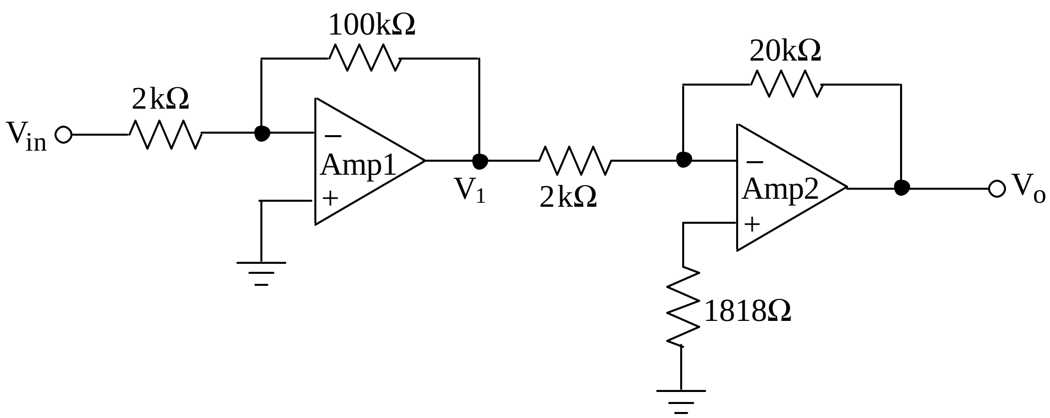
<u>Homework #2:</u>

1. (a) Explain how an amplifier works in your own words.
   (b) Explain in your own words what R_i is.
   (c) Explain in your own words what R_o is.
   (d) Describe the ideal characteristics for an amplifier (i.e. ideal value for R_i, R_o, A_{vo})
   (e) Describe the characteristics for a buffer amplifier.

2. Use the circuit below:

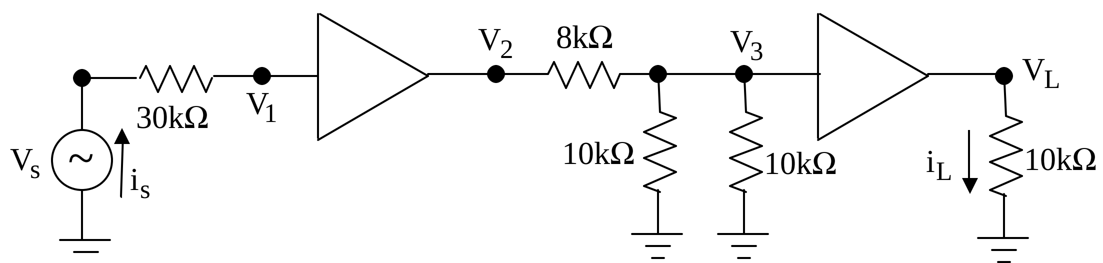


Amp1 is a CA3140 and Amp2 is an LM741. (See attached datasheet information)

(a) State each amplifiers frequency response transfer function (V_1/V_{in} and V_o/V_1)
(b) State the overall transfer function (V_o/V_{in})
(c) Solve for the overall f_{3dB} of the above circuit.

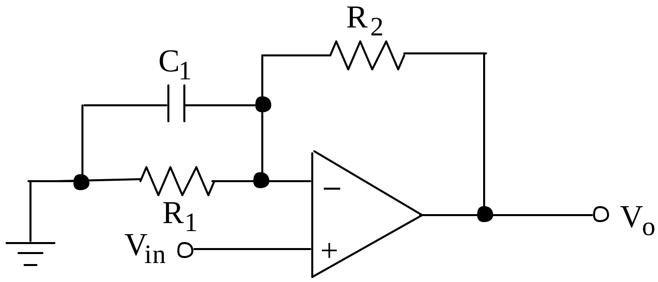
3. v_s is an AC signal. Both amplifiers have the following characteristics:

A_{vo}=20, R_i=10kΩ, R_o=2kΩ, Clipping levels: L=$\pm$12V (unloaded)

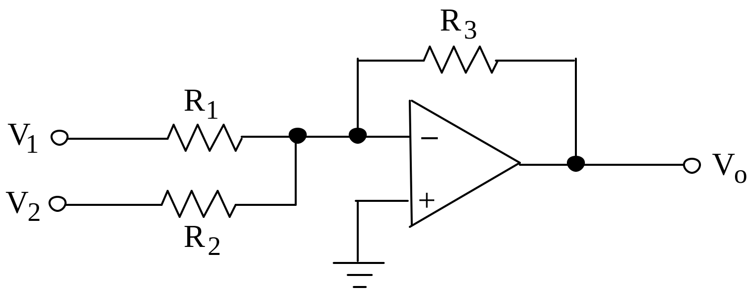


(a) Redraw this 2 stage amplifier using the voltage amplifier model. Make sure to label V_S, V_1, V_3, and V_0 on the schematic.
(b) Find $A_v = v_L / v_S$. Express your answer as a ratio(V/V) and in dB. [Round answer to the nearest whole number]
(c) Find $A_i = i_L / i_S$. Express your answer as a ratio(A/A) and in dB. [Round the answer to the nearest whole number]

4. Analyze the circuit below to obtain the transfer function, V_o/V_{in}. Assume an ideal op amp. Sketch the straight line approximation for the Bode Plots.



5. Redraw or add to the schematic below to show how to reduce the **input bias current**. State the symbolic value(s) of any components added to the schematic.



Electrical Specifications $V_{SUPPLY} = \pm15V$, $T_A = 25^oC$

PARAMETER	SYMBOL	TEST CONDITIONS		TYPICAL VALUES CA3140	CA3140A	UNITS
Input Offset Voltage Adjustment Resistor		Typical Value of Resistor Between Terminals 4 and 5 or 4 and 1 to Adjust Max V_{IO}		4.7	18	kΩ
Input Resistance	R_I			1.5	1.5	TΩ
Input Capacitance	C_I			4	4	pF
Output Resistance	R_O			60	60	Ω
Equivalent Wideband Input Noise Voltage, (See Figure 27)	e_N	BW = 140kHz, R_S = 1MΩ		48	48	µV
Equivalent Input Noise Voltage (See Figure 35)	e_N	R_S = 100Ω	f = 1kHz	40	40	nV/√Hz
			f = 10kHz	12	12	nV/√Hz
Short Circuit Current to Opposite Supply	I_{OM}+		Source	40	40	mA
	I_{OM}-		Sink	18	18	mA
Gain-Bandwidth Product, (See Figures 6, 30)	f_T			4.5	4.5	MHz
Slew Rate, (See Figure 31)	SR			9	9	V/µs
Sink Current From Terminal 8 To Terminal 4 to Swing Output Low				220	220	µA
Transient Response (See Figure 28)	t_r	R_L = 2kΩ C_L = 100pF	Rise Time	0.08	0.08	µs
	OS		Overshoot	10	10	%
Settling Time at $10V_{P-P}$, (See Figure 5)	t_S	R_L = 2kΩ C_L = 100pF Voltage Follower	To 1mV	4.5	4.5	µs
			To 10mV	1.4	1.4	µs

Electrical Specifications For Equipment Design, at $V_{SUPPLY} = \pm15V$, $T_A = 25^oC$, Unless Otherwise Specified

PARAMETER	SYMBOL	CA3140 MIN	CA3140 TYP	CA3140 MAX	CA3140A MIN	CA3140A TYP	CA3140A MAX	UNITS
Input Offset Voltage	$\|V_{IO}\|$	-	5	15	-	2	5	mV
Input Offset Current	$\|I_{IO}\|$	-	0.5	30	-	0.5	20	pA
Input Current	I_I	-	10	50	-	10	40	pA
Large Signal Voltage Gain (Note 3) (See Figures 6, 29)	A_{OL}	20	100	-	20	100	-	kV/V
		86	100	-	86	100	-	dB
Common Mode Rejection Ratio (See Figure 34)	CMRR	-	32	320	-	32	320	µV/V
		70	90	-	70	90	-	dB
Common Mode Input Voltage Range (See Figure 8)	V_{ICR}	-15	-15.5 to +12.5	11	-15	-15.5 to +12.5	12	V

LM741: