MATHEMATICAL QUESTIONS

Question 1

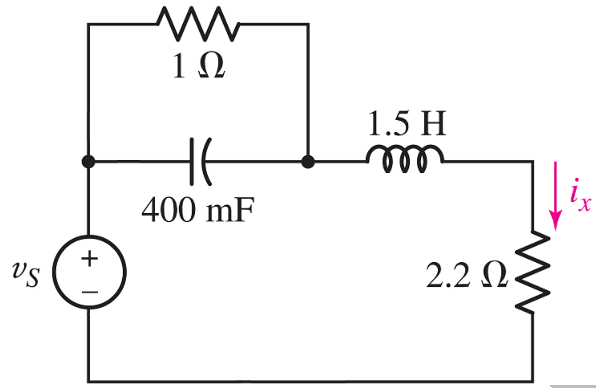

Figure 1: An LTI circuit.

Consider the LTI circuit shown in Fig. 1.

(a) Find the differential equation relating $i_x(t)$ *to* $v_s(t)$.

(b) Obtain the impulse response of $i_x(t)$.

(c) Calculate the steady state response of $i_x(t)$ *if* $v_s(t) = A\cos(\omega t + \theta)$.

Question 2

Determine the Thevenin equivalent seen by $-j10\ \Omega$ impedance of Fig. 2 and use this to compute V_1.

Question 2 continued on next page. . .

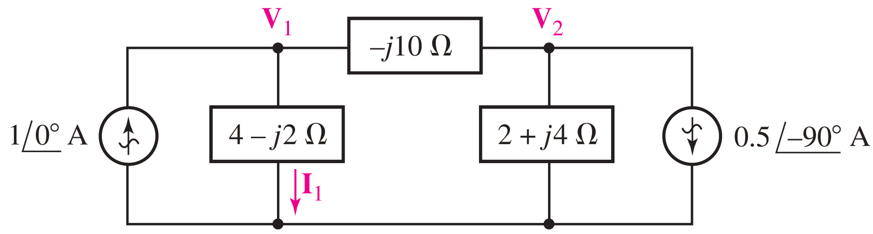

Figure 2: A circuit for which Thevenin equivalent seen by $-j10\ \Omega$ impedance is desired.

Question 3

A compensating capacitor parallel to the voltage source can be added to the circuit of Fig. 3 to make its overall power factor closer to 1. Calculate the capacitance value C of the compensating capacitor such that the overall power factor is 0.95. Assume that $Z_1 = 1.5\Omega$, $Z_2 = j\Omega$, and $Z_3 = (1 - j2)\Omega$.

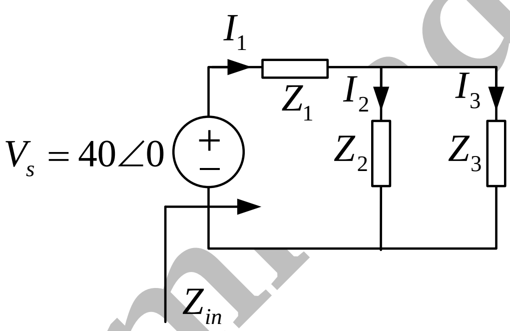

Figure 3: A circuit in phasor domain.

Question 4

Consider the one port shown in Fig. 4.

Question 4 continued on next page. . .

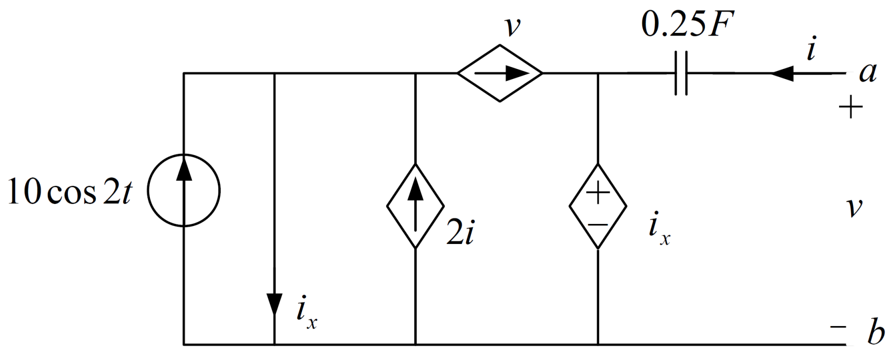

Figure 4: A circuit in sinusoidal steady state for which the Thevenin and Norton equivalent circuits are required.

(a) Find the equivalent Thevenin and Norton circuit seen from the port ab.

(b) Calculate the impedance of the load Z_L absorbing the maximum power from the port ab.

Question 5

Let $H_1(j\omega) = \frac{I}{I_{s1}}\Big|_{\substack{V_{s2}=0\\ Vs3=0}} = \frac{2+j\omega}{1+j\omega}$**,** $H_2(j\omega) = \frac{I}{V_{s2}}\Big|_{\substack{I_{s1}=0\\ Vs3=0}} = \frac{3-2j\omega}{1+j\omega}$**, and** $H_3(j\omega) = \frac{I}{V_{s3}}\Big|_{\substack{I_{s1}=0\\ Vs2=0}} = \frac{4+j\omega}{1+j\omega}$ **in the circuit shown in Fig. 5.**

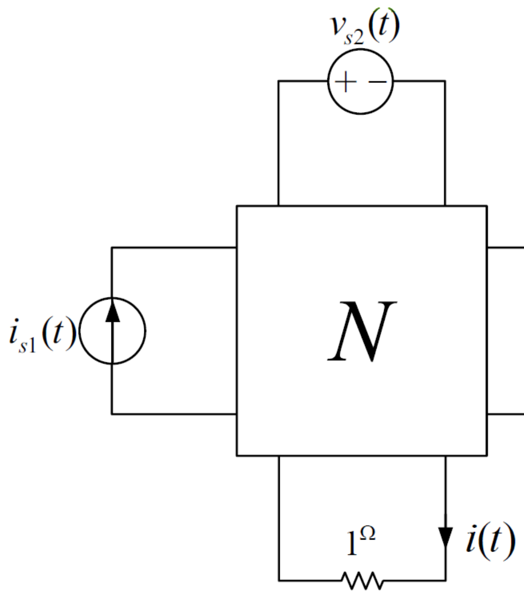

Figure 5: A multi-input circuit in sinusoidal steady state.

(a) Calculate the average power consumed by the $1\ \Omega$ *resistor if* $i_{s1}(t) = \cos(t)$, $v_{s2}(t) = 2\cos(t)$, *and* $v_{s3}(t) = 3\cos(t)$.

(b) Calculate the average power consumed by the $1\ \Omega$ *resistor if* $i_{s1}(t) = \cos(2t)$, $v_{s2}(t) = 2\cos(3t)$, *and* $v_{s3}(t) = 3\cos(2t)$.

Question 6

Consider the circuit shown in Fig. 6.

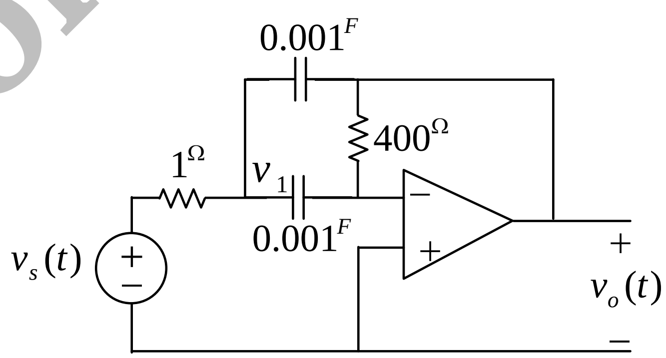

Figure 6: An op-amp circuit in sinusoidal steady state.

Question 6 continued on next page...

(a) Calculate the network function $H(j\omega) = \frac{V_o(j\omega)}{V_s(j\omega)}$.

(b) Calculate and plot the amplitude and phase of the network function.

(c) Investigate the filtering response of the network function and calculate its describing parameters such as central frequency, bandwidth, and quality factor.

SOFTWARE QUESTIONS

Question 7

Use AC sweep simulation of PSpice to investigate how the values of the elements affect the filtering response of a series RLC circuit. Particularly, analyze the impact of the circuit element values on the bandwidth and central frequency of the filtering response.

BONUS QUESTIONS

Question 8

Consider the circuit shown in Fig. 7.

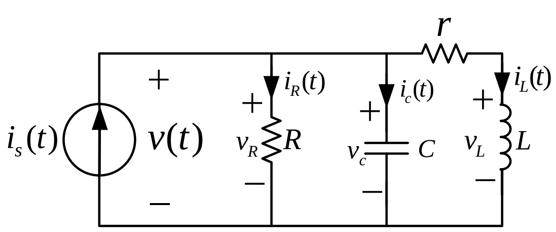

Figure 7: A parallel RLC circuit with real inductor.

Question 8 continued on next page...

(a) Calculate the network function $H(j\omega) = \frac{V(j\omega)}{I_s(j\omega)}$.

(b) Calculate and plot the typical amplitude and phase curves of the network function.

(c) Compare the filtering response with an RLC circuit with $r = 0$.

Question 9

Return your answers by filling the LaTeX template of the assignment.

EXTRA QUESTIONS

Question 10

Feel free to solve the following questions from the book *"Engineering Circuit Analysis"* by W. Hayt, J. Kemmerly, and S. Durbin.

1. **Chapter 10, question 10.**
2. **Chapter 10, question 15.**
3. **Chapter 10, question 35.**
4. **Chapter 10, question 40.**
5. **Chapter 10, question 44.**
6. **Chapter 10, question 47.**
7. **Chapter 10, question 48.**
8. **Chapter 10, question 60.**
9. **Chapter 10, question 61.**
10. **Chapter 10, question 66.**
11. **Chapter 10, question 68.**
12. **Chapter 10, question 74.**
13. **Chapter 10, question 76.**