Pre-Lab 3: Operational Amplifiers - Part 1

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Calculations:

1. **Solution**:

Read the datasheet for the UA741 opamp and write down the typical values of the following parameters:

Supply Voltage: ± 5 V (Min) ± 15 V (Max)
Power Consumption: 85 mW (Average)
Input Resistance: 0.3 MΩ
Input Offset Voltage: 1mV-6mV; 7.5mV (@ Full range)
Output Resistance: 75 Ω (Average)
Input Offset Current: 200 nA (Average); 300nA (@ Full range)
Voltage Gain: 106.02 dB open loop at 2K load
Bandwidth: .7MHz - 1 MHz GBP
Slew Rate: 0.5 V/ μs

*Average = (25 degrees Celsius)

Derive the voltage gains $\frac{V_{o1}}{V_i}$, $\frac{V_{o2}}{V_i}$, and $\frac{V_{o3}}{V_i}$ for the circuits in Fig. 1, assume the opamps are ideal.

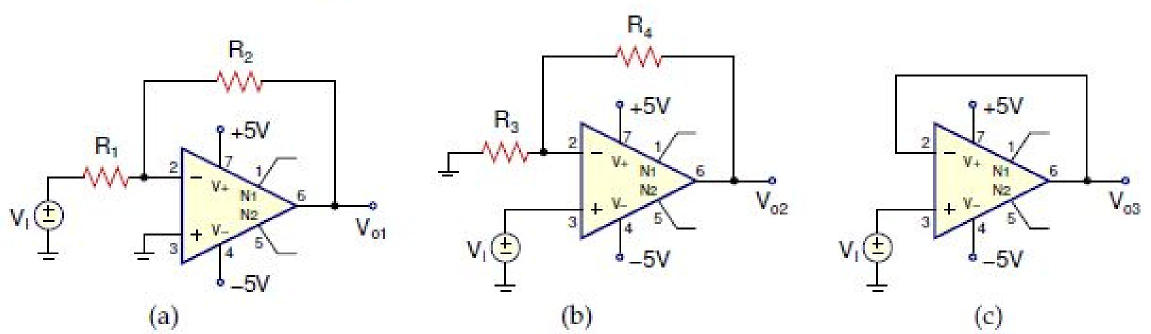


Figure 1: Opamp configurations (a) Inverting amplifier (b) Non-inverting amplifier (c) Voltage follower

2. Calculations

a.

$$V_X = 0\ ,\ I_1 = I_2\ ,\ \textit{No input current}$$

$$\frac{V_I - V_x}{R_1} = \frac{V_x - V_{o1}}{R_2}\ \ ;\ \frac{V_{o1}}{V_I} = \frac{-R_2}{R_1}$$

b.

$$V_y = V_I\ ,\ I_1 = I_2\ ,\ \textit{No input current}$$

$$\frac{0 - V_y}{R_3} = \frac{V_I - V_{o2}}{R_4}\ ;\ \frac{-V_I}{R_3} = \frac{V_I - V_{o2}}{R_4}$$

$$\frac{V_{o2}}{R_4} = \frac{V_I}{R_4} + \frac{V_I}{R_3}\ ;\ \frac{V_{o2}}{V_I} = \left(1 + \frac{R_4}{R_3}\right)$$

c.

$$\textit{Output voltage} = \textit{Input voltage}$$

$$V_{o3} = V_I$$

3. Calculations

$$R_1 = R_3 = 10k\Omega\ ,\ \frac{V_{o1}}{V_I} = -3\ \ ,\ \frac{V_{o2}}{V_I} = 6$$

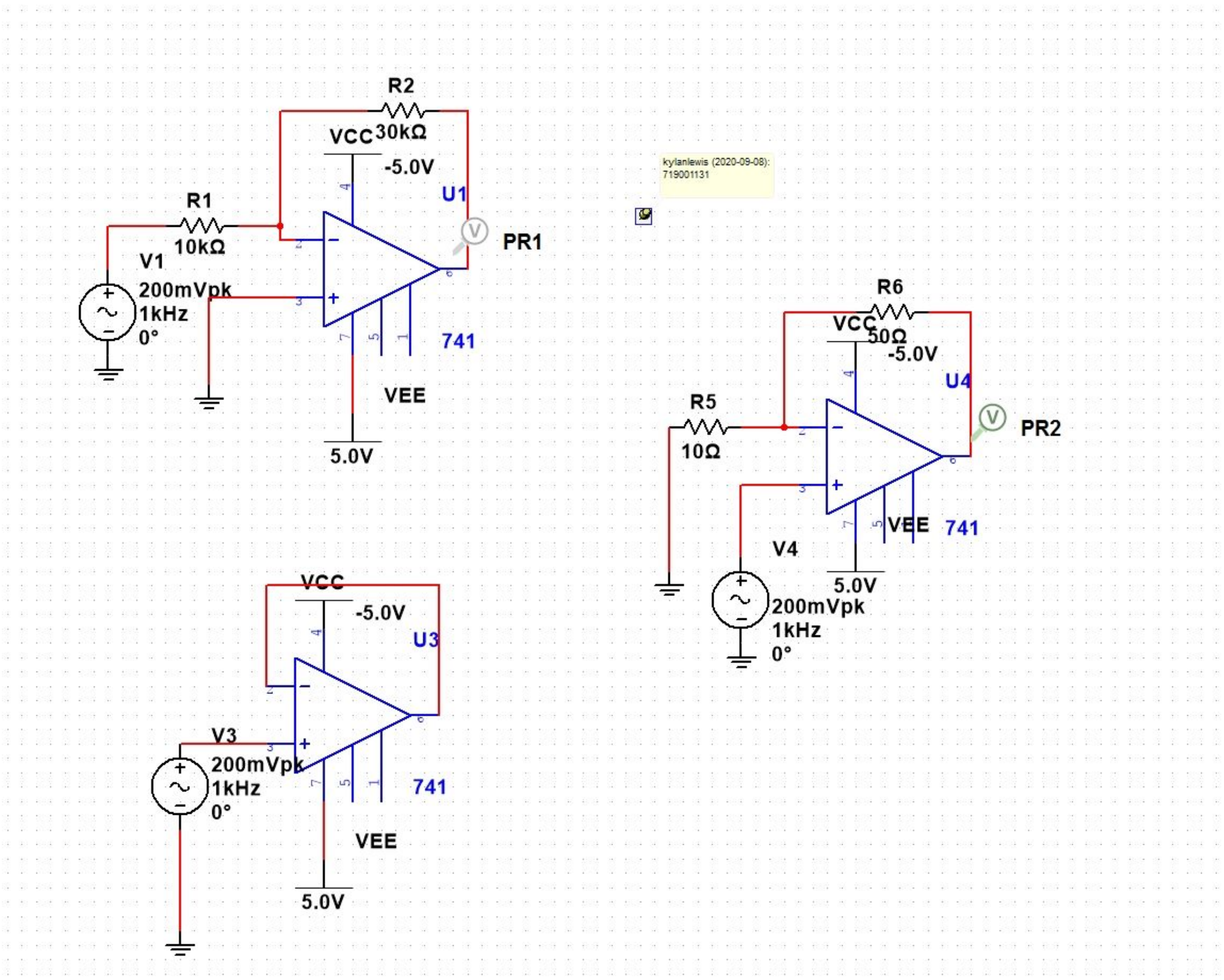
$$\frac{V_{o1}}{V_I} = -3\ ;\ \frac{-R_2}{R_1}V_I = -3$$

$$R_2 = 3R_1\ ;\ \mathbf{R_2 = 30\ k\Omega}$$

$$\frac{\mathrm{V_{o2}}}{\mathrm{V_I}} = 6\ ;\ \left(1 + \frac{\mathrm{R_4}}{\mathrm{R_3}}\right) = 6$$

$$\frac{\mathrm{R_4}}{\mathrm{R_3}} = 5\ ;\ \mathrm{R_4} = 5\left(\mathrm{R_3}\right)\ ;\ \mathbf{R_4 = 50\ k\Omega}$$

Circuit Design:



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