

Q1. [Problem 8.3]

What approximations are usually made about the voltages and currents shown in Figure P8.3 for the ideal operational amplifier model?

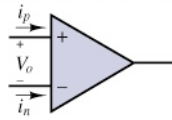


Figure P8.3

Q2. [Problem 8.4]

What approximations are usually made about the circuit components and parameters shown in Figure P8.4 for the ideal op-amp model?

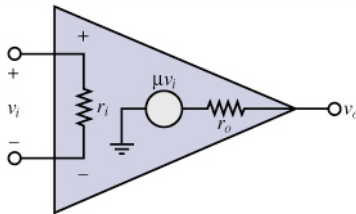
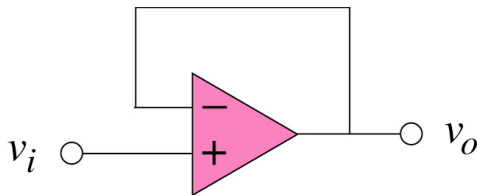


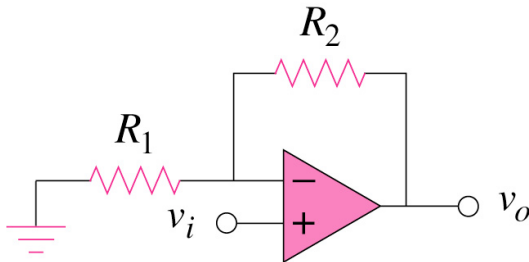
Figure P8.4

Q3 [Lecture notes: pages 4-5]

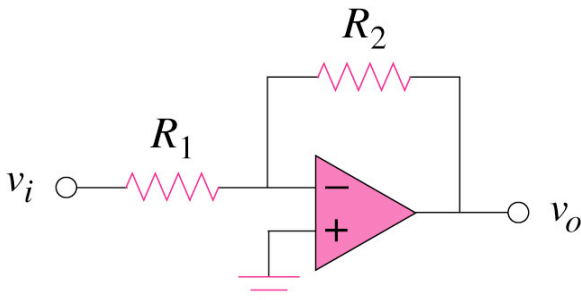
Derive the gain expression for the circuit below and find the input resistance.

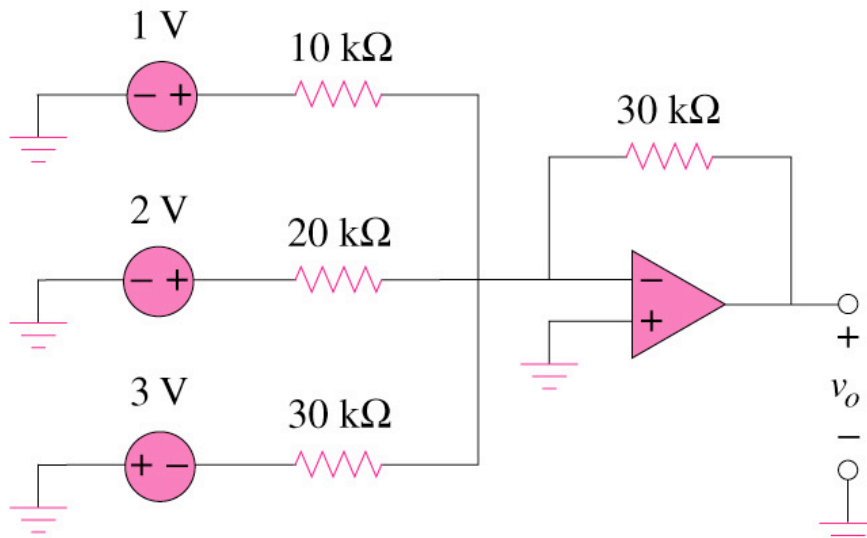
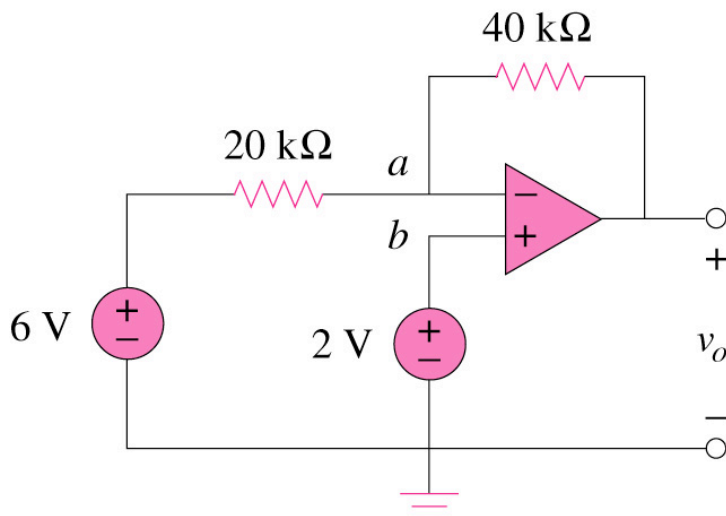
**Q4 [Lecture notes: pages 11-12]**

Derive the gain expression for the circuit below and find the input resistance.

**Q5 [Lecture notes: pages 8-10]**

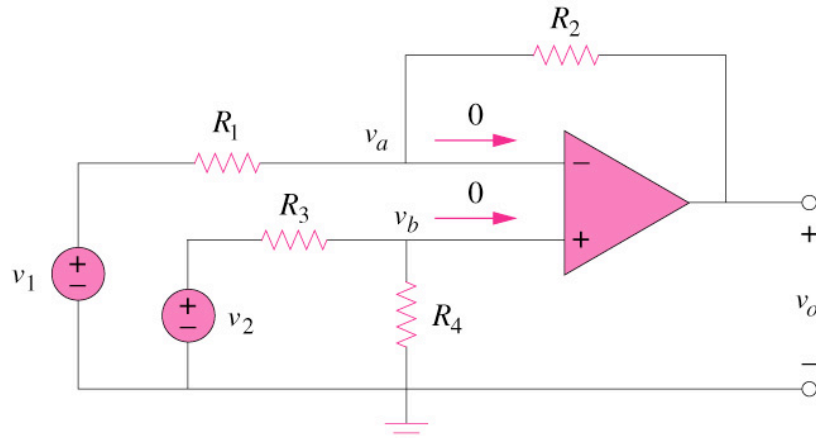
Derive the gain expression for the circuit below and find the input resistance.



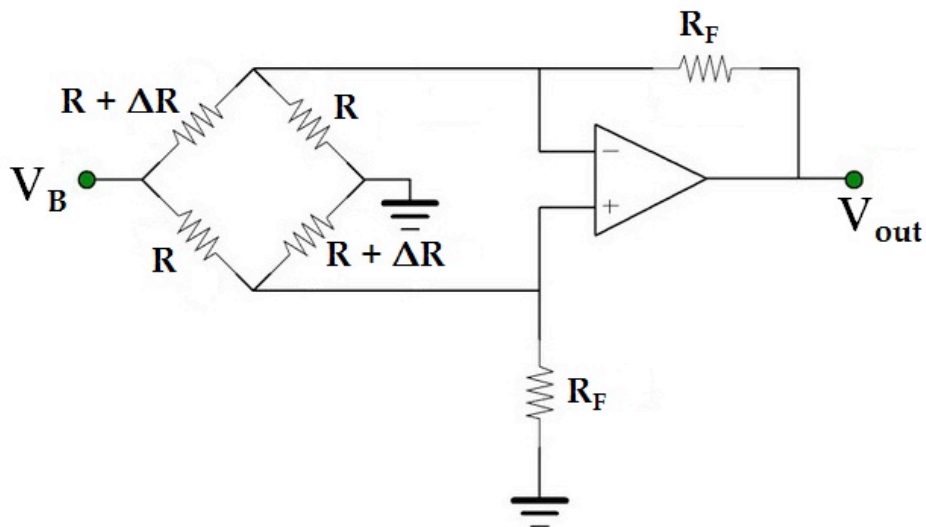
Q6 [Lecture notes: pages 13-14]Find v_o Re-calculate v_o if each source had an internal resistance of $10\text{k}\Omega$.How would you modify the circuit to reduce the effect of internal resistance on v_o ?**Q7**Find v_o for the circuit in Q4 again if the ground was replaced with a voltage source (v_b) **AND** the input v_i is now $v_i + v_b$. How do these changes affect v_o ?**Q8**Find v_o for the circuit in Q5 again if the ground was replaced with a voltage source (v_b) **AND** the input v_i is now $v_i + v_b$. How do these changes affect v_o ?Hence find v_o for the circuit shown below.**Q9**Find v_o again for the circuits in Q3 and Q4 if the input v_i had an internal resistance of R_S . How does the internal resistance R_S affect v_o and the gain of these circuits?

Q10

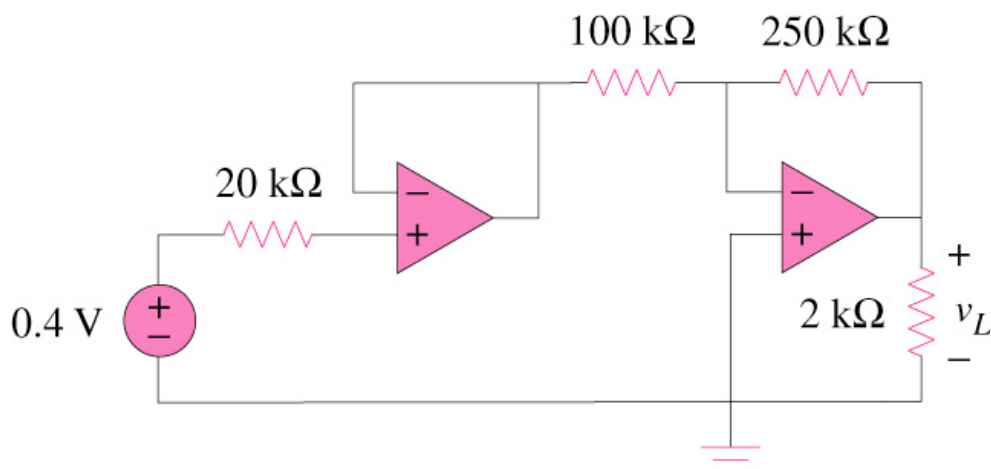
Given that $R_2 = R_4 = 100\text{k}\Omega$, $R_1 = R_3 = 10\text{k}\Omega$, $v_1 = 4.5\text{V}$ and $v_2 = 5.2\text{V}$, find v_o . If for now $v_1 = 2.3\text{V}$ and $v_2 = 3.0\text{V}$, would v_o be any different? What does v_o depend on?

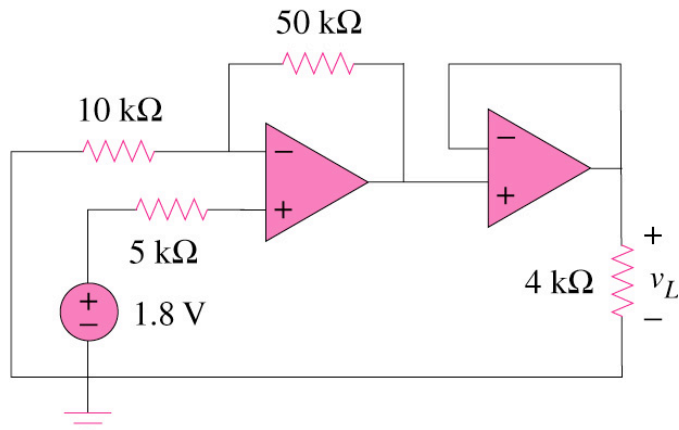
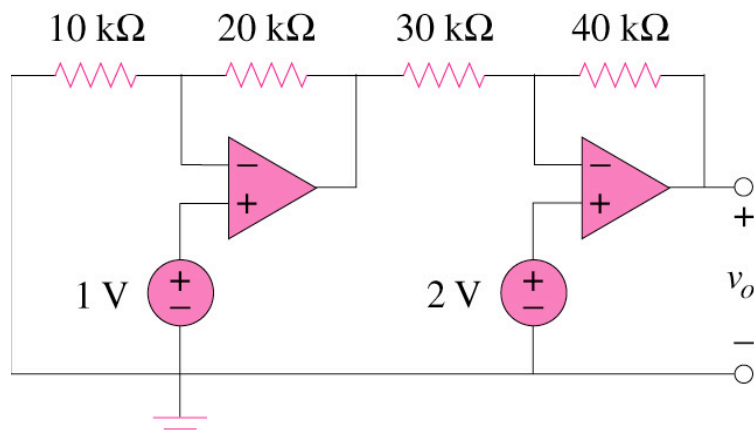
**Q11**

Find V_{out} when $\Delta R \ll R$

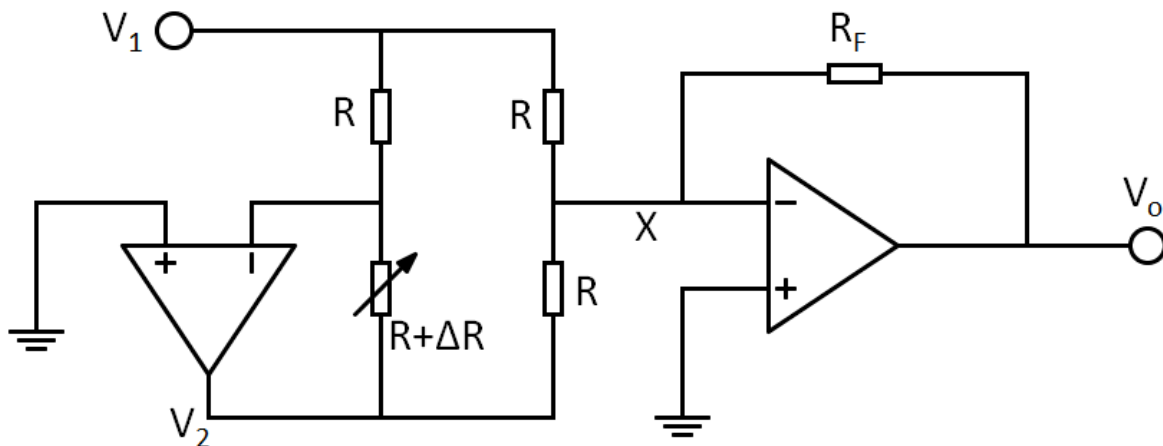
**Q12**

Find v_L



Q13Find v_L **Q14**Find v_o .**Q15 *Work on this question before Lab 3**In terms of V_1 , ΔR , R ,

- Find V_2
- Write down the voltage at node X
- Find V_{out} (by applying NVA at node X)



Brief solutions**Q6**

$$V_o = -30 * [(1)/(10) + (2)/(20) + (-3)/(30)] = -3V$$

$$\text{With } 10k\Omega \text{ internal resistance, } V_o = -30 * [(1)/(20) + (2)/(30) + (-3)/(40)] = -1.25V$$

Q7

V_o now contains an offset of v_b

$$v_o = \left(\frac{R_2}{R_1} + 1 \right) v_{in} + v_b$$

Q8

V_o now contains an offset of v_b

$$v_o = -\frac{R_2}{R_1} v_{in} + v_b$$

$$V_o = -2 * (4) + 2 = -6V$$

Q9

No effect

Q10

$$V_o = 10 * (v_2 - v_1) = 10 * 0.7 = 7V$$

Since the difference between v_1 and v_2 is the same, there is no change on V_o .

Q11

$$\text{Applying KCL at } v^-: \frac{V_B - v^-}{R + \Delta R} + \frac{V_{out} - v^-}{R_F} = \frac{v^-}{R} \quad (1)$$

$$\text{Applying KCL at } v^+: \frac{V_B - v^+}{R} = \frac{v^+}{R + \Delta R} + \frac{v^+}{R_F} \quad (2)$$

$$\text{But } v^+ = v^-: \frac{V_B}{R + \Delta R} + \frac{V_{out}}{R_F} = \frac{V_B}{R}$$

$$V_{out} = V_B \left(\frac{R_F}{R} \right) \left(\frac{\Delta R}{R + \Delta R} \right)$$

In the limited case where $\Delta R \ll R$:

$$V_{out} \approx V_B \left(\frac{R_F}{R} \right) \left(\frac{\Delta R}{R} \right)$$

Q12

Output from first stage: $V_{o1} = 0.4V$

Output from second stage: $V_o = (-2.5) * (0.4) = -1V$

Q13

Output from first stage: $V_{o1} = (6) * (1.8) = 10.8V$

Output from second stage: $V_o = V_{o1} = 10.8V$

Q14

Output from first stage: $V_{o1} = (1 + 20/10) * (1) = 3V$

Output from the second stage: $V_o = 2/3V$

Q15

(a) Apply NVA at inverting input of op amp on the left:

Note that this is an INVERTING OP AMP CIRCUIT

(b) Consider the assumption that $V_+ = V_-$ in an op amp

(c) Apply NVA at inverting input of op amp on the right:

Note that this is a summing amplifier