MATHEMATICAL QUESTIONS

Question 1

Show that the circuits shown in Fig. 1 are degenerate, i.e., they may have no or several solutions.

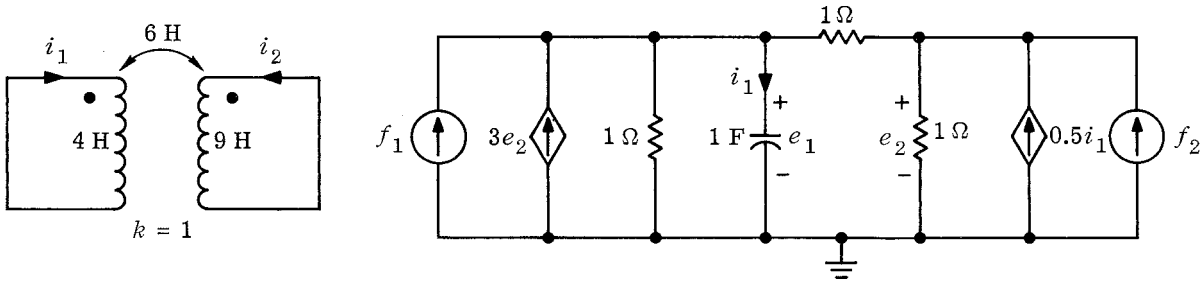

Figure 1: Degenerate LTI circuits.

Question 2

The results of two measurement scenarios for the reciprocal circuit of Fig. 2 are

$$\begin{cases} v_1(t) = (-6e^{-t} + 14e^{-2t})u(t) \\ v_2(t) = 0 \\ v_3(t) = (-6e^{-t} + 12e^{-2t})u(t) \\ i_1(t) = \delta(t) \\ i_2(t) = -2e^{-2t}u(t) \\ i_3(t) = 0 \end{cases}, \quad \begin{cases} \hat{v}_1(t) = ? \\ \hat{v}_2(t) = 24u(t) \\ \hat{v}_3(t) = (-12e^{-t} + 24e^{-2t})u(t) \\ \hat{i}_1(t) = 0 \\ \hat{i}_2(t) = 24e^{-2t}u(t) \\ \hat{i}_3(t) = 2\delta(t) \end{cases}$$

. Find $\hat{v}_1(t)$ in the second measurement scenario.

Question 2 continued on next page...

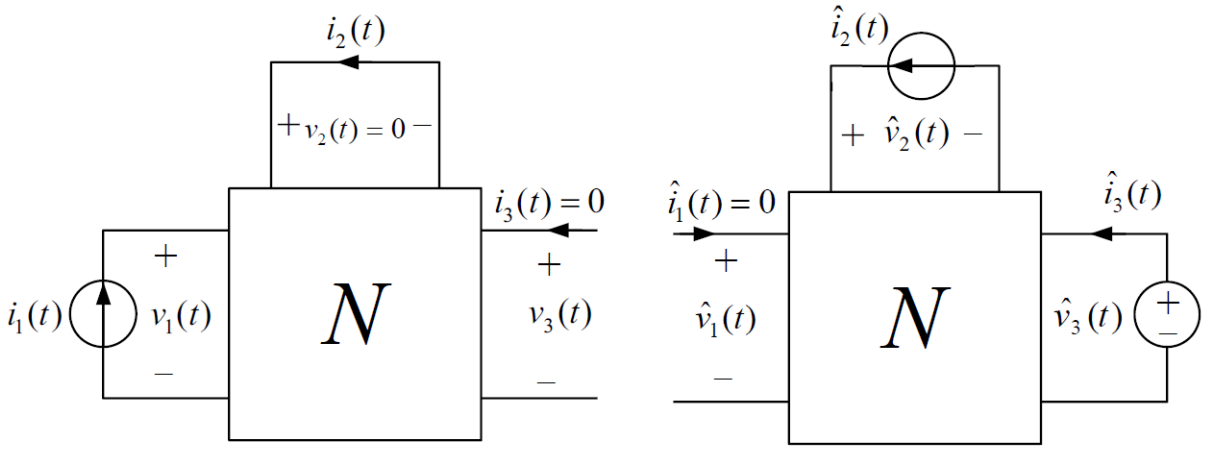

Figure 2: Two-measurement experiment for a reciprocal circuit.

Question 3

Verify that if the superposition theorem holds for the voltage response v at the nonlinear circuit of Fig. 3 or not.

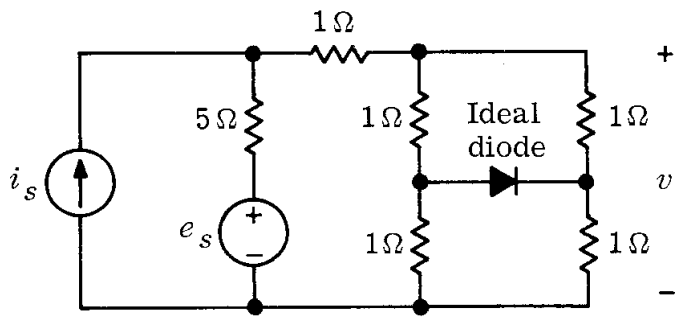

Figure 3: A balanced bridge nonlinear circuit.

Question 4

The small-signal model of the transistor amplifier of Fig. 4 is drawn.

Question 4 continued on next page...

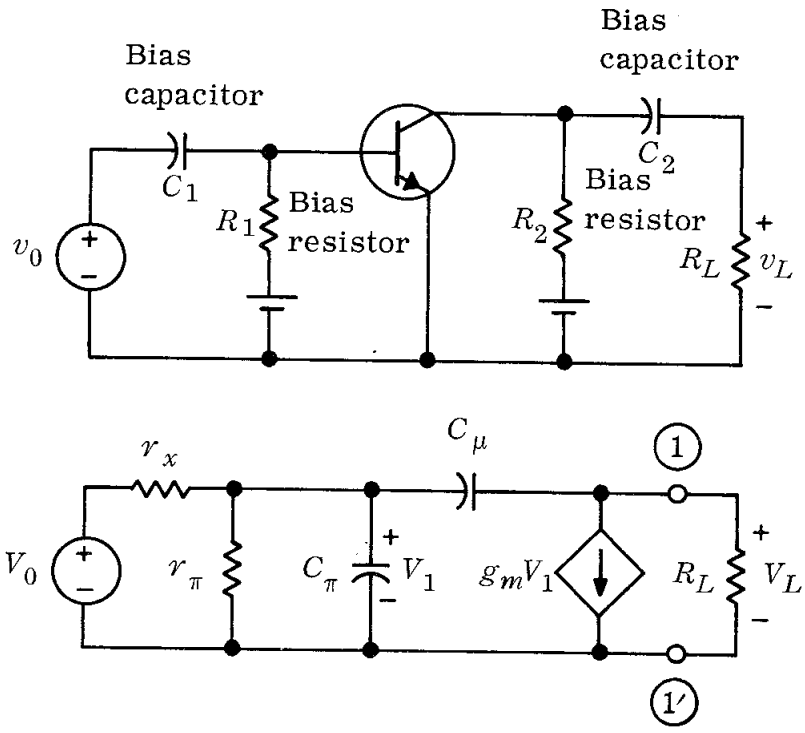

Figure 4: A simple transistor amplifier and its small-signal equivalent circuit.

(a) Find the Thevenin and Norton equivalent circuits seen from port $1-1'$ of the small-signal model.

(b) Find the voltage gain $H(s) = \frac{V_L(s)}{V_0(s)}$.

SOFTWARE QUESTIONS

Question 5

An audio file can be considered as the output voltage of a microphone versus time. Develop a MATLAB function that receives an audio file, passes it through the RC lowpass filter $H(j\omega) = \frac{1}{1+j\frac{\omega}{\omega_c}}, \omega_c = \frac{1}{RC}$, and generates a filtered audio file. Listen to the filtered output for different values of ω_c and examine the filtering impact on the quality of the filtered audio.

BONUS QUESTIONS

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 16, question 3.**
2. **Chapter 16, question 4.**
3. **Chapter 16, question 5.**
4. **Chapter 16, question 8.**
5. **Chapter 16, question 16.**
6. **Chapter 16, question 17.**
7. **Chapter 16, question 18.**