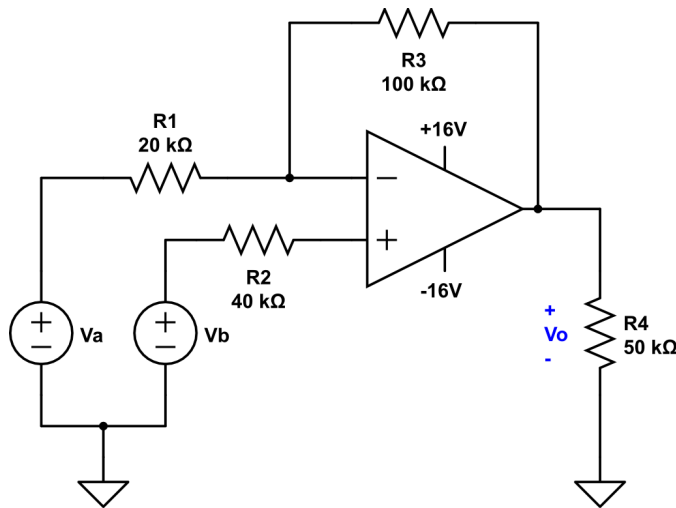


**Question 1** [10]

Assume the Op Amp below is ideal



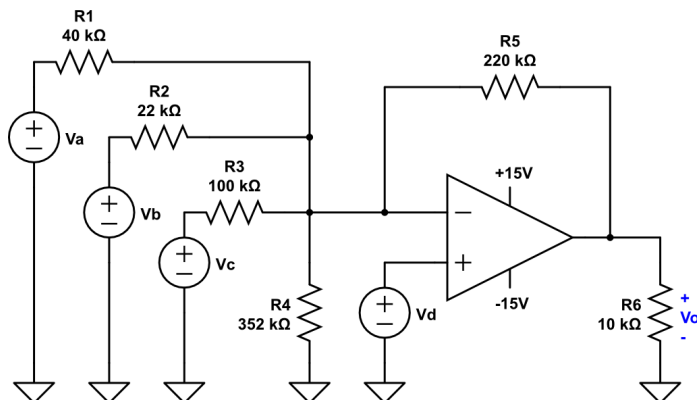
- (a) Calculate  $v_o$  if  $v_a = 4V$  and  $v_b = 0V$ .
- (b) Calculate  $v_o$  if  $v_a = 2V$  and  $v_b = 0V$ .
- (c) Calculate  $v_o$  if  $v_a = 2V$  and  $v_b = 1V$ .
- (d) Calculate  $v_o$  if  $v_a = 1V$  and  $v_b = 2V$ .
- (e) If  $v_o = 1.6V$ , specify the range of  $v_a$  such that the amplifier does not saturate.

**Question 2** [10]

- (a) Design an inverting amplifier with a gain of 4. Use an ideal ops amp, a  $30k\Omega$  resistor in the feedback path, and  $\pm 12V$  power supplies.
- (b) Using your design from part (a), determine the range of input voltages that will keep the op amp in the linear operating regions.
- (c) Suppose you wish to amplify a  $2V$  signal, using your design from part (a) with a variable feedback resistor. What is the largest value for the feedback resistance that keeps the op amp in the linear operating region? Using this resistance value, what is the new gain of the inverting amplifier.

### Question 3 [10]

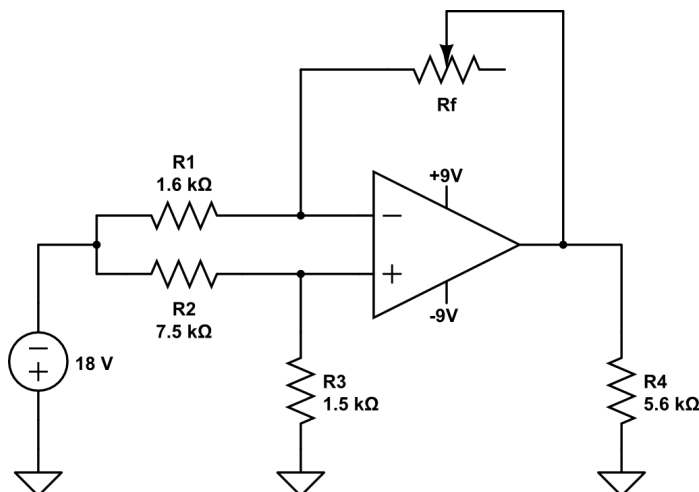
Consider the ideal op amp below:



- (a) Find  $v_o$ , if  $v_a = 4\text{V}$ ,  $v_b = 9\text{V}$ ,  $v_c = 13\text{V}$ , and  $v_d = 8\text{V}$ .
- (b) Assume  $v_b$ ,  $v_c$ , and  $v_d$  retain their values from part (a). Specify the range of  $v_a$  such that the op amp operates within the linear region.

### Question 4 [10]

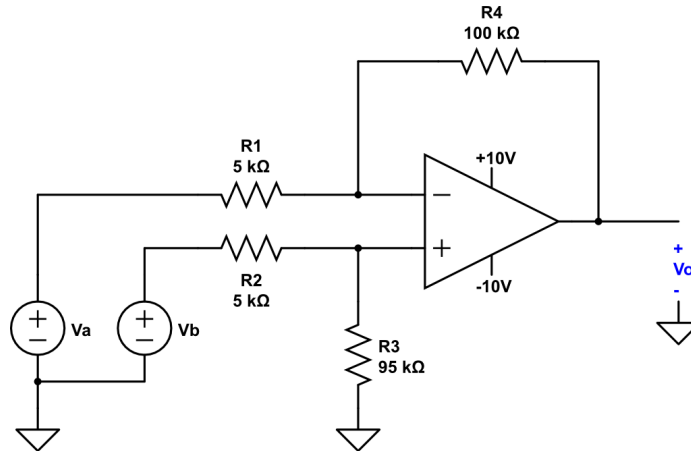
The resistor  $R_f$  in the circuit below is adjusted until the ideal op amp saturates. Specify  $R_f$  in kilohms.



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**Question 5** [10]

In the differential amplifier shown below, find:



- (a) The differential mode gain
- (b) The common mode gain
- (c) the CMRR