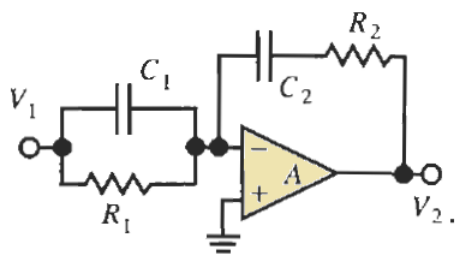
*Higher Technological Institute 10^{th} of Ramadan City
Department of Electrical & Computers Engineering
Mid Term Examination

Subject: Shaping Circuits /(EEC 242)(G1 - V2)
Examiner : Dr. Mustafa M. Shiple

Term: June - August 2015
Exam Time:60 min

ANSWER THE FOLLOWING QUESTIONS:

1. Consider the inverting Op Amp circuit in the next figure. [15 marks] $[A_a, C_p]$
   - (a) Drive an expression for the characteristic equation. Define the function of this circuit.
   - (b) Briefly, discuss the effects of the pole locations.
   - (c) Reconnect C_2 to be shunted across R_2. Drive an expression for the new structure.[Hint: arrange the equation in form to be drawn by bode plot]
   - (d) Calculate the component values to realize a zero at $f_z = 830Hz$, pole at $f_p = 2kHz$, and a high frequency gain of $6.36dB$.[Hint: $C_1 = 50nF$]
   - (e) Draw the bode plot of the characteristic equation of the previous item.



Solution: Q1.(a)

$$Z_F = \frac{1}{SC_2} + R_2 = \frac{SR_2C_2 + 1}{SC_2}$$

$$Z_i = \frac{\frac{1}{SC_1}R_1}{\frac{1}{SC_1} + R_1} = \frac{R_1}{SC_1R_1 + 1}$$

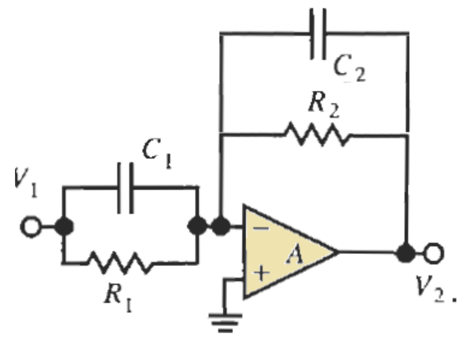
$$\text{inverting Op Amp gain } = -\frac{Z_F}{Z_i}$$

$$\therefore \frac{V_o}{V_i} = \frac{\frac{SC_2+R_2}{SC_2}}{\frac{R_1}{SC_1R_1+1}} = \frac{(SR_2C_2+1)(SC_1R_1+1)}{SC_2R_1}$$

(b) The characteristic equation of previous circuit will be affected by poles location since we have two poles @ $0, \infty$.
these poles will imply infinite gain at the origin and at infinity.
at $\omega = 0 \Rightarrow C_2 =$ open circuit. The Op Amp will operate in open loop.
at $\omega = \infty \Rightarrow C_1 =$ short circuit. The Op Amp gain will be infinity.
(c)

[Total Marks is 30]

Signature of: Good Luck
Examiner:



$$Z_F = \frac{\frac{1}{SC_2}R_2}{\frac{1}{SC_2}+R_2} = \frac{R_2}{SC_2R_2+1}$$

$$Z_i = \frac{\frac{1}{SC_1}R_1}{\frac{1}{SC_1}+R_1} = \frac{R_1}{SC_1R_1+1}$$

$$\text{inverting Op Amp gain } = -\frac{Z_F}{Z_i}$$

$$\therefore \frac{V_o}{V_i} = -\frac{R_2}{R_1}\frac{(SC_1R_1+1)}{(SR_2C_2+1)}$$

(d)

$$K = 23 = 20\log\left(\frac{R_2}{R_1}\right) \Rightarrow \frac{R_2}{R_1} = 10^{6.36/20} = 2.08$$

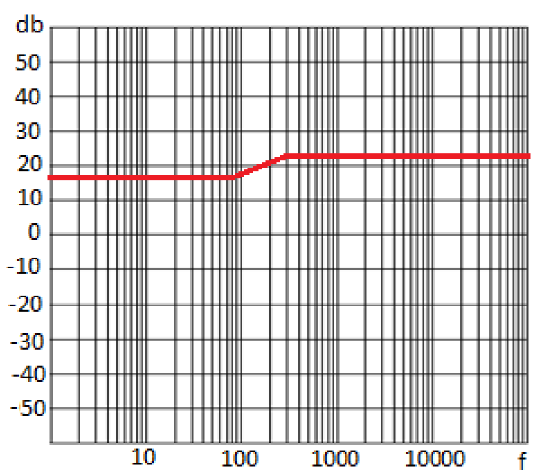
$$\text{zero at 830Hz} \Rightarrow \omega_z = \frac{1}{C_1R_1} = 2\pi\times 830 = 5212.4$$

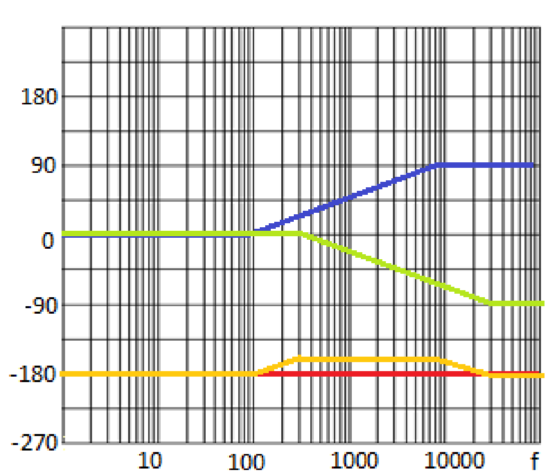
$$\text{assume } C_1 = 50nF \Rightarrow R_1 = 3.84k\Omega$$

$$\therefore R_2 = 2.08R_1 = 7.98k \approx 8k\Omega$$

$$\text{pole at 2K} \Rightarrow \omega_p = \frac{1}{C_2R_2} = 2\pi\times 2k = 12560 \Rightarrow C_2 \approx 10nF$$

(e)



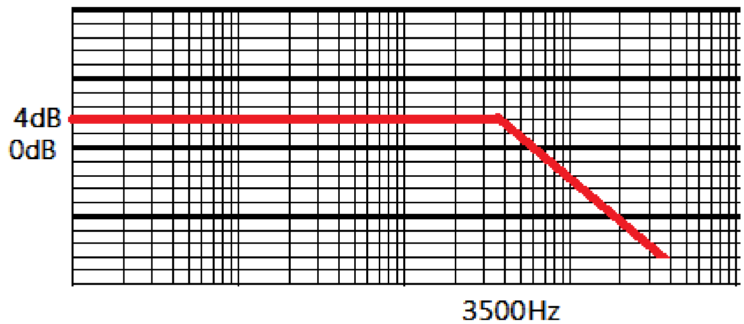


2. Consider the magnitude plot in the next figure. [15 marks] [B_a, A_d, A_q]

   (a) Find the Sallen Key circuit that will realize the given specifications. Find the proper values of the circuit components.

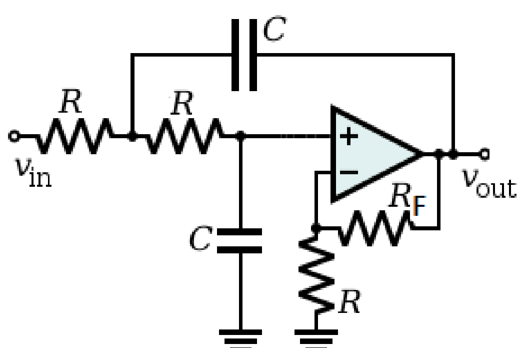
   (b) Calculate the error percentage of Q if the R_F increased 10%.

   (c) Design Band pass Filter (1250 to 3500 Hz). Draw the circuit.



Solution: (a)

- From the figure Q=0.707 $\Rightarrow gain = 3 - \frac{1}{Q} = 1.58$
- Assume C=0.01uF $\Rightarrow R = \frac{1}{2\pi \times 3500 \times 0.01u} = 4.5k\Omega$
- $R_F = 0.58R = 0.58 \times 4.5 = 2.6K\Omega$



(b)

- Error percentage in gain$k = 1 + \frac{1.1R_F}{R} = 1 + 1.1 \times 0.58 = 1.638 \Rightarrow \Delta K = \frac{1.638}{1.58} = 1.036$
- $Q = \Delta K Q = 1.036 * 0.707 = 0.733$

(c)

- For HPF: Q=0.707 $\Rightarrow gain = 3 - \frac{1}{Q} = 1.58$

- Assume C=0.01uF $\Rightarrow R = \frac{1}{2\pi \times 1250 \times 0.01u} = 1.273k\Omega$
- $R_F = 0.58R = 0.58 \times 4.5 = 746K\Omega$
- For the LPF: use the same values.