University of Michigan
EECS 311: Electronic Circuits
Fall 2008

PROBLEM SET 3

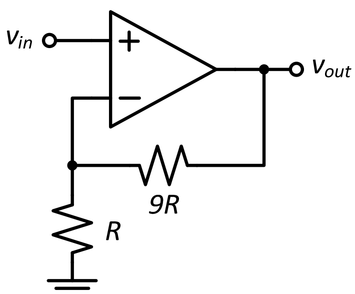
Issued 9/24/2008
Due in Lecture 10/1/2008

J&B refers to the course text: “Microelectronic Circuit Design (3rd Edition),” by Richard Jaeger and Travis Blalock.

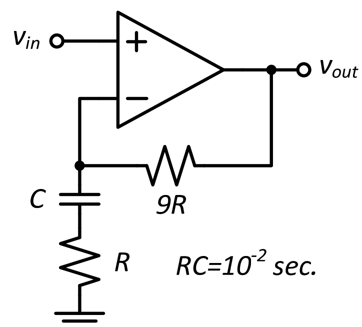
P3.1 Graphical filter design. For each circuit below, assume the amplifier has gain $A(s) = 10^6/(1+s)$. Derive a transfer function for $\beta(s)$. Using Matlab, plot the magnitude of $|1/\beta(s)|$, $|A(s)|$, and $|v_{out}/v_{in}|$ on the same plot, substituting in the values given for RC and LC when appropriate. Use the following example Matlab code as a guide.

```
%%% Example Matlab Code for P3.1
close all; clear;
s=tf('s');
% Amplifier A(s)
A_s = 1e6/(1+s);
% This is an example Beta B(s), substitute for other B(s)
B_s = (1e-3*s)/(1+1e-3*s);
% Vout/Vin = A(s)/(1+B(s)*A(s))
vout_vin = A_s/(1+B_s*A_s);
% Plot A(s), 1/B(s), and Vout/Vin
figure; bode(A_s,1/B_s,vout_vin); grid on;
```

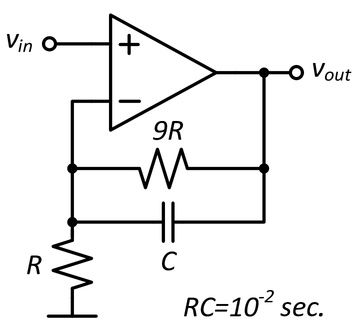
a)



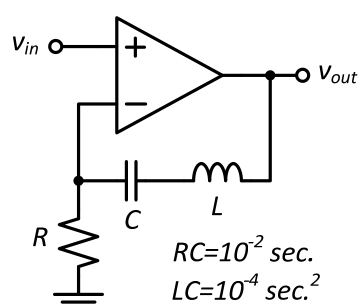
b)



c)



d)



P3.2 In this problem you will design low-pass Sallen-Key filters using the topology discussed in lecture (topology 1 from Sallen&Key p76). The desired transfer function takes on the form given below by $H(s)$. The poles and filter gain are given in each part.

http://www.eecs.umich.edu/courses/eecs311/f08/handouts/1955_sallen_key.pdf

$$H(s) = \frac{\mathrm{K} \cdot |\mathrm{p}_1| \cdot |\mathrm{p}_2|}{(\mathrm{s} - \mathrm{p}_1)(\mathrm{s} - \mathrm{p}_2)}$$

For each part, specify the values of K, d, ω_n, T_1, and T_2. Also specify the values you used for R_1, R_2, C_1, and C_2. You may choose arbitrary values for R's and C's, however they should be reasonable to implement.

a) $p_1 = -100\, rad/s$, $p_2 = -10000\, rad/s$, $K = 2$

b) $p_1 = -1000/\sqrt{2} + j1000/\sqrt{2}\, rad/s$, $p_2 = -1000/\sqrt{2} - j1000/\sqrt{2}\, rad/s$, $K = 1$

P3.3 Problems J&B 3.78 and 3.83 on p138. Assume the Zener diodes ideally clamp at reverse bias voltage V_Z.

P3.4 Problem 3.91, *parts a) and b) only*. Use the *constant voltage source model* for the diode.

P3.5 Problem J&B 11.91 on p606. Use the *constant voltage source model* for the diodes.