MATHEMATICAL QUESTIONS

Question 1

The circuit shown in Fig. 1 is called Sallen active lowpass filter, where the triangle abstracts an op-amp amplification circuit with the gain K.

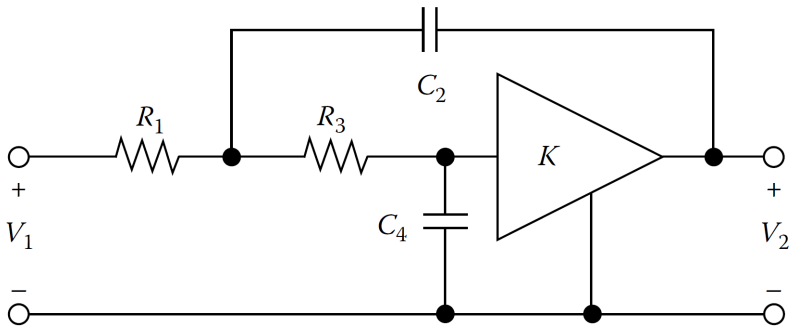

Figure 1: Sallen active lowpass filter.

(a) Find the transfer function of the circuit.

(b) Find the frequency response of the circuit.

(c) Draw the approximated frequency response using the corresponding zero-pole diagram.

Question 2

The circuit shown in Fig. 2 is called Sallen active highpass filter, where the triangle abstracts an op-amp amplification circuit with the gain K.

Question 2 continued on next page...

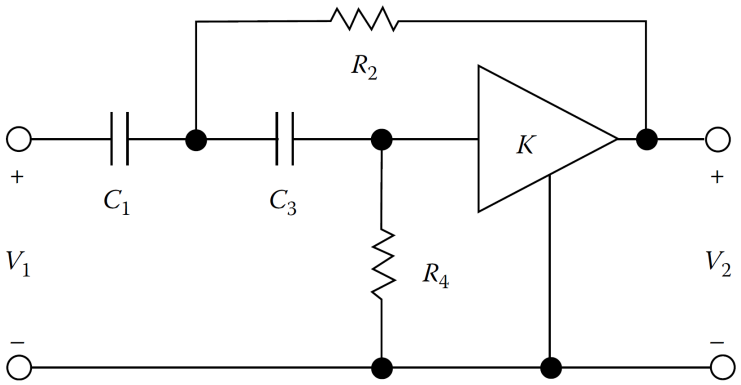

Figure 2: Sallen active highpass filter.

(a) Find the transfer function of the circuit.

(b) Find the frequency response of the circuit.

(c) Draw the approximated frequency response using the corresponding zero-pole diagram.

Question 3

Consider the lattice network shown in Fig. 3, where Z and Z' are horizontal and diagonal impedances.

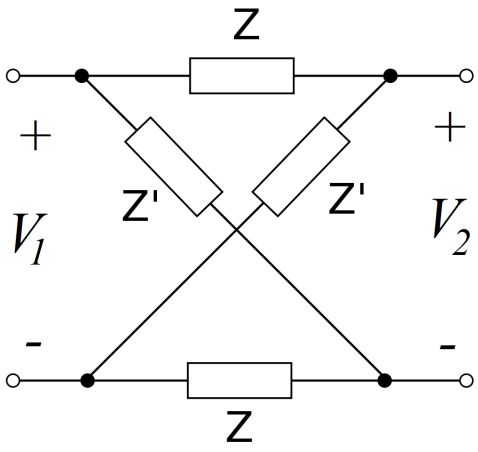

Figure 3: Lattice network.

Question 3 continued on next page...

(a) Find the transfer function $H(s) = \frac{V_2(s)}{V_1(s)}$ of the circuit.

(b) Find the frequency response $H(j\omega) = \frac{V_2(j\omega)}{V_1(j\omega)}$ of the circuit.

(c) Assume that Z is a resistor of $R\ \Omega$ and Z' is an inductor of L H. Draw the approximated frequency response of the circuit. Can you interpret the filtering response of the circuit?

Question 4

For the LC ladder network shown in Fig. 4,

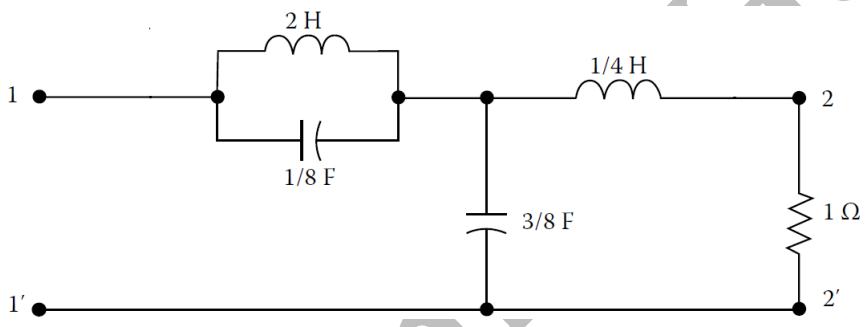

Figure 4: LC ladder network.

(a) Find the transfer function $H(s) = \frac{V_{22'}(s)}{V_{11'}(s)}$ of the circuit.

(b) Find the frequency response $H(j\omega) = \frac{V_{22'}(j\omega)}{V_{11'}(j\omega)}$ of the circuit.

(c) Plot the Bode diagram of the circuit.

SOFTWARE QUESTIONS

Question 5 continued on next page...

Question 5

The circuit shown in Fig. 5 is called biquad active filter. The triangles denote amplifiers with the gains -1 and 2. The amplifiers may be implemented using inverting and non-inverting op-amp circuits. The admittances Y_1, Y_2, Y_3 and Y_4 can be replaced by series or parallel RC circuits. A sample customized configuration is shown in Fig. 6. Depending on the configuration, the circuit provides various filtering responses. Simulate the circuit in PSpice and investigate the filtering response of the circuit for various configurations of Y_1, Y_2, Y_3 and Y_4.

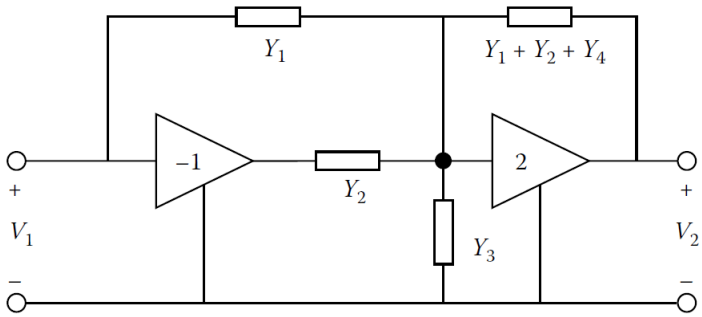

Figure 5: Biquad active filter.

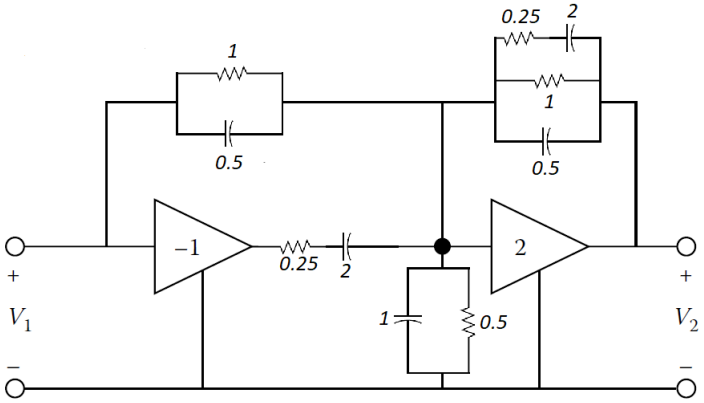

Figure 6: A sample customized realization of the biquad active filter.

BONUS QUESTIONS

Question 6 continued on next page...

Question 6

Return your answers by filling the LaTeXtemplate of the assignment. If you want to add a circuit schematic, you can draw it directly using TikZ package, or draw it in a secondary application such as Microsoft Visio and then, import it as a figure.

EXTRA QUESTIONS

Question 7

Feel free to solve the following questions from the book *"Basic Circuit Theory"* by C. Desoer and E. Kuh.

1. **Chapter 15, question 4.**
2. **Chapter 15, question 5.**
3. **Chapter 15, question 6.**
4. **Chapter 15, question 7.**
5. **Chapter 15, question 10.**