Texas A&M University
Department of Electrical and Computer Engineering

ECEN 325 – Electronics

Fall 2022

Exam #1

Instructor: Sam Palermo

- Please write your name in the space provided below
- Please verify that there are **6** pages in your exam
- Good Luck!

Problem	Score	Max Score
1		30
2		25
3		25
4		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.

$$H(s) = \frac{(s+10^4)(s+10^6)}{10^2 s^2}$$

DC gain $= \frac{10^{10}}{0} = \infty = \infty dB$

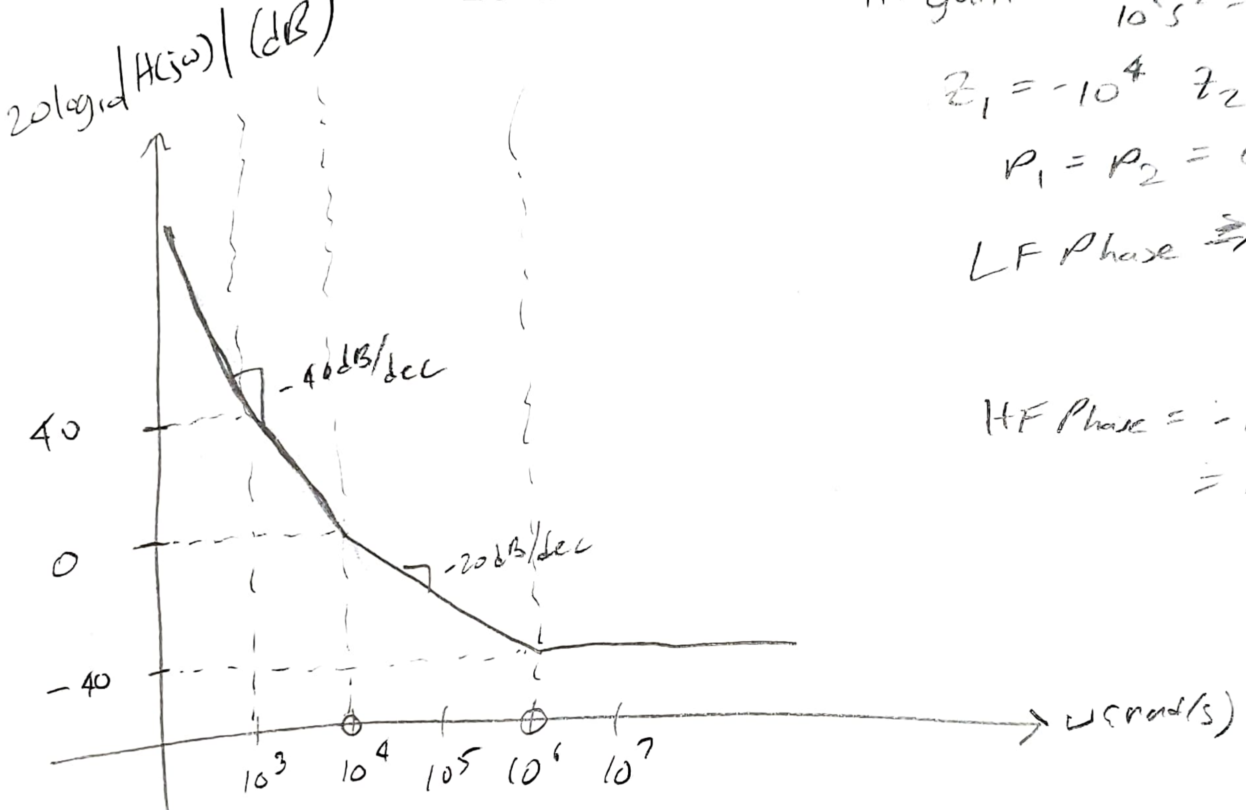
HF gain $= \frac{s^2}{10^2 s^2} = \frac{1}{100} = -40dB$

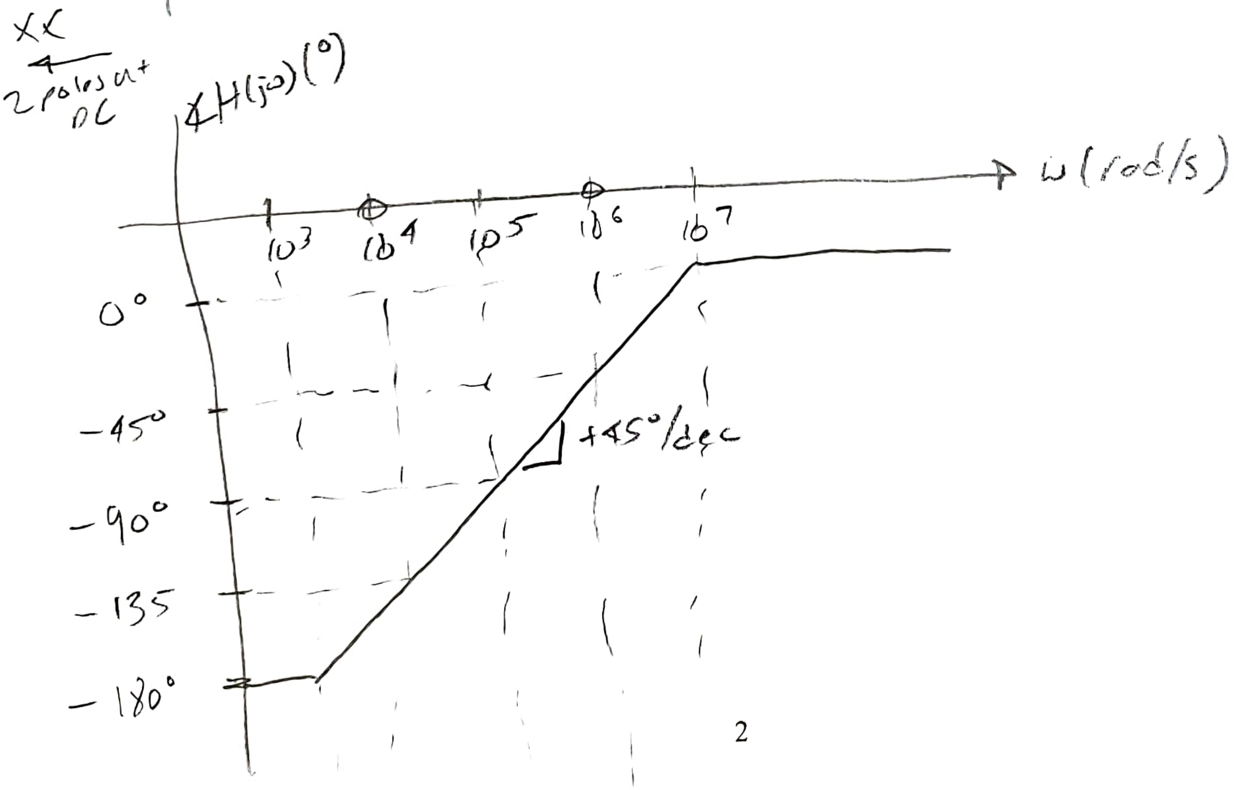
$z_1 = -10^4 \quad z_2 = -10^6$

$P_1 = P_2 = 0$

LF Phase ⇒ 2 DC poles $= 2(-90°) = -180°$

HF Phase $= -180° + 2(90°) = 0°$





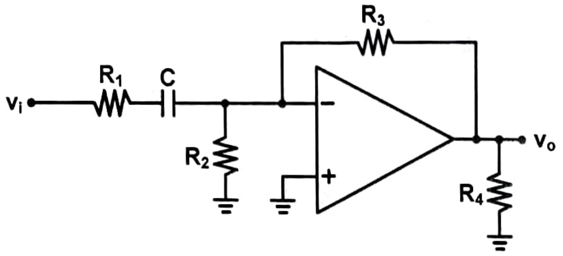
Problem 2 (25 points)

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

For the following circuit:

i. Obtain the transfer function, $v_o(s)/v_i(s)$

ii. Set the component values to achieve a 1kΩ high-frequency input resistance, 20dB high-frequency gain (magnitude), and a pole frequency of $|\omega_p| = 10$krad/s.



$$\frac{V_o(s)}{V_i(s)} = -\frac{Z_{R3}}{Z_{R1}+Z_C} = -\frac{R_3}{R_1+\frac{1}{sC}} = \frac{-R_3/R_1\, s}{s+\frac{1}{R_1C}}$$

$$\boxed{\frac{V_o(s)}{V_i(s)} = \frac{-\frac{R_3}{R_1}s}{s+\frac{1}{R_1C}}}$$

$$HF\ R_{in} = R_1 = 1k\Omega$$

$$|HF\ Gain| = \frac{R_3}{R_1} = 10 \Rightarrow R_3 = 10R_1 = 10k\Omega$$

$$|\omega_p| = \frac{1}{R_1C} \Rightarrow C = \frac{1}{R_1|\omega_p|} = \frac{1}{(1k\Omega)(10k)} = 100nF$$

$R_1 = 1k\Omega$

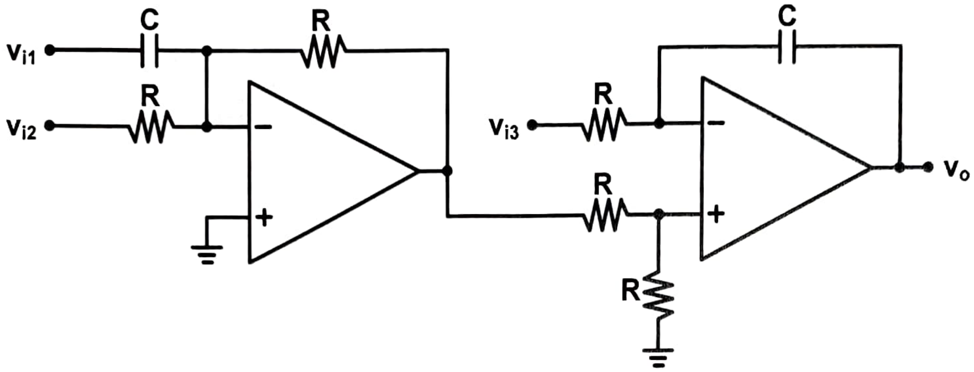
$R_3 = 10k\Omega$

$C = 100nF$

Problem 3 (25 points)

Assume for Problem 3 circuits that all operational amplifiers are ideal.

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.



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

$$-\frac{Z_C}{Z_R}V_{i3}$$

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

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

Problem 4 (20 points)

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

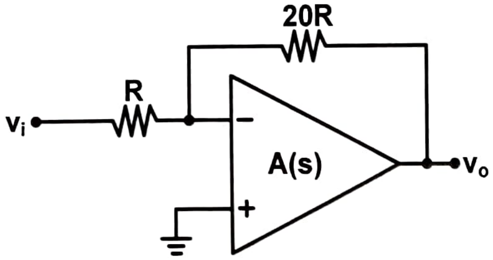
$$A(s) = \frac{10^4}{1 + \frac{s}{10^2}}$$

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

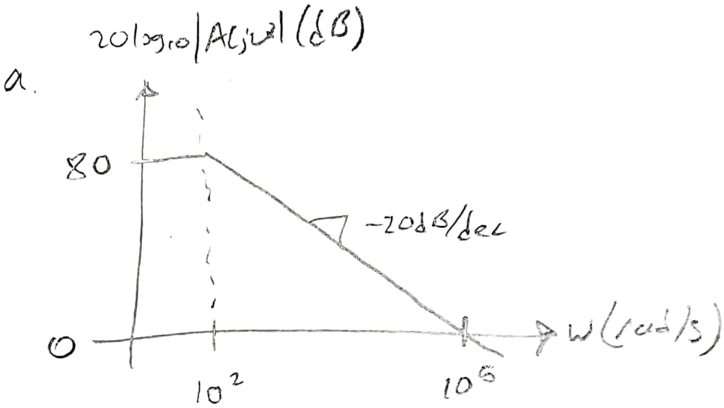
b) The finite gain-bandwidth operational amplifier from part (a) is used in the following amplifier circuit. Find the expression for the **closed-loop** transfer function (v_o/v_i).

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.



b. $$\frac{V_o(s)}{V_i(s)} = \frac{-20}{1 + \frac{s}{10^6/21}}$$

c. $$\omega_{CL} = \frac{10^6}{21} \text{ rad/s}$$

d.