Texas A&M University
Department of Electrical and Computer Engineering

ECEN 325 – Electronics

Spring 2020

Exam #1

Instructor: Sam Palermo

- Please write your name in the space provided below
- Please verify that there are **5** pages in your exam
- You may use <u>one</u> double-sided page of notes and equations for the exam
- Good Luck!

Problem	Score	Max Score
1		30
2		50
3		20
Total		**100**

Name: SAM PALERMO

UIN: _____

Problem 1 (30 points)
Plot the magnitude and phase response of the following transfer function. Label key points and slopes.

$$F(s) = \frac{10(s+10^6)(s+10^9)}{(s+10^7)(s+10^8)}$$

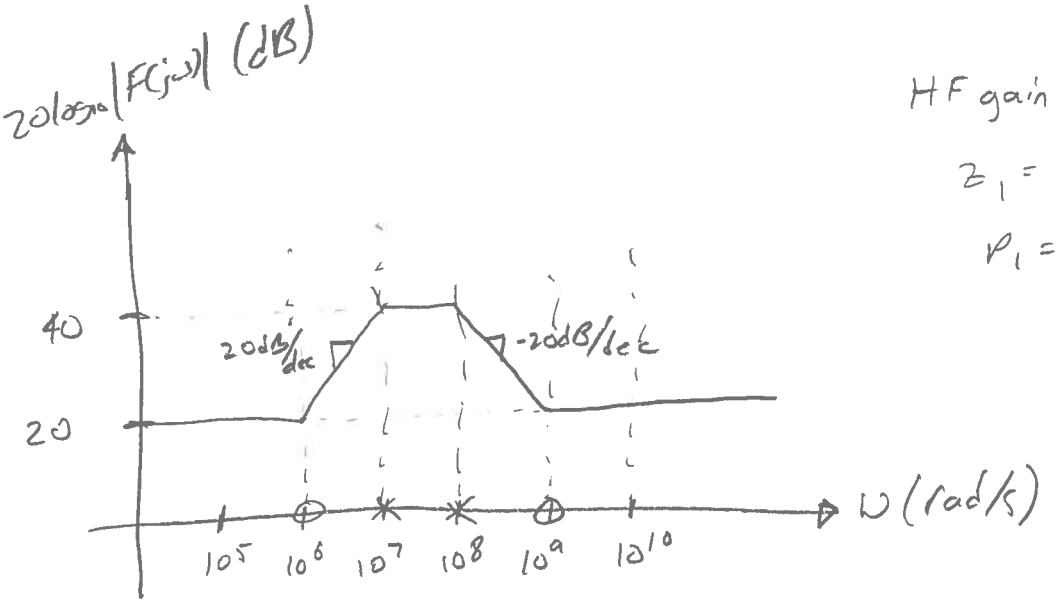
DC gain $= \frac{10(10^6)(10^9)}{(10^7)(10^8)} = \frac{10^{16}}{10^{15}} = 10 \Rightarrow 20dB$

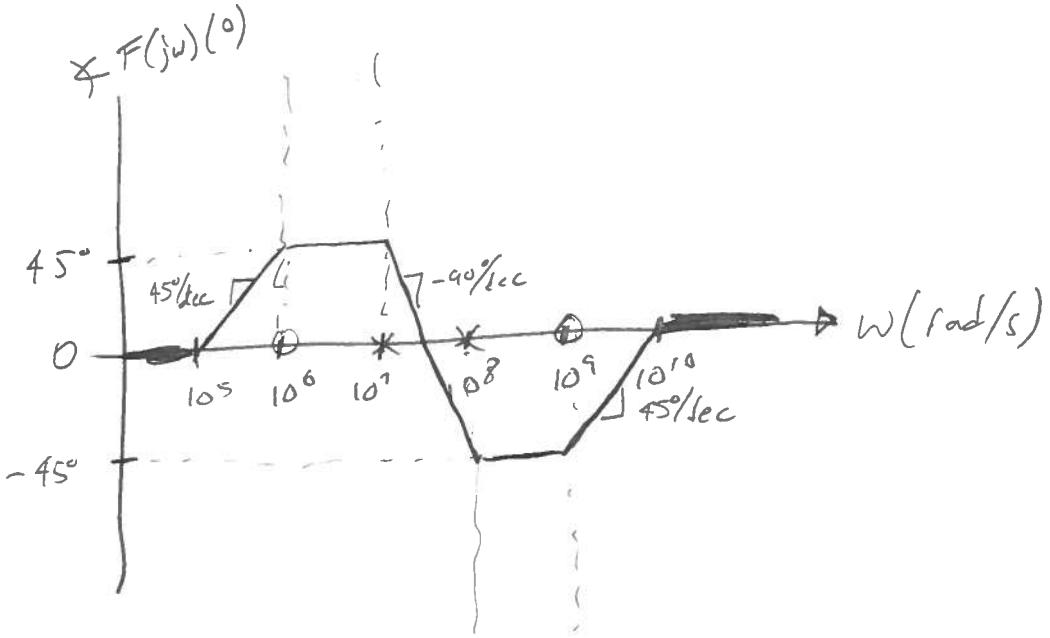
HF gain $= 10 \Rightarrow 20dB$

$z_1 = -10^6$, $z_2 = -10^9$

$p_1 = -10^7$, $p_2 = -10^8$

LF Phase $= 0^\circ$





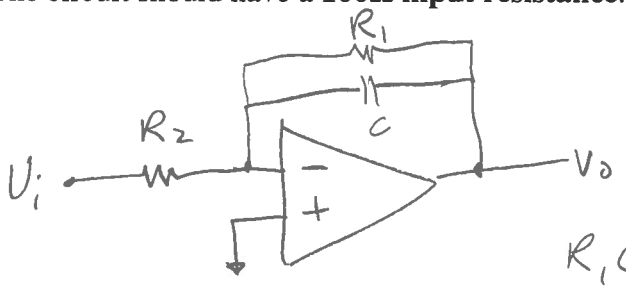
Problem 2 (50 points)

Assume for problem 2 circuits that all operational amplifiers are ideal.

a) Design an operational amplifier circuit to implement the following transfer function.

$$\frac{V_o(s)}{V_i(s)} = -\frac{100}{1+\frac{s}{10^6}}$$

The circuit should have a **100Ω input resistance**. (25 points)



$R_1 = 10k\Omega$

$R_2 = 100\Omega$

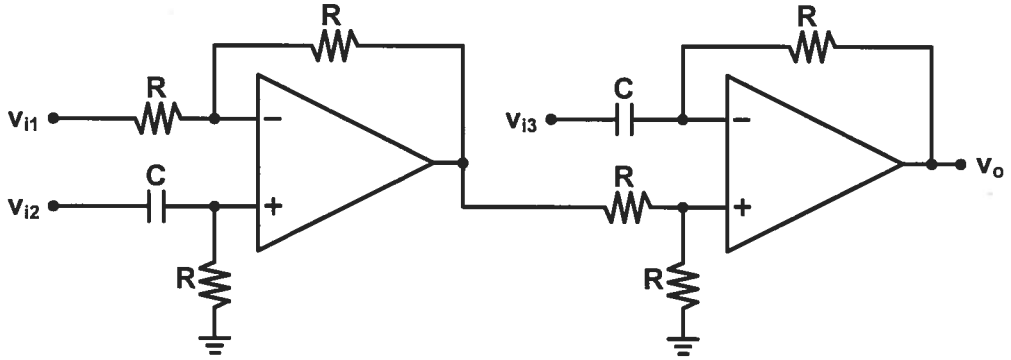
$C = 100pF$

$R_1 C = \frac{1}{10^6}$

$\frac{V_o}{V_i} = \frac{-\frac{R_1}{R_2}}{1+sR_1C}$ $\quad C = \frac{1}{10^6 R_1} = \frac{1}{10^6(10k\Omega)} = 100pF$

$R_{in} = R_2 = 100\Omega \Rightarrow R_1 = 100R_2 = 10k\Omega$

b) For the following circuit obtain the expression for v_o as a function of v_{i1}, v_{i2}, and v_{i3}. Assume ideal opamps. Hint: apply superposition. (25 points)



$$V_o = (-1)\left(\frac{1}{2}\right)\left(1+\frac{Z_R}{Z_C}\right)V_{i1} + \left(\frac{Z_R}{Z_C+Z_R}\right)(2)\left(\frac{1}{2}\right)\left(1+\frac{Z_R}{Z_C}\right)V_{i2} - \frac{Z_R}{Z_C}V_{i3}$$

$$V_o = -\frac{1}{2}(1+sRC)V_{i1} + sRCV_{i2} - sRCV_{i3}$$

Problem 3 (20 points)

The operational amplifier used in the remainder of the problem has the following **open-loop** transfer function

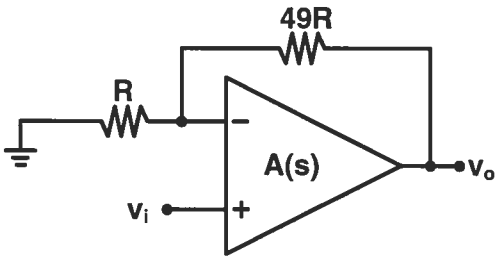
$$A(s) = \frac{10^5}{1 + \frac{s}{10}}$$

a) Sketch the **open-loop** magnitude response of the operational amplifier. **Make sure to label the unity-gain frequency.**

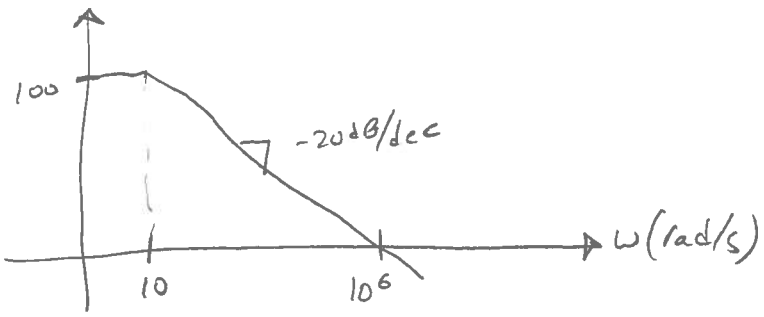
b) The finite gain-bandwidth operational amplifier from part (a) is used in the following amplifier circuit. Find the expression for the **closed-loop** transfer function (v_o/v_i).

c) What is the **closed-loop** -3dB frequency (bandwidth) of the total amplifier circuit?

d) Sketch the **closed-loop** magnitude response of the amplifier circuit. **Make sure to label the unity-gain frequency.**



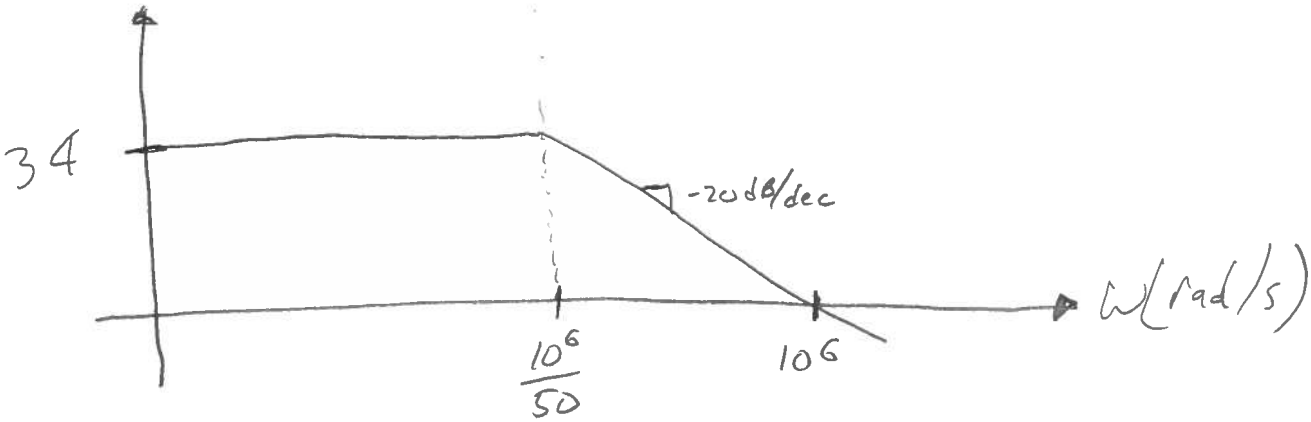
a. $20\log_{10}|A(j\omega)|$ (dB)



b. $\frac{V_o(s)}{V_i(s)} \cong \frac{50}{1 + \frac{5}{10^6/50}}$

c. $\omega_{cl} = \frac{10^6}{50}$

d. $20\log_{10}\left|\frac{V_o(j\omega)}{V_i(j\omega)}\right|$ (dB)



Scratch Paper