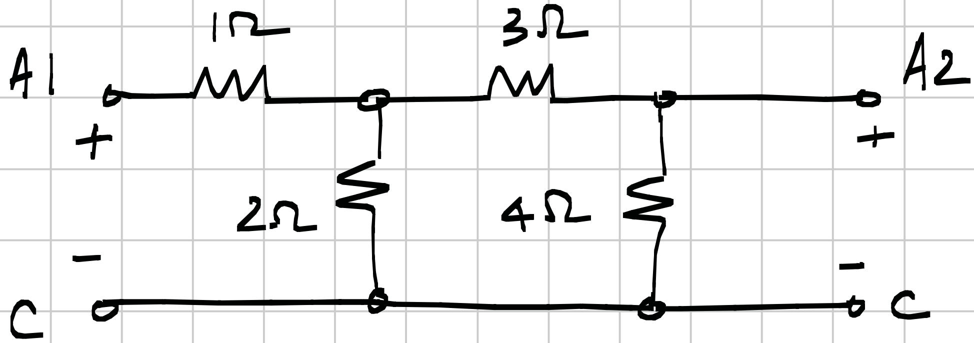
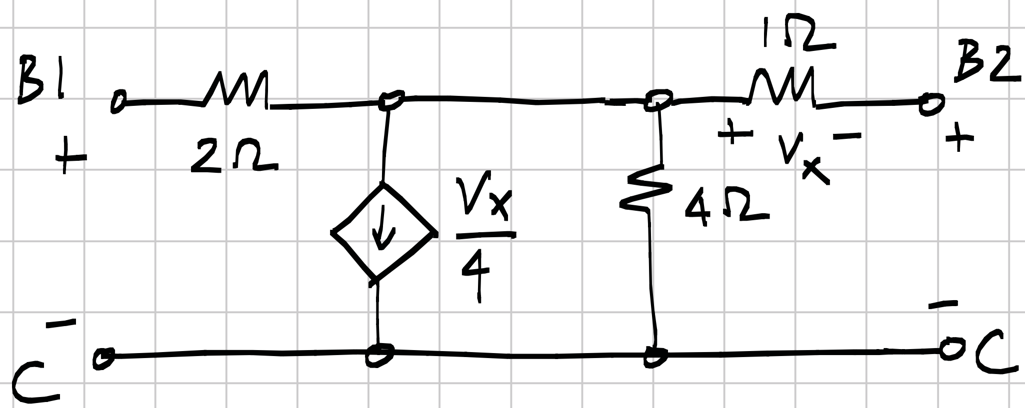
EE5310/EE3002: Analog Circuits
Tutorial 1
Problems 6, 8, 10, 11 are optional.

1) Find the y-parameters of the following 2 port network



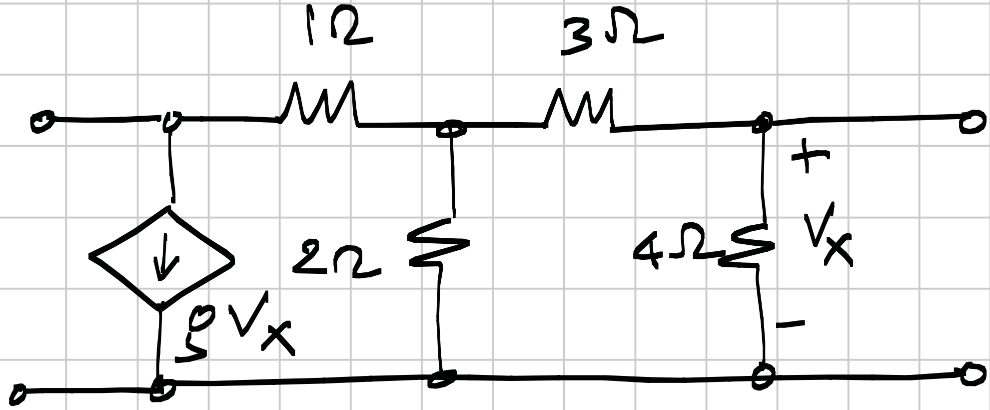
2)



Determine the y-parameters of the network above.

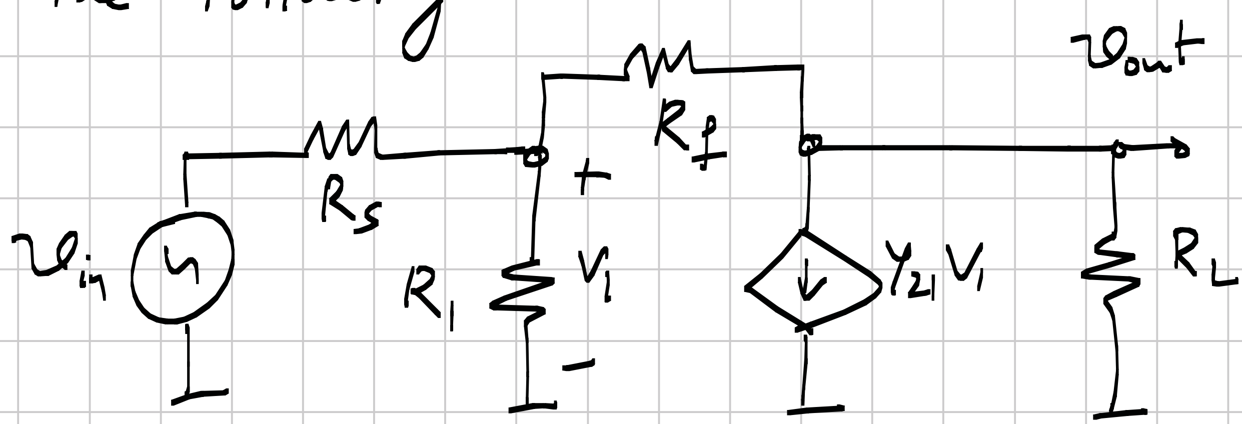
3) The terminals A1 & B1 in the figures above are shorted. So are A2 & B2; and the terminals marked C. Determine the y-parameters of the resulting 2 port.

4)



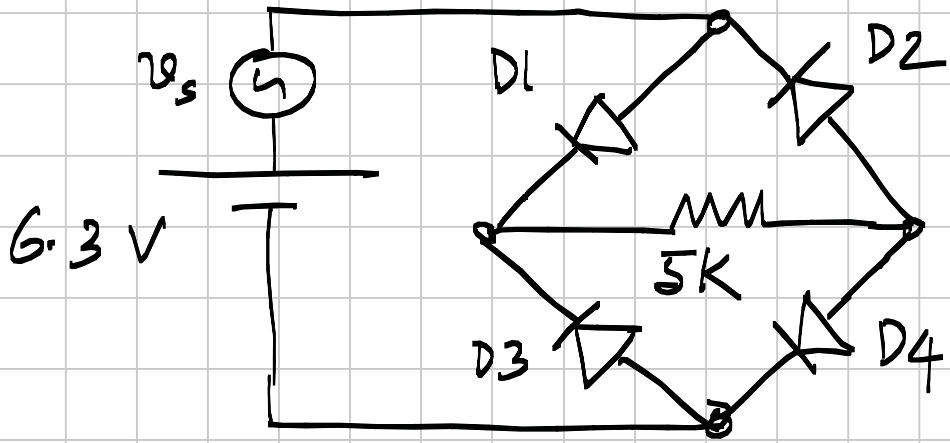
What do you understand by a unilateral two port? What constraint(s) does it impose on the y-matrix? The network above needs to be made unilateral. Determine "g" for this to happen.

5) Determine the voltage gain of the following network.



Evaluate the limit of this gain as $Y_{21} \longrightarrow \infty$.

6)



v_s is a small signal. Determine

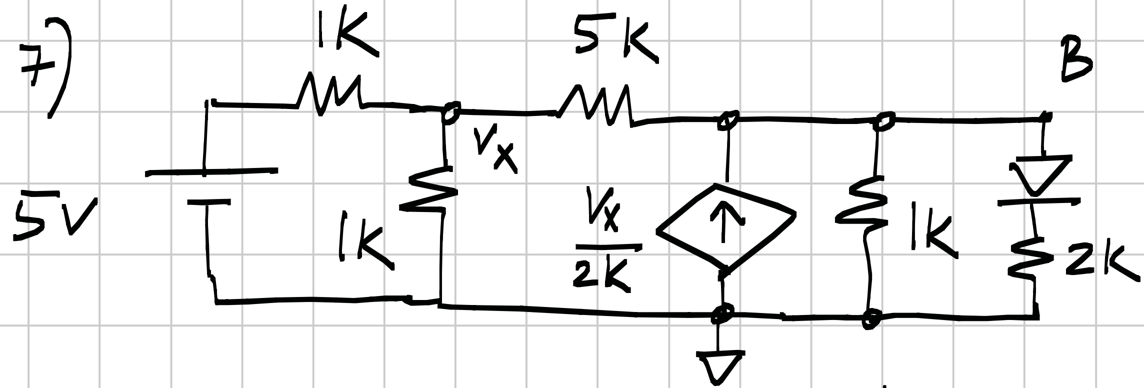
(a) the operating points of the diodes

(b) the DC current through the 5K resistor

(c) the incremental voltage across the 5K resistor.

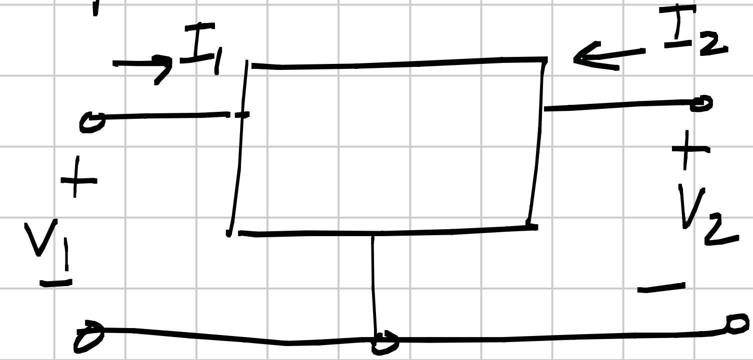
Assume that $V_\gamma = 0.65V$

7)



Determine the quiescent current through the diode. If a small signal source v_s is inserted in series with the 5V source, determine the TOTAL voltage at B. V_γ can be assumed to be 0.6 V.

8) A passive three terminal two port is shown below.



It is characterized by the equations

$$I_1 = \alpha V_1$$

$$I_2 = \beta V_1^2 + \gamma V_2$$

Where α, β, γ are positive constants with appropriate dimensions.

(a) Sketch the input & output

characteristics of the device.

(b) Determine the incremental y-matrix when the two port is biased at an operating point (V_1, V_2).

(c) Is this a passive two port?

Problem 9)

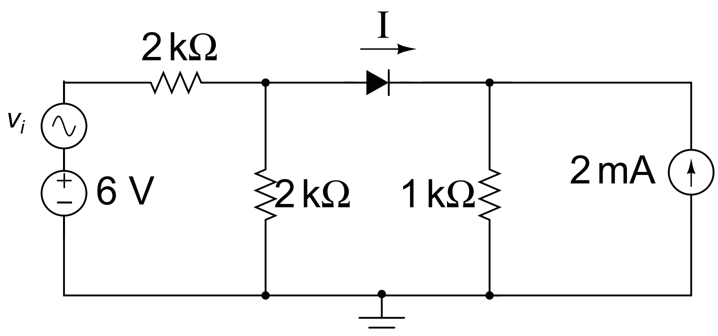


Figure 1: Circuit for Problem

For the circuit of Figure 1, assume that v_i is an incremental voltage source. Determine the operating point of the network. Find also the small signal voltage across the $1\,\mathrm{k}\Omega$ resistor.

Problem 10)

In this problem, we delve deeper into the notion of "small signal". Consider two nonlinear amplifiers, with input-output characteristics given by $V_{out} = \frac{V_{in}^2}{V_A}$ and $V_{out} = V_A \exp(\frac{V_{in}}{V_A})$.

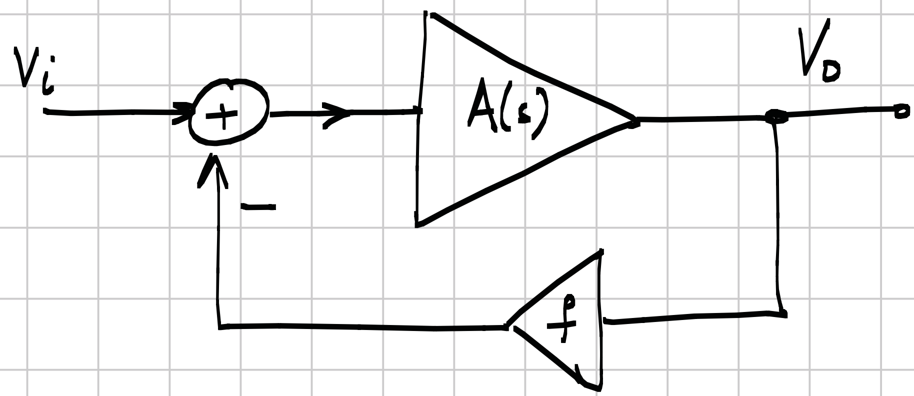
- An incremental gain of 10 is desired of both amplifiers. Determine the operating points so that this gain may be achieved.
- We saw in class that the "small signal" approximation is valid only when the higher order terms in the Taylor series can be safely neglected in relation to the linear term. Compare the second order derivative of the two amplifers around the operating point. What can you say about the relative magnitudes of the incremental inputs for each of the amplifiers which qualify as small signals ?

11) The Loop gain function of a feedback amplifier is of the form

$$\frac{A_{of}}{\left(1+ s/\omega_0\right)^N}$$

Determine the maximum allowable A_{of}, so that the closed loop system is stable.

12)



The transfer function of the forward amplifier is known to be

$$A(s) = \frac{10000}{\left(1+\frac{s}{\omega_1}\right)\left(1+\frac{s}{\omega_2}\right)}, \quad \omega_2 > \omega_1$$

The desired closed loop gain is 2, and the Q of the poles of the closed loop system should not exceed 2. How low should ω_1 be relative to ω_2, to ensure this?

13) The gain of many practical opamps can be approximated by

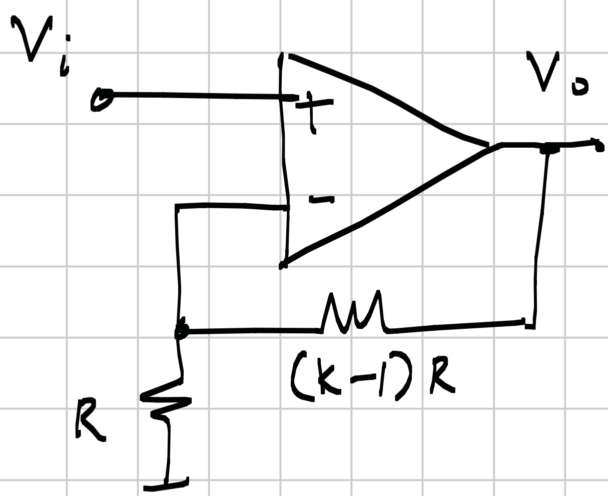
$$A(s) = \frac{A_0}{1 + \frac{s}{\omega_d}}, \text{ where}$$

$A_0 \to \infty$

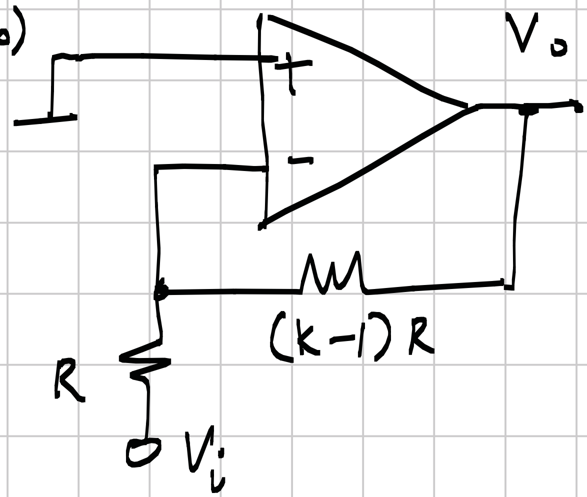
& $\omega_d A_0$ remains constant

Denote $A_0 \omega_d$ by GB

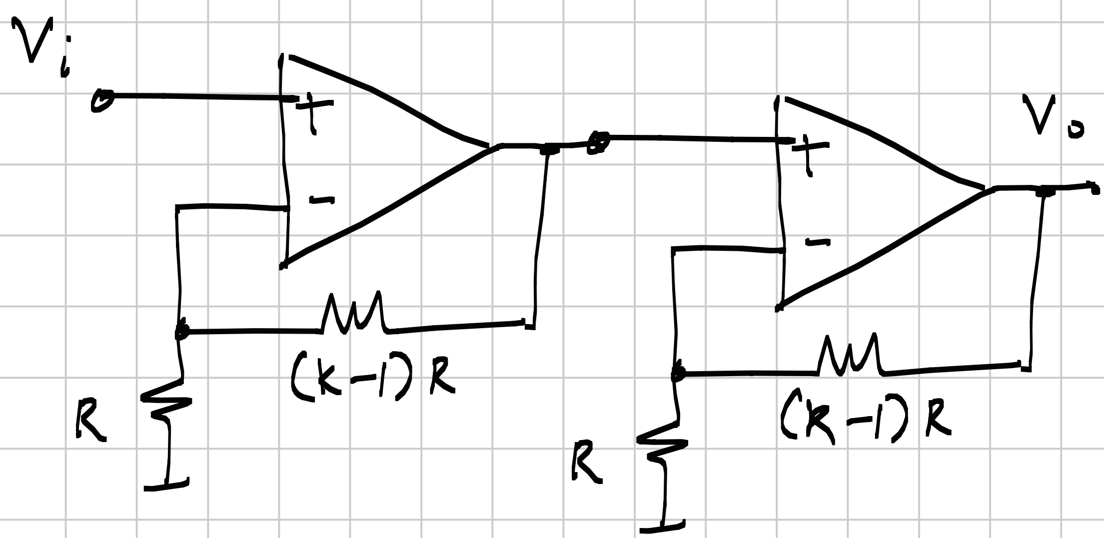
(a)



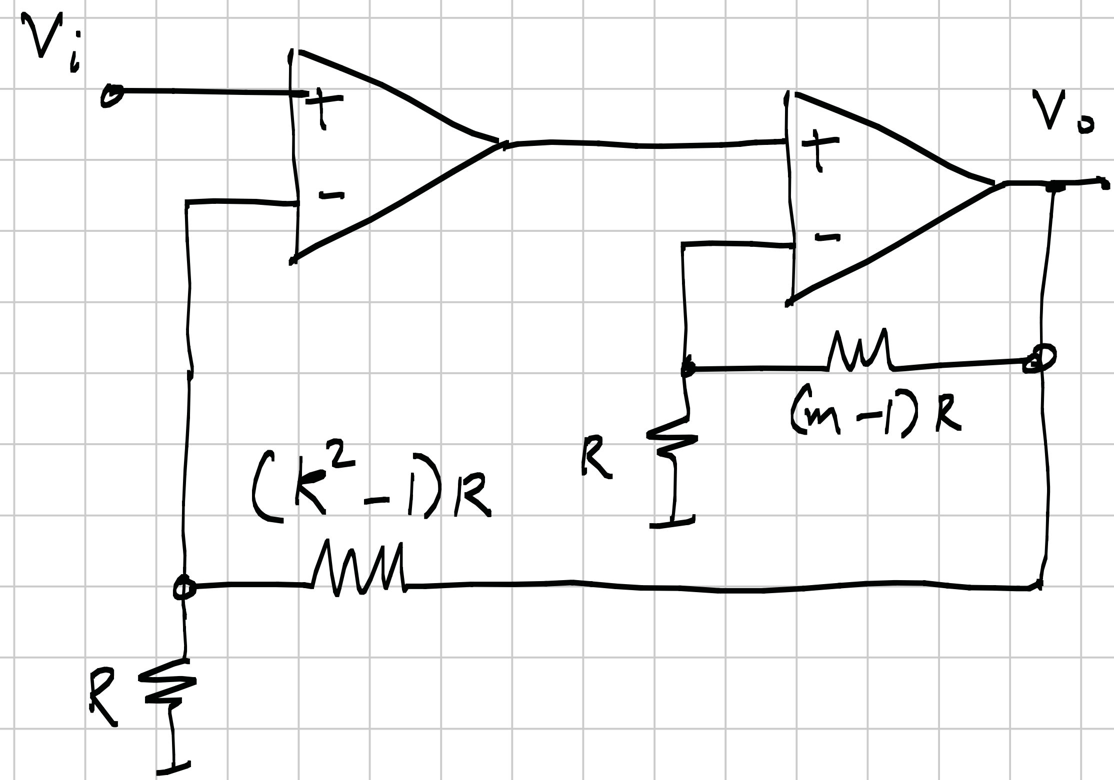
(b)



(c)



(d)



Determine the transfer functions of each of these amplifiers.

For part (d), determine "m" so that the closed loop transfer function's poles have $Q = 1/\sqrt{2}$. Under these circumstances, what is the 3dB bandwidth of the amplifier.