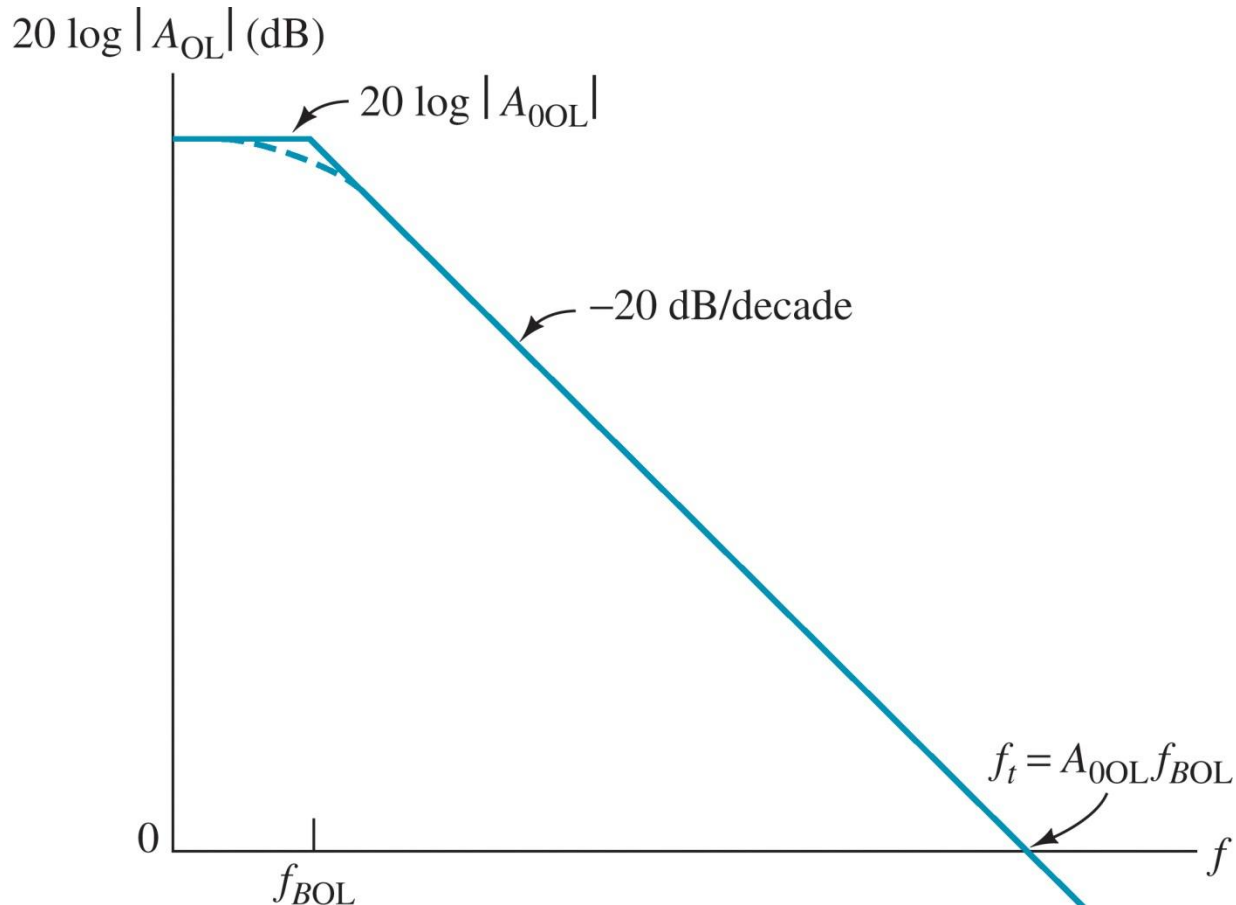
(c) Circuit with bias current sources



(d) Circuit with offset current source

Input bias and offset currents: current at each input is not exactly zero, and not exactly balanced.

Frequency Response



Open loop gain decreases as frequency increases, so assumption that A_{OL} is huge does not hold at higher frequencies.

Output limitations

- Output voltage swing -- clipping
- Output current – clipping or droop
- Slew rate: limit on dV/dt -- distortion

Typical specs

	741	OP-27	LF353
Input bias current	1.5 μA	35 nA	50 pA
Input offset voltage	6.5 mV	25 μV	5 mV
Gain x BW	1 MHz	8 MHz	4 MHz
Slew Rate	0.5 $\text{V}/\mu\text{sec}$	2.8 $\text{V}/\mu\text{sec}$	13 $\text{V}/\mu\text{sec}$
Max output current	25 mA	30 mA	25 mA
Input noise	20	3.8	20
Price	\$ 0.88	\$ 3.00	\$ 0.66