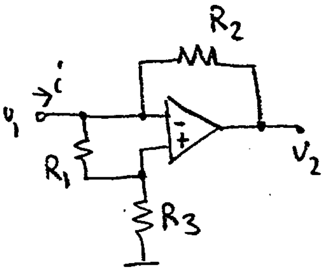
METU / EEED

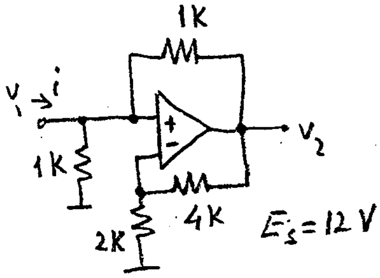
EE 201 / ZPS IV

Fall 2009

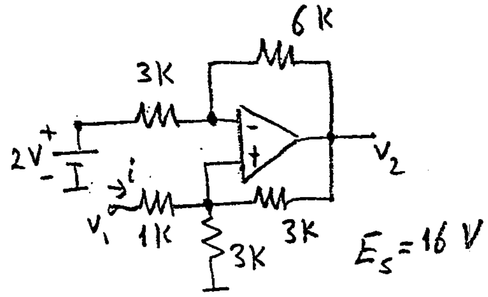
1) Find and sketch the transfer and input characteristics.



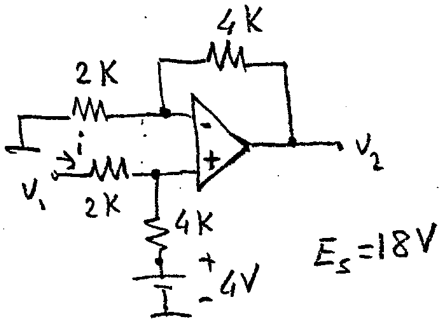
(a)



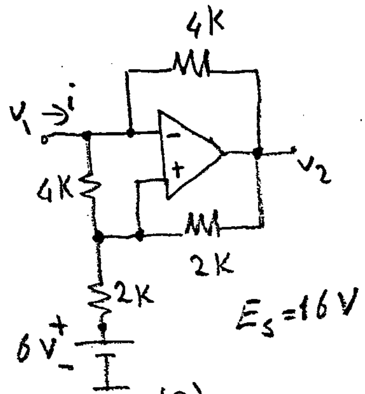
(b)



(c)



(d)



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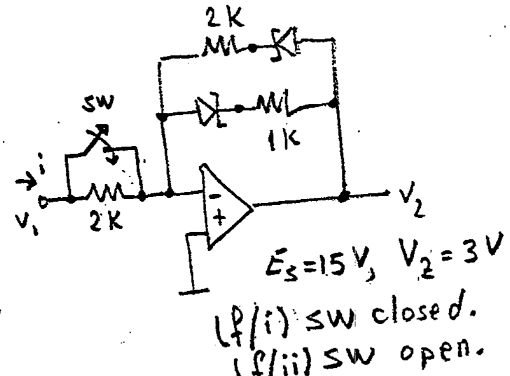

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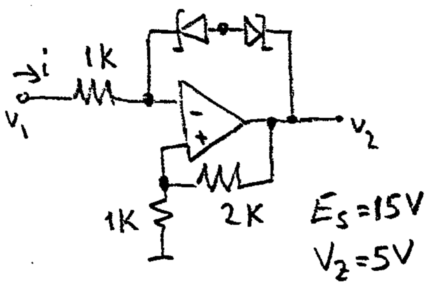
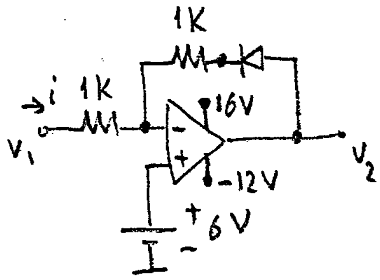
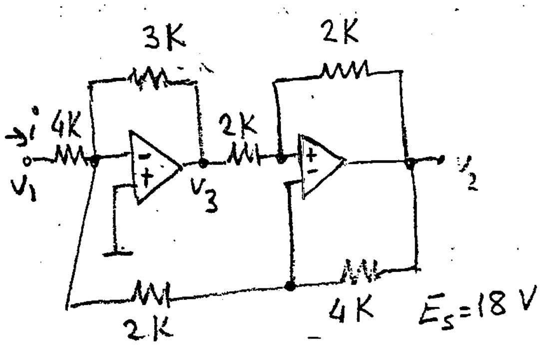


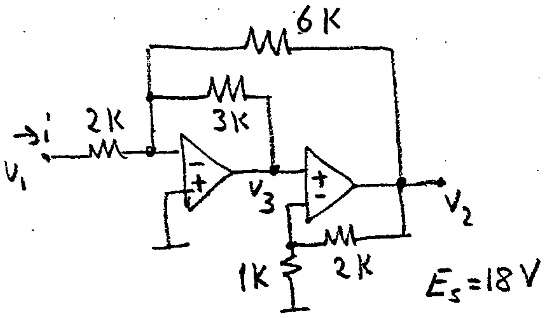
(g)



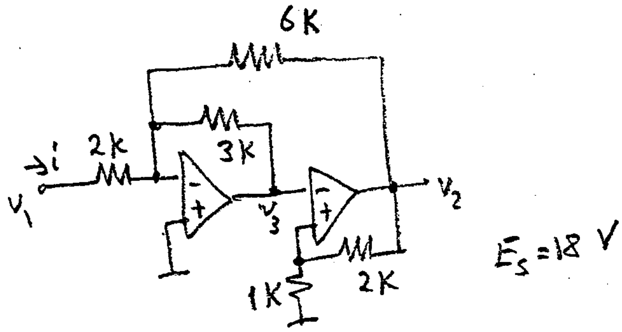
(h)



(i)

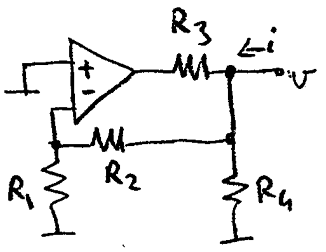


(j)



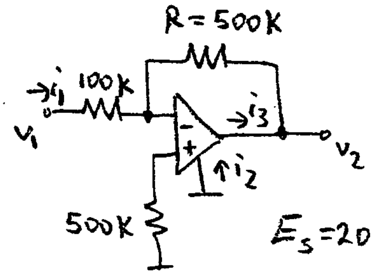
(k)

2)



Using the more realistic op-amp model express i in terms of v.

3)

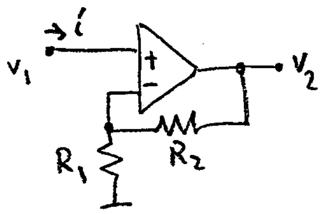


$E_s = 20\ V$

(a) Using the more realistic op-amp model with $A = 10^3$, $R_i = 500\ K$, $R_o = 0$, express v_2, i_1, i_2, i_3 in terms of v_1.

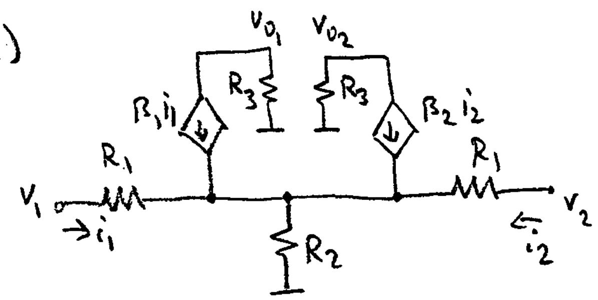
(b) Suppose R is variable. Determine the maximum value of R so that the op-amp remains in the linear region when $|v_1| \leq 2\ V$.

4)



Let A_c and A_d denote the common-mode and the differential mode gains of the op-amp, respectively. Using the more realistic op-amp model with $R_o = 0$, express v_2 and i in terms of v_1.

5)



$R_1 = R_2 = 1\ \Omega$, $R_3 = 2\ \Omega$

$\beta_1 = 5$, $\beta_2 = \beta$

$v_o \triangleq v_{o_1} - v_{o_2}$, the output voltage

$v_c \triangleq \frac{1}{2}(v_1 + v_2)$, the common-mode input voltage

$v_d \triangleq v_1 - v_2$, the differential-mode input voltage

(a) Express v_o in the form $v_o = A_c v_c + A_d v_d$; i.e., find the common-mode gain A_c and the differential mode gain A_d as functions of β.

(b) For which value of β is $A_c = 0$? Explain.

(c) Compute the CMRR in dB ($20 \log_{10} |A_d|/A_c$) for $\beta = 4$.

(d) Does the CMRR increase or decrease when R_2 is increased? Explain.

Hint: Consider the case $R_2 = \infty$.