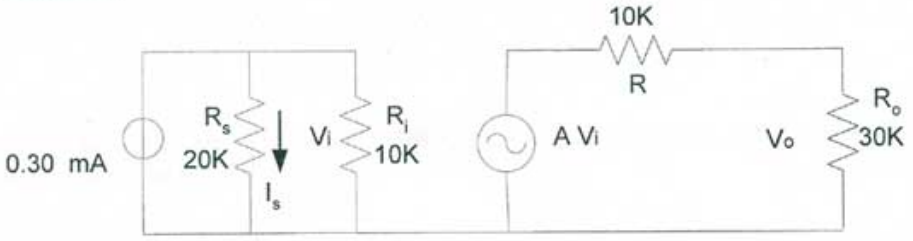
February 11, 2004 Duration: 50 minutes	EE311 Midterm Exam. # 1 (Closed notes & book)	Spring 2004 School of EECS/ WSU
Name:----------	ID #: ----------	

Problem 1:



In the above amplifier circuit, A=800. Determine the following:

a) Voltage gain $A_v = V_o/V_i = AV_i \frac{R_o}{R+R_o} = 800 \times \frac{30}{40}$ $A_v =$ 600 V/V

$V_o = \frac{30}{30+10} AV_i \Rightarrow \frac{V_o}{V_i} = \frac{30}{40} \times 800$

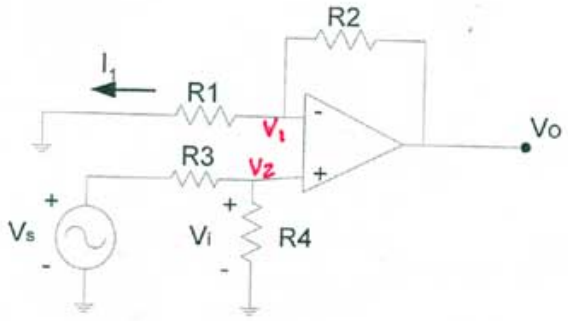
b) Current gain $A_i = I_o/I_i = \frac{V_o/R_o}{V_i/R_i} = \frac{V_o}{V_i} \times \frac{R_i}{R_o} = 600 \times \frac{10}{30}$ $A_i =$ 200 A/A

c) Current gain $A_{is} = I_o/I_s$ $A_{is} =$ 400 A/A

$I_s = V_i/R_s$

$\frac{I_o}{I_s} = \frac{V_o/R_o}{V_i/R_s} = \left(\frac{V_o}{V_i}\right) \cdot \left(\frac{R_s}{R_o}\right) = 600 \cdot \frac{20}{30}$

Problem 2:



In the OpAmp circuits, R1 = 1K, R2= 199 K, R3= 40K, and R4= 10K. Assuming the OpAmp is ideal, Determine the following:

a) Voltage gain $A_v = V_o / V_i$ $V_2 = V_i$ $A_v =$ 200 V/V

$$A_V = \frac{V_o}{V_i} = (1 + R_2/R_1)$$

b) Over all voltage gain $A_{vs} = V_o/V_s$ $V_o = (1+R_2/R_1)V_i$ $A_{vs} =$ 40 V/V

$$V_i = \frac{R_4 V_s}{R_3 + R_4} = \frac{1}{1 + R_3/R_4} V_s$$

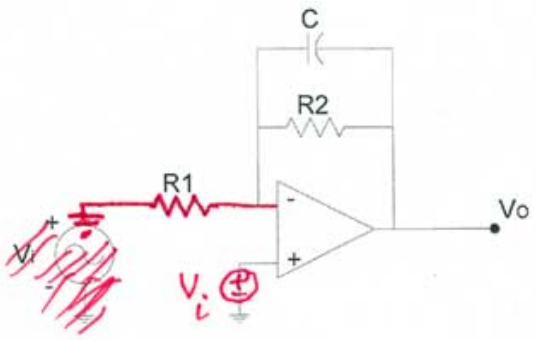
$$\therefore \frac{V_o}{V_s} = \frac{(1 + R_2/R_1)}{(1 + R_3/R_4)} = \frac{200}{1+4} = 40$$

c) If V_s = 50 mV, determine the current through R1. $V_1 = V_2$ $I_1 =$ 10 μA

$$V_2 = V_i = \frac{V_s}{1+4} = \frac{50\,mV}{5} = 10\,mV$$

$$I_1 = \frac{10\,mV}{10^3} = \frac{10^{-2}}{10^3} = 10^{-5}A = 10 \times 10^{-6}$$

Problem 3



In the above amplifier circuit, R2= 100K, C= 1 nF, and the cutoff frequency ω_T = 500 kHz..rad
Determine the following:

a) The 3 dB frequency ω_{3db} = 10 kHz

$$1 + Z_2/R_1 = 1 + \frac{1}{R_1(1/R_2 + j\omega C)} = 1 + \frac{R_2/R_1}{1 + j\omega R_2 C}$$

R_1 unknown, Assume $\omega_{3dB} = \frac{1}{R_2 C} = \frac{1}{10^5 \times 10^{-9}} = 10\,kHz$

b)The low frequency amlpifier gain A_v = 50

$$A_V(\omega \to 0) = 1 + R_2/R_1$$

$$A_{V0}\,\omega_{3dB} = 1 \cdot \omega_T \quad A_V = \frac{500\,kHz}{10\,kHz}$$

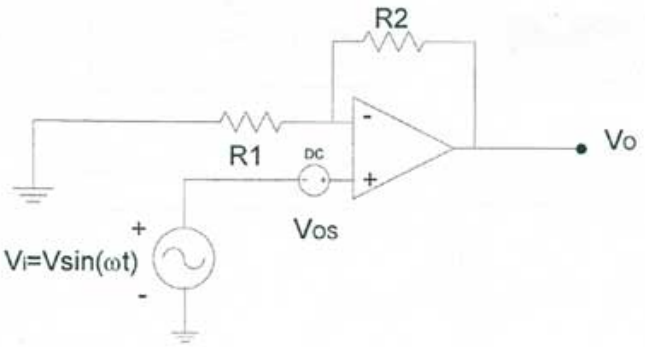
c) Value of resistance R1 R1= 2.04 kΩ

$$50 = 1 + R_2/R_1$$

$$R_2/R_1 = 49 \Rightarrow R_1 = \frac{R_2}{49} = \frac{100}{49}$$

$$49 \overline{)\,100} \quad 2.04$$
$$98$$
$$200$$

Problem 5:



The above OpAmp has slew rate = 10V/ μs and offset voltage V_{OS} =10 mV, R1=1K Ω , R2=99KΩ. If the magnitude of maximum output swing = 10V.

a) Determine the maximum amplitude of input signal V_i V = 90 mV

$A_V = 1 + R_2/R_1 = 100$

$V_o = A_V(V_i + V_{os})$

$100V_i + 1V = 10V$, $V_i = \frac{9V}{100}$

$\max V_i = V$

c)If the input signal angular frequency w = 1 MHz rad, what the maximum amplitude of the input signal?

$\left.\frac{dV_o}{dt}\right|_{max} = A_V \left.\frac{dV_i}{dt}\right|_{max} = A_V V\omega = SR$

$V = \frac{10}{100 \times 10^6 \times 10^{-6}} = 100\ mV$

d) What is the useful input voltage range?

Maximum useful range is limited by V_o $\ominus \rightarrow 90\ mV$