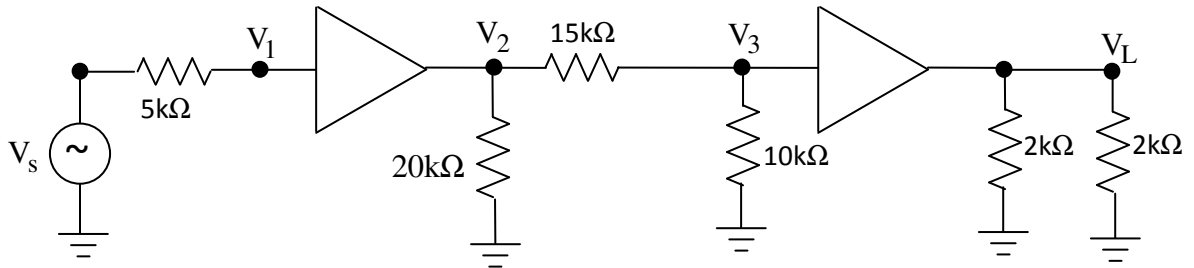


## Examples

$V_s$  is an AC signal. Both amplifiers have the following characteristics:

$$A_{v0}=20, \quad R_i=20\text{k}\Omega, \quad R_o=2\text{k}\Omega, \quad \text{Clipping levels: } L=\pm 12\text{V (unloaded)}$$

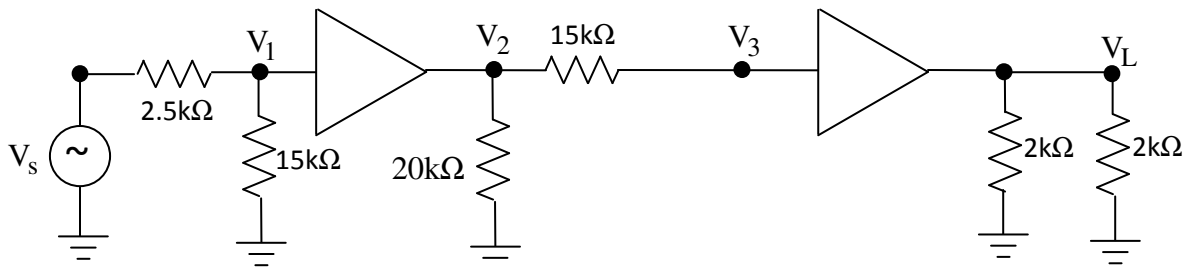


(a) Redraw this 2 stage amplifier using the voltage amplifier model. Make sure to label  $V_s$ ,  $V_1$ ,  $V_3$ , and  $V_L$  on the schematic.

(b) Find  $A_v = \frac{v_L}{v_s}$ . Express your answer as a ratio(V/V) and in dB.

$V_s$  is an AC signal. Assume linear operation. Both amplifiers have the following characteristics:

$$A_{vo}=9, \quad R_{in}=15k\Omega, \quad R_o=1k\Omega \quad \text{power supplies} = \pm 12 \text{ V}$$



(a) Draw this 2 stage amplifier using the voltage amplifier model. Make sure to label  $V_s$ ,  $V_1$ ,  $V_2$ ,  $V_3$ , and  $V_L$  on the schematic.

(b) Find the voltage gain  $V_L/V_s$  without frequency dependence or op amp imperfections [in dB].

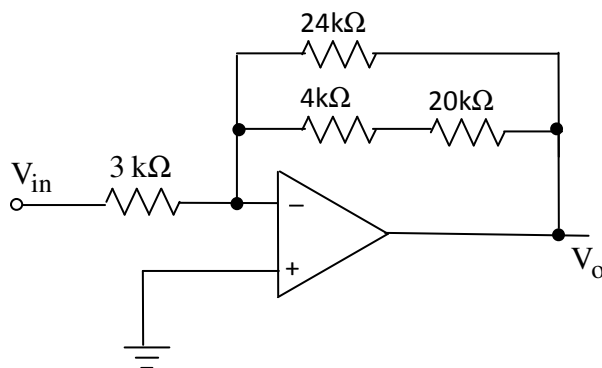
(c) If  $V_s=\sin(\omega t)$ , does clipping occur at the output of the first op amp ( $V_2$ )?

(d) If  $V_s=\sin(\omega t)$  what is the maximum output value at  $V_L$ ?

You are given the following characteristics for a real amplifier:

- Input offset voltage,  $V_{ios}=5\text{mV}$
- Input Resistance,  $R_i=1\text{M}\Omega$
- Unity-gain bandwidth,  $f_T=12\text{MHz}$
- Output swing limits, within 2Volts of power supply
- Slew Rate,  $SR=4 \frac{\text{V}}{\mu\text{sec}}$

a) Given the following circuit with the operational amplifier powered at  $\pm 12\text{V}$ .

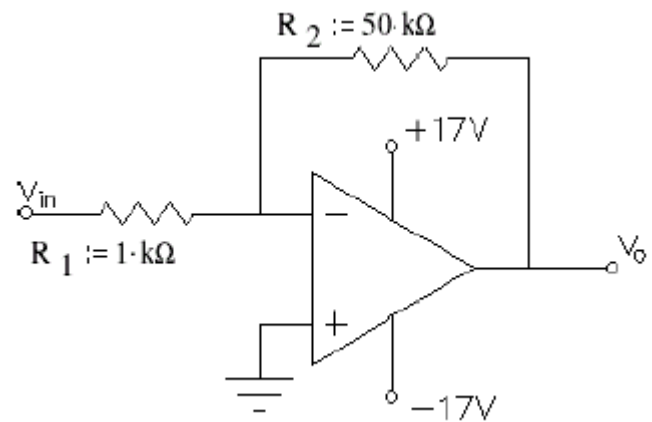


- Find the ideal gain of the above circuit.
- For small input signals, what is the bandwidth of the circuit.
- What is the bandwidth when the circuit is operated to produce the maximum possible peak voltage value?
- For  $V_{in}=0.001\sin(2\pi 90kt)$ , what is the ideal value for the peak to peak voltage value at the output?
- For  $V_{in}=0.002\sin(2\pi 90kt)$ , what is the peak to peak voltage value at the output considering the input offset voltage?
- How should the circuit above be modified to minimize the effect of the input bias current? Draw the schematic of the modified circuit and state values of added component(s).

You are given the following characteristics for a real amplifier along with the circuit on the right.

Op amp Characteristics

Input offset voltage:	$V_{ios} := 2.0\text{-mV}$
Input offset current:	$I_{os} := 100\text{-nA}$
Input bias current:	$I_{iB} := 500\text{-nA}$
Input resistance:	$R_i := 2\text{-M}\Omega$
Output resistance:	$R_o := 75\text{-}\Omega$
Open-loop gain:	$A_{o1} = 106\text{-dB}$
Unity-gain bandwidth:	$f_T := 4\text{-MHz}$
Output swing limits:	within 2 V of supplies $L+ = V+ - 2V$ $L- = V- + 2V$
Slew rate:	$SR := 2 \cdot \frac{V}{\mu s}$



- What is the voltage gain of the circuit? (make sure the sign is right)
- For small input signals, what is the bandwidth of the circuit?
- For an output signal of 12Vpp, what is the bandwidth of the circuit?
- What is the maximum peak-to-peak output you can get without clipping?
- What is the input impedance?
- Find the effect of the input offset voltage ( $v_{in}=0V$ ).
- How should the circuit be modified to minimize the effect of the input bias current? Show the modification on a schematic and find the value of any added parts.

