
MATHEMATICAL QUESTIONS

Question 1

Derive the impedance matrix of the op-amp circuit shown in Fig. 1 and show that the impedance matrix looks like that of a gyrator. Is this circuit an exact equivalent implementation of a gyrator?

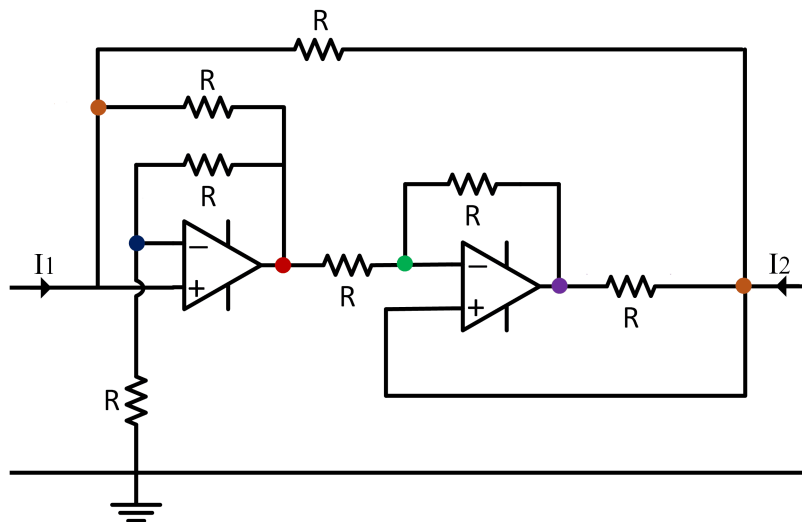


Figure 1: An Op-Amp circuit.

Question 2

The impedance matrix Z of a two-port is given. Prove the equations that relate the admittance, hybrid H, and ABCD transmittance matrices of the two-port to the elements of its impedance matrix Z .

Question 3

Obtain both the impedance and admittance parameters for the two-port networks of Fig. 2.

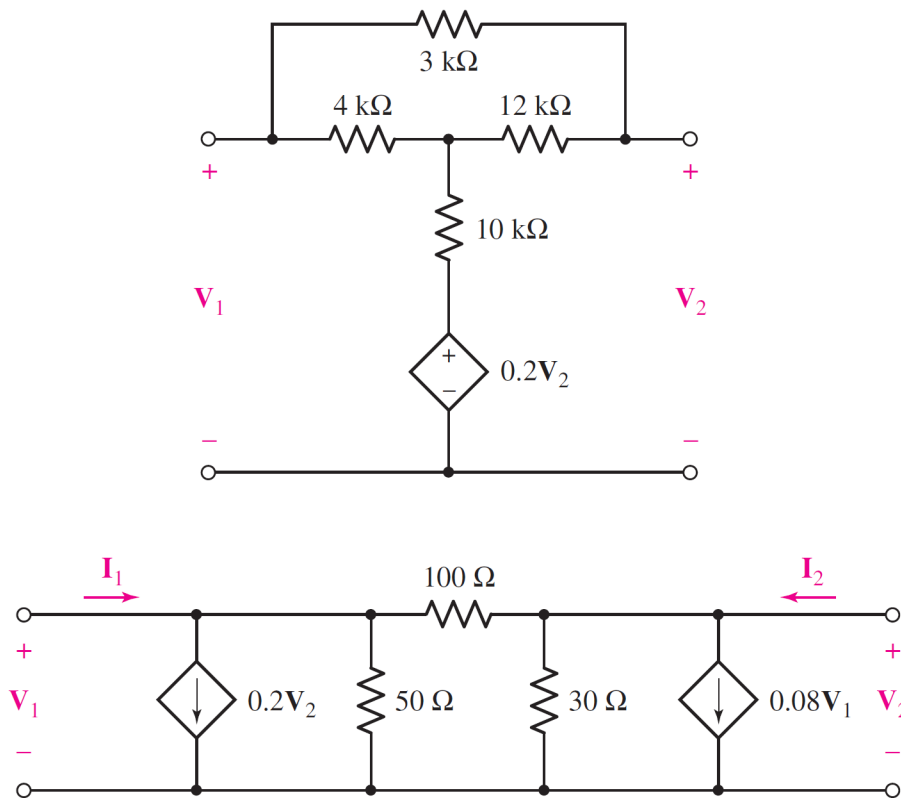


Figure 2: Two two-ports for which the impedance and admittance specifications are required.

Question 4

The purpose of this problem is to justify a method for checking whether a given two-port is a reciprocal two-port at frequency ω_0 . Consider the two situations shown in Fig. 3. All measurements are sinusoidal steady-state measurements made at frequency ω_0 ; consequently $V_1, V_2, I_1, I_2, \hat{V}_1, \hat{V}_2, \hat{I}_1,$ and \hat{I}_2 are the phasors representing the sinusoidal waveforms. The impedances \hat{Z}_1 and Z_2 and the internal impedance of the generator are arbitrary, except that $\frac{I_1}{I_2} \neq \frac{\hat{I}_1}{\hat{I}_2}$. Show that the two-port is reciprocal at frequency ω_0 if and only if $V_1\hat{I}_1 + V_2\hat{I}_2 = \hat{V}_1I_1 + \hat{V}_2I_2$.

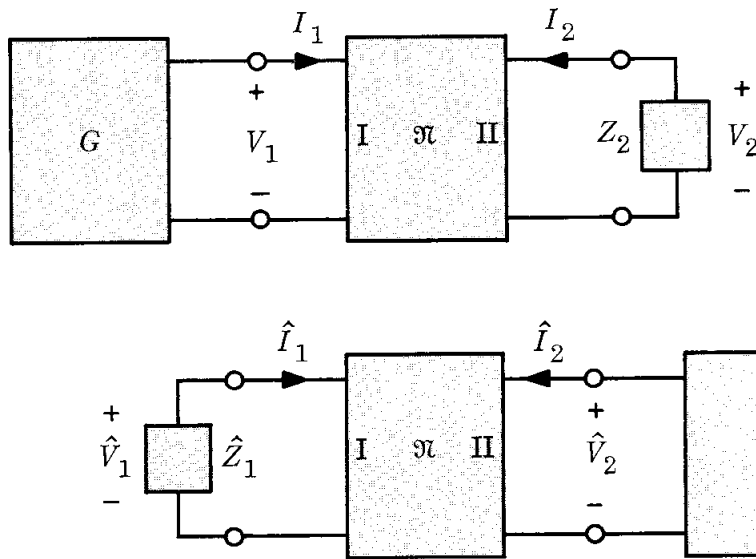


Figure 3: Test setup for checking the reciprocity of a two-port at frequency ω_0 .

Question 5

Find the admittance matrix Y for the two-port shown in 4.

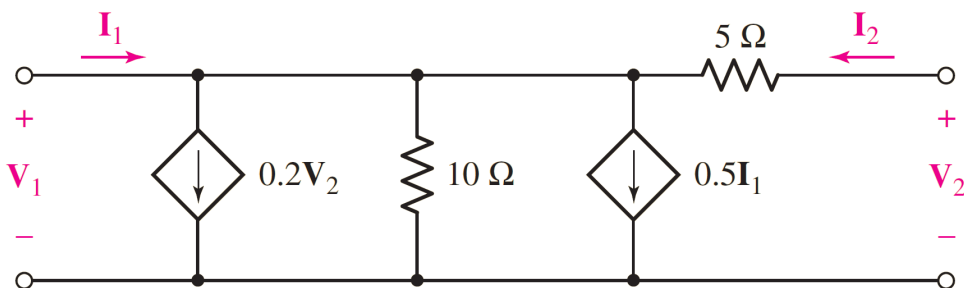


Figure 4: An LTI circuit with dependent sources.

Question 6

Find the impedance matrix Z for the small-signal model of the bipolar current mirror shown in 5.

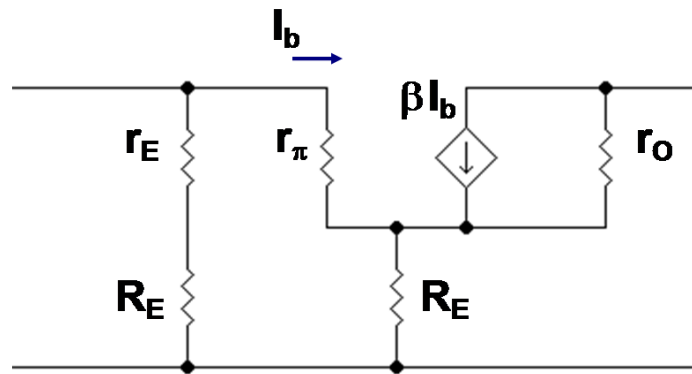


Figure 5: Small-signal model of the bipolar current mirror.

SOFTWARE QUESTIONS

Question 7

Use AC analysis of PSpice to obtain the frequency curves of the impedance and admittance parameters for the double-tuned circuit shown in Fig. 6. You should provide a Bode diagram for each parameter.

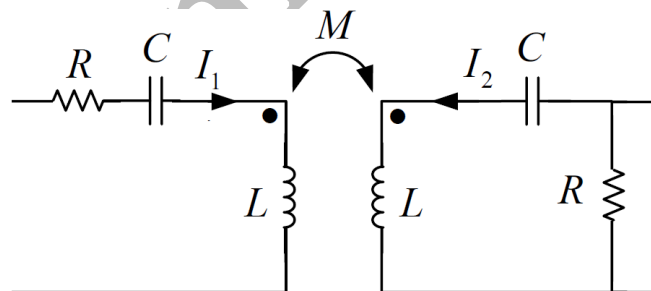


Figure 6: Double-tuned circuit.

BONUS QUESTIONS

Question 8

Return your answers by filling the \LaTeX template 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 9

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

1. Chapter 17, question 4.
2. Chapter 17, question 5.
3. Chapter 17, question 6.
4. Chapter 17, question 9.
5. Chapter 17, question 10.
6. Chapter 17, question 11.
7. Chapter 17, question 15.
8. Chapter 17, question 16.