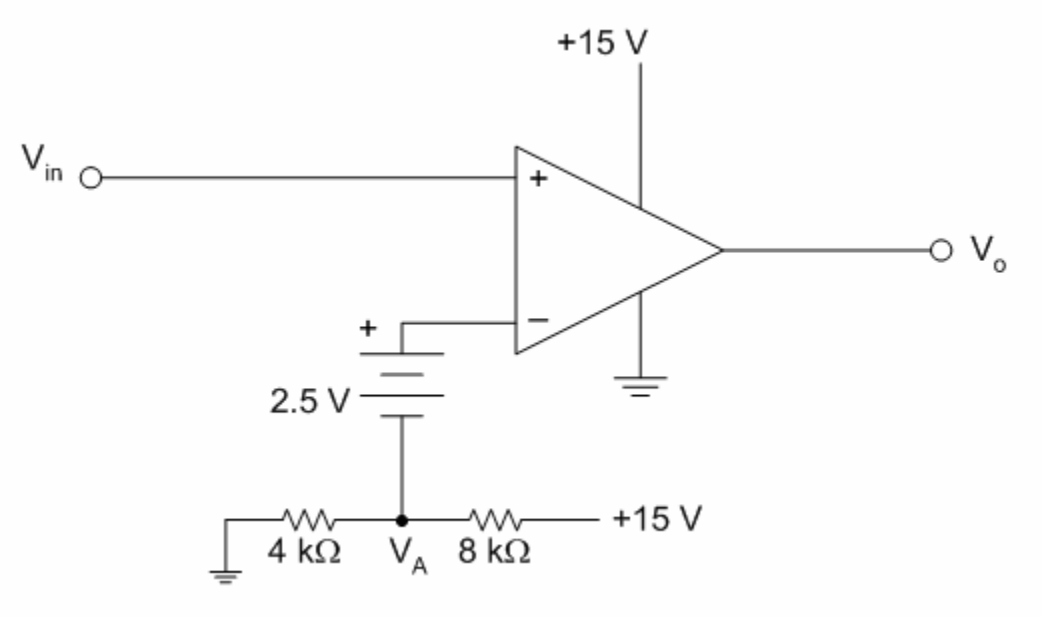
Name : _____ Section:_____ CWRU e-mail:_____

CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)

Quiz No. 8 3/22/04

PUT ANSWERS IN THE SPACE PROVIDED AND SHOW YOUR WORK IF APPROPRIATE
BE SURE TO STATE ALL ASSUMPTIONS

Problem 1 Comparators (10 points)



(a) For the given component values, what is V_n? 7.5 V (3 points)
First, we can calculate the value of V_A.

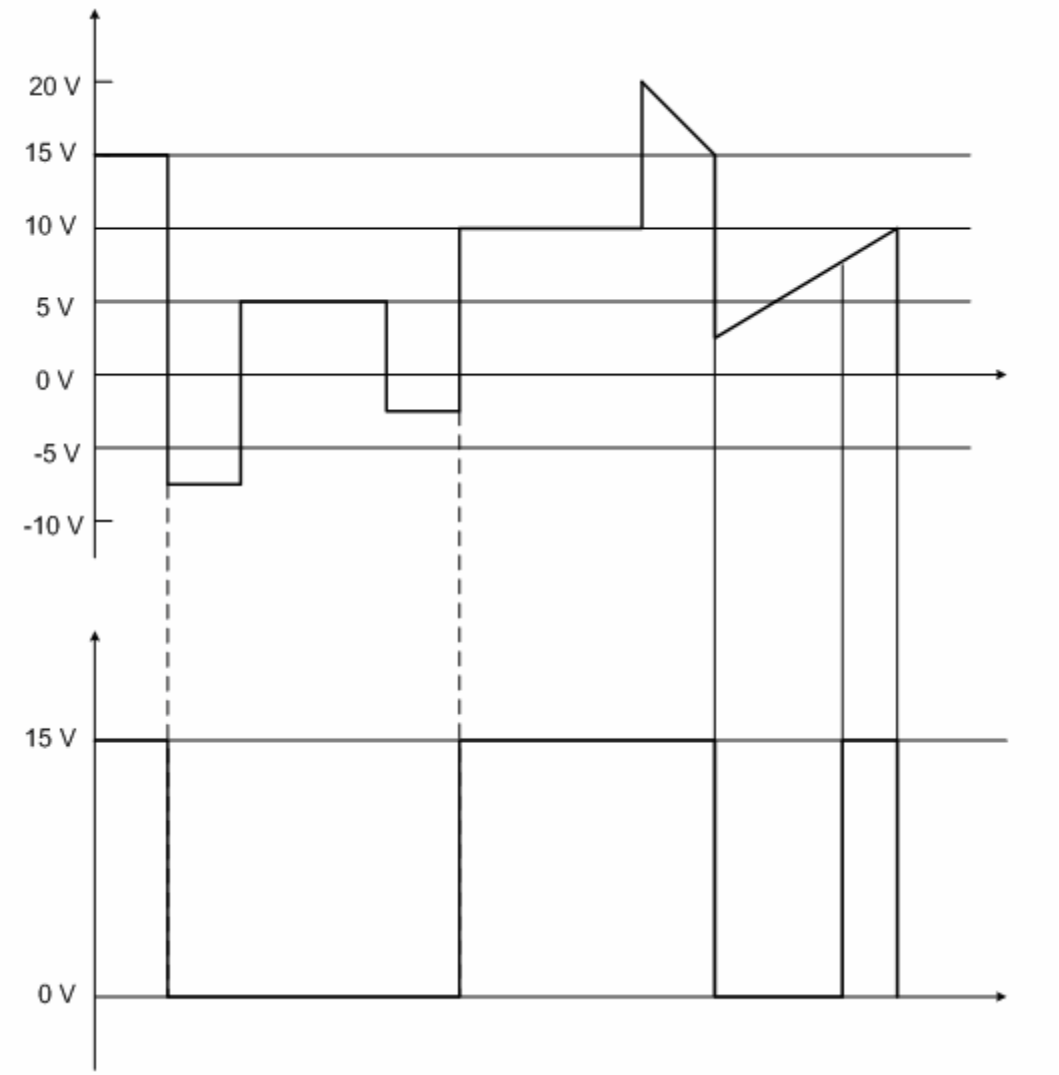
$$V_A = 15V \cdot \frac{4k\Omega}{4k\Omega + 8k\Omega} = 5V$$

Then $V_n = 2.5V + V_A = 7.5V$

(b) What is the range of possible output voltage V_o? 0~15V (3 points)
The possible output voltage range is between $-V_{CC}$ and $+V_{DD}$. For this problem, $-V_{CC}$=0V and $+V_{DD}$=15V

(c) Suppose V_{in} is the waveform below. Sketch the corresponding values of V_o for this circuit. Be sure to lable the values of the output voltages.

Name : _____ Section:_____ CWRU e-mail:_____

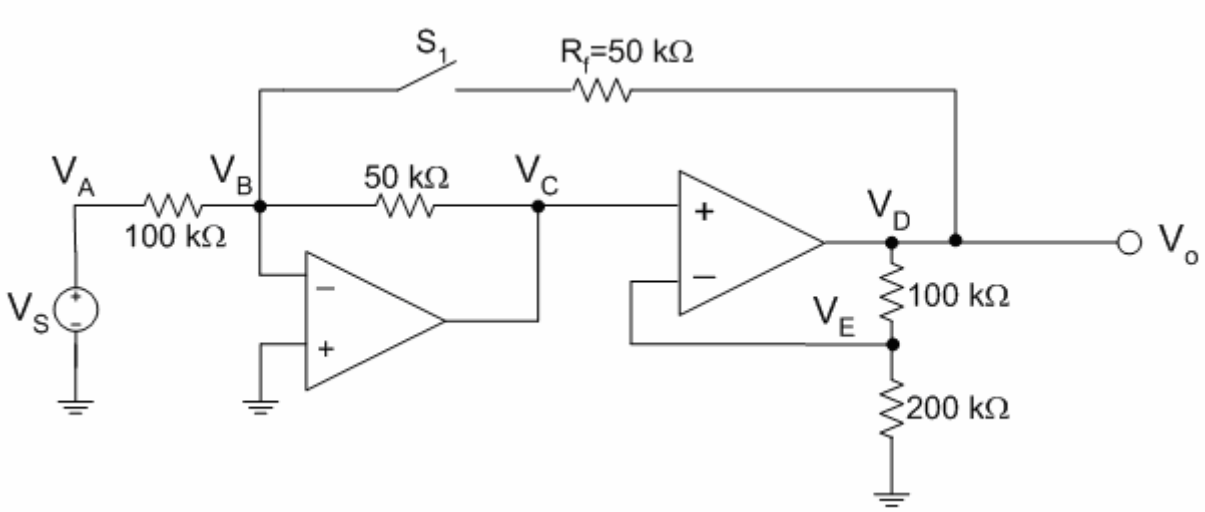


When Vp>Vn, $V_o=+V_{DD}=15V$
When Vp<Vn, $V_o=-V_{CC}=0V$

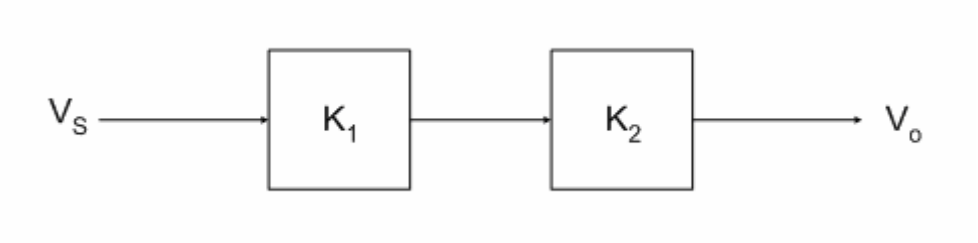
(4 points)

Name : _____ Section:_____ CWRU e-mail:_____

Problem 2 (10 points)



(a) Assume that switch S_1 associated with R_f is open, i.e., the resistor is not connected in the circuit. Draw a block diagram of the above circuit showing the function of each OP AMP.



(2 points)

(b) What is the gain of each block in your answer of (a)?
If S1 is open, then for the first stage, it is an inverting OPAMP.

$$K_1 = -\frac{R_2}{R_1} = -\frac{50k\Omega}{100k\Omega} = -\frac{1}{2}$$

For the second stage, it is an non-inverting OPAMP.

$$K_2 = \frac{R_1 + R_2}{R_2} = \frac{100k\Omega + 200k\Omega}{200k\Omega} = \frac{3}{2}$$ (3 points)

(c) Assume that switch S_1 in now closed, connecting V_o through R_f to the input of the first operational amplifier.

(1) What is the voltage V_B at this node? 0 (2 points)
$V_n=V_p=0$

(2) Write KCL for this node. Please write your answer in terms of Vs and Vo only. You do not have to solve this equation – only set it up.

Name : _____ Section:_____ CWRU e-mail:_____

$$\frac{V_A - V_B}{100k\Omega} + \frac{V_o - V_B}{50k\Omega} + \frac{V_C - V_B}{50k\Omega} = 0$$

And $V_A = V_S, V_C = V_o \cdot \frac{200k\Omega}{100k\Omega + 200k\Omega} = \frac{2}{3}V_o$

$$\Rightarrow \frac{V_S - 0}{100k\Omega} + \frac{V_o - 0}{50k\Omega} + \frac{\frac{2}{3}V_o - 0}{50k\Omega} = 0$$

$$\Rightarrow \frac{V_S}{100k\Omega} + \frac{V_o}{50k\Omega} + \frac{V_o}{75k\Omega} = 0$$ (3 points)