December 19th, 2006

Active Network Synthesis

Midterm

1- Using the operational-simulation method, find an opamp-RC circuit corresponding to the elliptic-type lowpass passive prototype in Fig. 1. Considering that cut-off frequency of the passive prototype is ω=1rad/s, calculate the element values so as the filter cut-off be 20kHz and all the resistances be equal to 1kΩ.

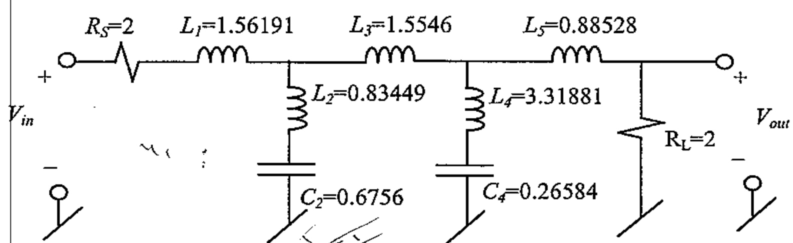


Fig. 1

RC = 1Mhz olmalı

2-) A second order bandpass filter with a center frequency of 1MHz and Q of 1 is to be designed using the topology in Fig. 2*a*. The input signal, I_{in} and the output signal, I_{out} are currents, so the filter will realise a current transfer function. The involved amplifer is a current amplifer with an amplification factor of α whose defining equations are given as in Fig. 2*b*.

a) Determine for what type of t_{AB} $(= I_A / I_B)$, the center frequency will be independent of α. Explain why the center frequency is preferred to be independent of α?

Assume that, the passive network is as in Fig. 2*c*.

b) Determine the types of the component.

c) Find the values of the components.

d) Determine where to inject the input signal in order to obtain a bandpass response. Draw the overall filter.

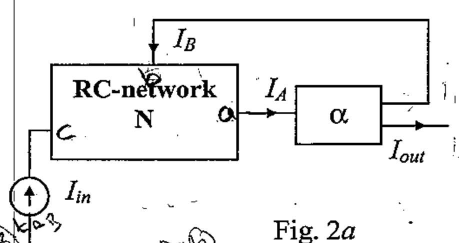
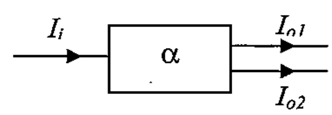


Fig. 2*a*



V_i=0
$I_{o1}=\cancel{I_i}\ \alpha I_i$
$I_{o2}=\cancel{I_i}\ \alpha I_i$

Fig. 2*b*

$(I_{o1} - I_{o2})s =$

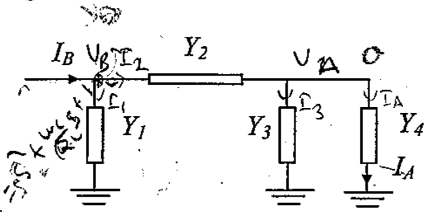


Fig. 2*c*

$(U_B - U_A)Y_2 + Y_1 U_B = I_B$

$(Y_3 + Y_4)U_A =$

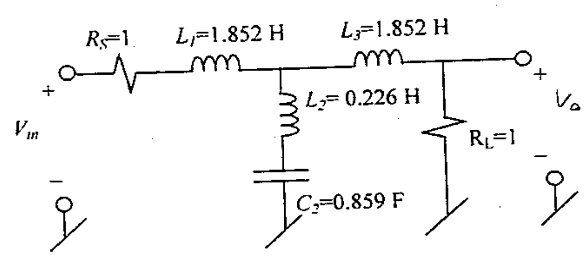
January 16th, 2006

ACTIVE NETWORK SYNTHESIS
Final Exam

1) a) Find an OTA-C circuit which simulates the given third-order Chebyshev type lowpass filter whose cut-off angular frequency is 2rad/s.

b) Determine element values so that the filter cut-off frequency be 10MHz and OTA g_ms be 100µS.

c) Explain how you can convert this circuit into a fully-balanced OTA-C filter.



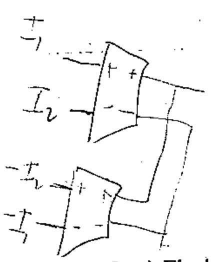
$$\frac{a_0 a_1}{s^2}$$

$$1+\frac{a_1}{s}+\frac{a_1 a_0}{s^2}$$

$$s^2+a_1 s+a_1 a_0$$

2. a) Find the transfer function of the basic circuit in Fig. 2a. Using this circuit, find a second-order Butterworth type lowpass filter ($Q=1/\sqrt{2}$) based on the signal flow graph in Fig. 2b. (Hint: Find an elementary signal flow graph from the circuit in Fig. 2a. Determine how this type of subgraphs are used to compose the graph in Fig. 2b.)

b) Determine element values in order to have a cut-off frequency of 1MHz. All caps should be 10pF.



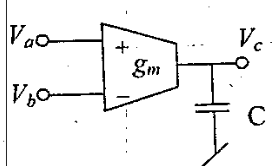


Fig. 2a

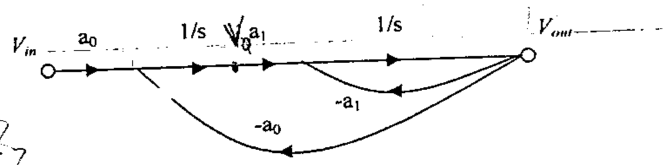


Fig. 2b

3. a) Find z-domain transfer function of the circuit in Fig. 3 and show that the circuit is an integrator.

b) If the integration constant of the circuit is G_{eq}/C_f, find the approximate value of G_{eq} in terms of switching period T and C_G. (Use the following expression: $s=\frac{1}{T}\frac{1-z^{-1}}{z^{-1}}$)

c) Using this circuit and the graph of Fig. 2b, find a second order Butterworth type lowpass filter whose cut-off frequency is 1MHz. Take switching frequency as 10MHz.

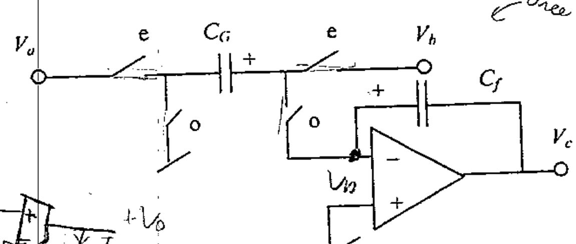


Fig. 3

even C_f

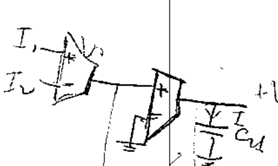
$-V_c^e + z^{-\frac{1}{2}} V_c^o = 0$

$V_c^e = z^{-\frac{1}{2}} V_c^o$

odd

C_g C_f

$-V_c^o \cdot C_f - z^{-\frac{1}{2}}\left[(C_f \cdot -V_c^e) + C_g \cdot (V_a^e - V_b^e)\right] = 0$



$\frac{I}{sC_u} = V_o$

$100 \times 10^{-5} \cdot 10^{-4}$

$V_i \cdot g_m = I = V_o \cdot s C_u$

December 25th. 2001

Active Network Synthesis
Midterm

1- Using the operational-simulation method, find an opamp-RC circuit corresponding to the elliptic-type lowpass passive prototype in Fig. 1. The cut-off frequency is to be 1kHz and the resistances are to be all equal to 1kΩ.

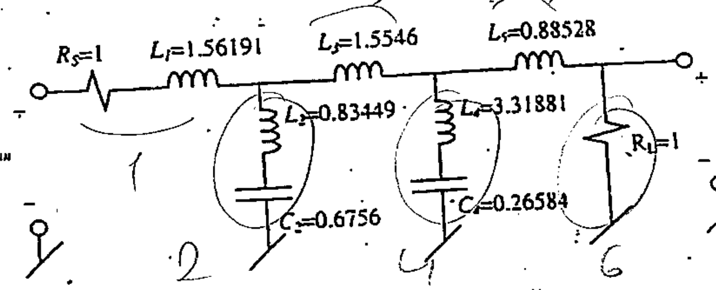


Fig. 1

6 adet opamp kullanılacaktır

2- a) Find the transfer function of the circuit in Fig. 2. Using this circuit, a second-order Butterworth type filter based on two-integrator loop-topology is to be designed. Find a lowpass filter using 3 OTA and 2 capacitors.
Note: The cut-off frequency should be $2.\pi.10^6$ rad/s, all the caps should be 10pF and take all g_ms (except possibly one) equal.

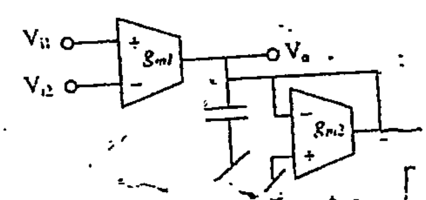


Fig. 2

b) At high frequencies, OTA transconductance can be modeled as $g_m(s) = \frac{g_m}{1+s/p}$. Find the expression of the nonideal ω_0 and pole-Q in terms of the ideal ones.

Hint: Use the following approximation: $\frac{1}{(1+s/p)^n} = 1 - ns/p$

Find a compensation method to reduce the effects of the OTA finite bandwidths. (Hint: In order to insert a zero to the transfer function of the circuit in Fig. 2, use a small valued resistor)

c) Convert the circuit you have obtained in (a) into a second-order bandpass filter without using any additional component.

$k=0,1,2,3$

s_k $\qquad \frac{e^{j\pi\left(\frac{3+2k}{4}\right)}}{1}$

$n=2$ $\qquad Q=\frac{1}{\sqrt{2}}$ $\quad \omega_0=1$ $\qquad \frac{1}{s^2+\sqrt{2}s+1}$ $\qquad \Delta = 2-4=-2$ $\quad j\sqrt{2}$

$\left(s-\frac{\sqrt2}{2}+j\frac{\sqrt2}{2}\right)\left(s\right.$ $\quad \frac{-\sqrt2 \mp j\sqrt2}{2}$

December 17th, 2005

ACTIVE NETWORK SYNTHESIS

Midterm

1-) a) Find the transfer function defined as $H(s)=\dfrac{V3}{V1-V2}$ of the circuit in Fig. 1a which employs current conveyor as active element.

b) Using this circuit, realize the signal flow graph of Fig. 1b. $\quad \frac{1}{s^2+\sqrt2 s+1}$

c) Using the circuit obtained in b), a Butterworh type ($Q=1/\sqrt{2}$) second-order lowpass filter with a cut-off frequency of 100KHz is to be designed. Determine passive component values.

$s_n=\frac{s}{2\pi\cdot 10^5}$

$R_n=\frac{R}{10^4}$

$V_3=\frac{1}{sRC}(V_1-V_2)$

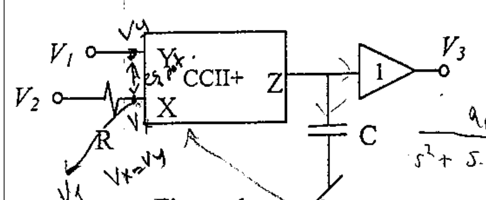


Figure 1a

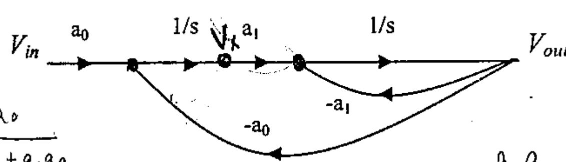
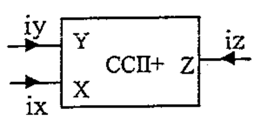


Figure 1b

$\frac{a_1 a_0}{s^2+s\cdot a_1+a_1 a_0}$ $\qquad \sum P_i\Delta_i=\frac{a_1 a_0}{s^2}$

$\Delta = 1-\left(\frac{-a_1}{s}+\frac{-a_0 a_1}{s^2}\right)$

$1+\frac{a_1}{s}+\frac{a_1 a_0}{s^2}$



2-) Find an opamp-RC circuit corresponding to the passive prototype in Fig. 2 using operational simulation method.

b) Assuming that the passive prototype is a lowpass filter with a cut-off frequency of 1rad/sec, design the opamp filter such that the cut-off frequency be 1MHz and all resistors be 1kΩ.

$\boxed{\text{DC blocking, lowpass}}$

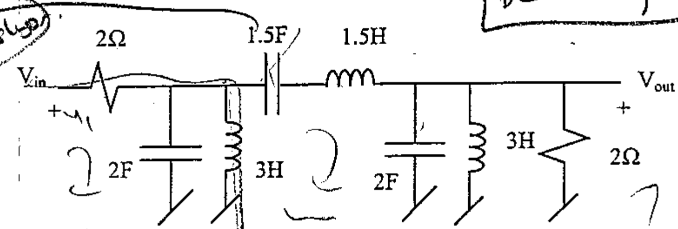


Figure 2

$a_1 a_0$

$2\pi\cdot 10^6$ $\quad 10^7$

December 26th, 2007

ACTIVE NETWORK SYNTHESIS

Midterm Exam

1) The topology in Fig. 1*a* consists of an (grounded) RC passive network and a current to voltage converter built around two opamps. Using this topology, a second order Butterworth-type highpass filter with a center frequency of 1MHz and Q of $1/\sqrt{2}$ will be designed.

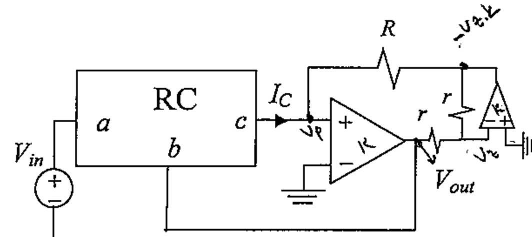


Fig. 1*a*

a) Determine for what type of G_{cb} (= I_C / V_{out}), the center frequency will be independent of the opamps finite gains. Show that complex-poles can be realised using this filter (Hint: Express the pole-Q of the system in terms of the parameters of RC-network and R).

Assume that, RC-network is chosen as in Fig. 1b.

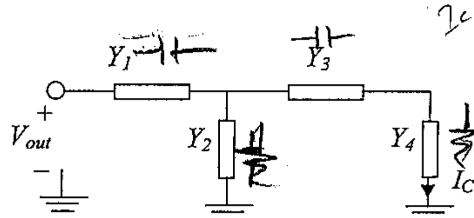


Fig. 1*b*

b) Determine component types.

b) Determine where to inject the input signal in order to obtain highpass response.

c) Show that the filter realizes highpass characteristic.

d) Find the values of components assuming that all capacitors are 1*pF*.

2) a) The circuit in Fig. 2 is a second-order lowpass filter with a cut-off frequency of 1 rad/sec. Obtain a fourth-order bandpass filter with a center frequency of 1 rad/sec and Q=5 using lowpass-bandpass transformation. Find an OPAMP-RC circuit realising the bandpass filter.

b) Determine the values of passive components in order to have a cut-off frequency of 10MHz. All R's will be 1kΩ.

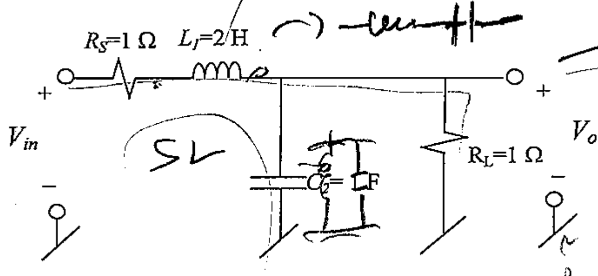


Fig. 2

bandpass