

Review on Operational Amplifiers

Q1 [Modified from Rizzoni Problem 8.4]

With reference to the Figure P8.4 that shows an ideal op amp model,

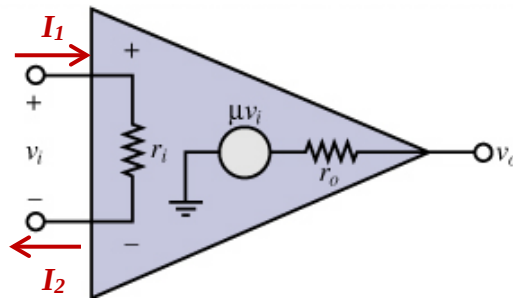


Figure P8.4

- What approximations are made about the values of r_i , μ , and r_o ?
- Find the value of I_1 and I_2 if a voltage source was applied across the input terminals.
- If the ideal op amp is connected in negative feedback, what would be the value of v_i ?

Source Follower

Q2 [Modified from Alexander Problem 5.27]

For the circuit shown in Figure 5.65, assuming the op amp is ideal,

- Determine I_1 and I_2 ;
- Find v_1 and v_2 ;
- Find v_o and I_4 .
- Determine I_3 .

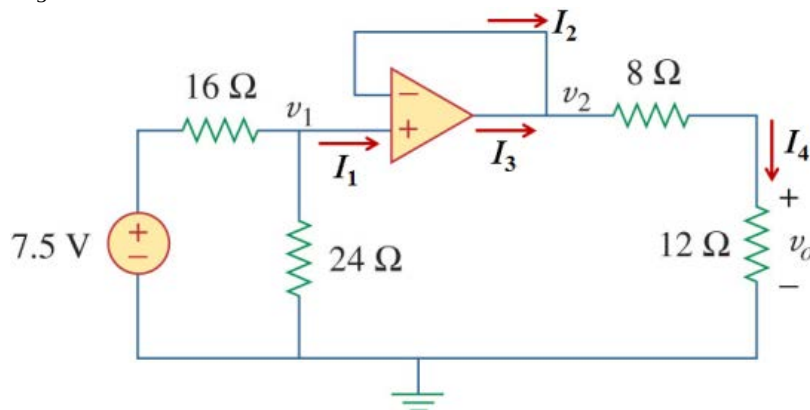


Figure 5.65

Inverting Amplifier

Q3 [Modified from Alexander Problem 5.12]

For the circuit shown in Figure 5.51, assuming the op amp is ideal, and given $v_s = 1$ V,

- Find I_1 and I_2 ;
- Find the voltage at the inverting and non-inverting inputs;
- Find I_5 and I_F ;
- Find v_o ;

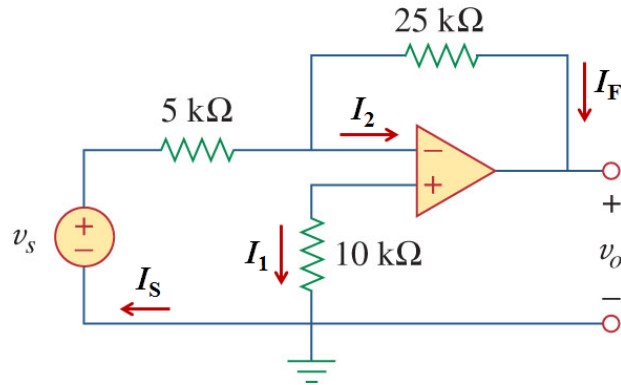


Figure 5.51

Q4 [Modified from Alexander Problem 5.19]

For the circuit shown in Figure 5.58, assuming the op amp is ideal,

- Find V_1 ;
- Find I_1 , I_2 , and I_3 ;
- Find v_o and i_o .
- Find the current supplied by the source and hence input resistance by the source.

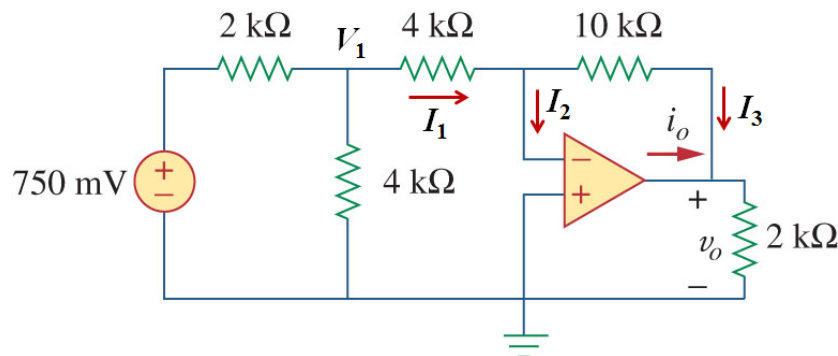


Figure 5.58

Q5 [Modified from Alexander Problem 5.21]

For the circuit shown in Figure 5.60, assuming the op amp is ideal,

- Find the voltage at the inverting input;
- Find I_1 , I_2 and I_3 ;
- Find v_o .

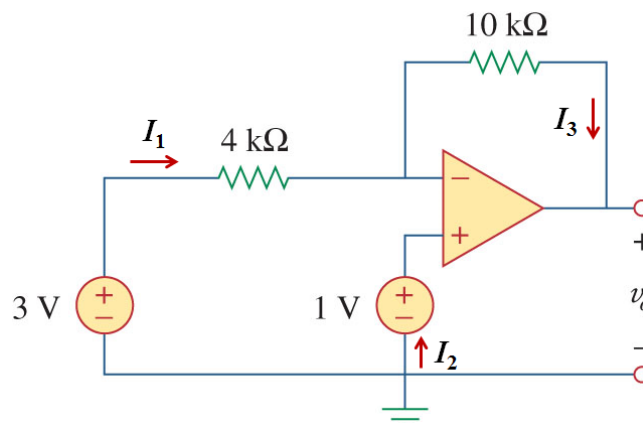


Figure 5.60

Non-inverting Amplifiers

Q6 [Modified from Alexander Problem 5.10]

For the circuit in Figure 5.49, assuming the op amp is ideal and letting $v_s = 1$ V,

- Find I_1 and I_2 ;
- Determine the voltage at the inverting input;
- Find v_o and hence determine v_o/v_i ;
- Find I_3 ;
- If a $5\text{ k}\Omega$ load is added across v_o , find the resulting I_3 ;
- Determine the input resistance seen by the source v_s .

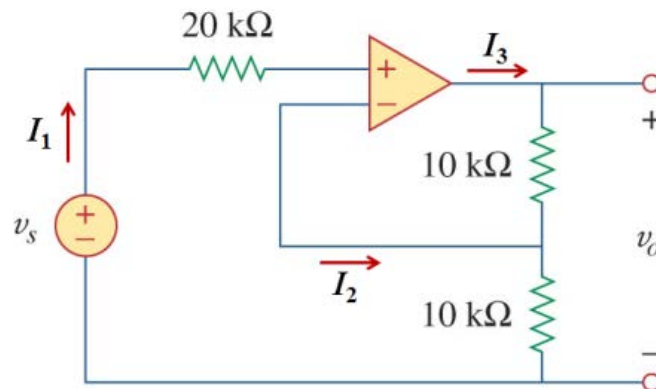


Figure 5.49

Q7 [Modified from Alexander Problem 5.13]

For the circuit in Figure 5.52, assuming the op amp is ideal,

- Find the voltages at the inverting and non-inverting inputs of the op amp;
- Find I_1 , I_2 , and I_3 ;
- Find v_o and i_o ;

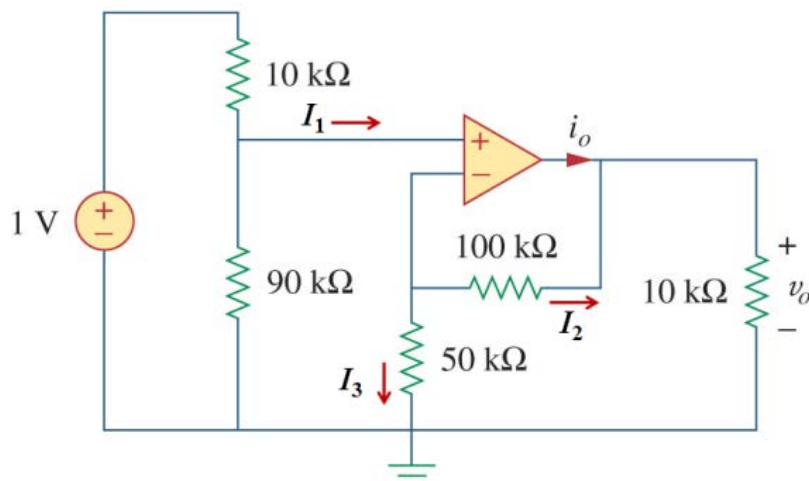


Figure 5.52

Summing Amplifiers

Q8 [Modified from Alexander Problem 5.37]

For the circuit shown in Figure 5.74, assuming the op amp is ideal,

- Determine the voltage at the inverting input;
- Find currents I_1 , I_2 and I_3 ;
- Find current I_4 ;
- Hence find v_o .

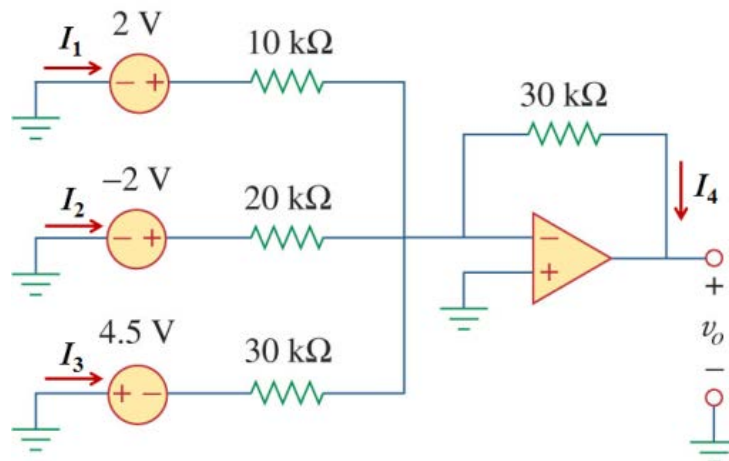


Figure 5.74

Q9 [Modified from Alexander Problem 5.40]

For the circuit shown in Figure 5.77, assuming the op amp is ideal and $v_1 = 1$ V and $v_2 = 2$ V,

- Find currents I_1 and I_2 ;
- Find currents I_3 and I_4 ;
- Hence find V_o and I_o .
- If a 10 k Ω resistor was connected between the inverting input and ground, find the resulting value of V_o .

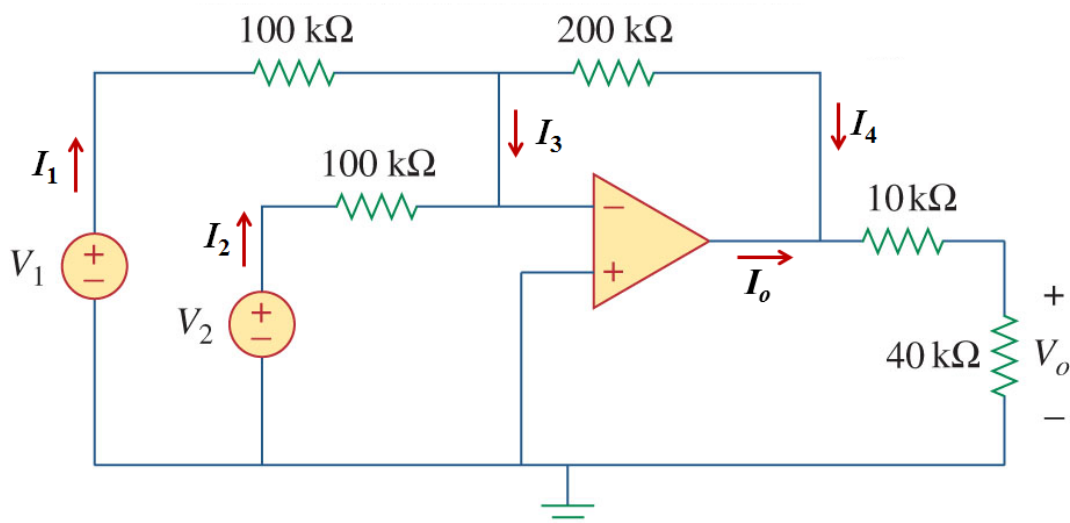


Figure 5.77

Numerical solutions**Q1 [Modified from Rizzoni Problem 8.4]**

- a) Input resistance, $r_i \rightarrow \infty$, Open loop gain, $\mu \rightarrow \infty$, Output resistance, $r_o = 0$
- b) $I_1 = 0$ A, $I_2 = 0$ A
- c) In negative feedback, $v_i = 0$

Q2 [Modified from Alexander Problem 5.27]

- a) $I_1 = 0$ A, $I_2 = 0$ A
- b) $v_1 = 4.5$ V, $v_2 = 4.5$ V
- c) $v_o = 2.7$ V, $I_4 = 0.225$ A
- d) $I_3 = 0.225$ A

Q3 [Modified from Alexander Problem 5.12]

- a) $I_1 = 0$ A, $I_2 = 0$ A
- b) $v^+ = 0$ V, $v^- = 0$ V
- c) $I_S = 0.2$ mA, $I_F = 0.2$ mA
- d) $v_o = -5$ V

Q4 [Modified from Alexander Problem 5.19]

- a) $V_1 = 375$ mV
- b) $I_1 = 93.75$ μ A, $I_2 = 0$, $I_3 = 93.75$ μ A
- c) $v_o = -0.9375$ V, $i_o = -0.5625$ mA
- d) Source current = 0.1875 mA, Input resistance = 4 k Ω

Q5 [Modified from Alexander Problem 5.21]

- a) $v^- = 1$ V
- b) $I_1 = 0.5$ mA, $I_2 = 0$ A, $I_3 = 0.5$ mA
- c) $V_o = -4$ V

Q6 [Modified from Alexander Problem 5.10]

- a) $I_1 = 0$ A, $I_2 = 0$ A
- b) $v^- = 1$ V
- c) $v_o = 2$ V, $v_o/v_i = 2$
- d) $I_3 = 0.1$ mA
- e) With load added, $I_3 = 0.5$ mA
- f) Input resistance seen by source is infinite

Q7 [Modified from Alexander Problem 5.13]

- a) $v^+ = 0.9$ V, $v^- = 0.9$ V
- b) $I_1 = 0$ A, $I_2 = -18$ μ A, $I_3 = 18$ μ A
- c) $v_o = 2.7$ V, $i_o = 288$ μ A

Q8 [Modified from Alexander Problem 5.37]

- a) $v^- = 0$ V
- b) $I_1 = 0.2$ mA, $I_2 = -0.1$ mA, $I_3 = -0.15$ mA
- c) $I_3 = -0.05$ mA
- d) $v_o = 1.5$ V

Q9 [Modified from Alexander Problem 5.40]

- a) $I_1 = 10 \mu\text{A}$, $I_2 = 20 \mu\text{A}$
- b) $I_3 = -20 \mu\text{A}$, $I_4 = 30 \mu\text{A}$
- c) $V_o = -4.8 \text{ V}$, $I_o = -0.15 \text{ mA}$