Question 1

For the circuit shown in Fig. 1,

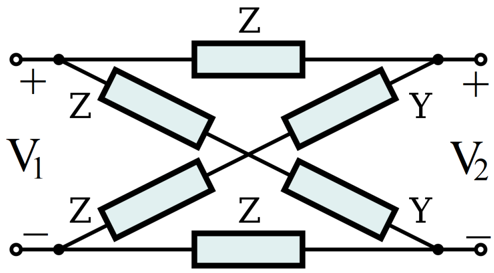

Figure 1: Lattice network.

(a) Find the network function $H(j\omega) = \frac{V_2(j\omega)}{V_1(j\omega)}$*, where* $Z(j\omega)$ *and* $Y(j\omega)$ *denote impedance and admittance of the diagonal single-port passive networks.*

(b) Let $Z(j\omega) = j\omega + \frac{1}{j\omega}$ *and* $Y(j\omega) = j\omega + \frac{1}{j\omega}$ *be a series and a parallel LC network, respectively. Find the simplified transfer function* $H(j\omega) = \frac{V_2(j\omega)}{V_1(j\omega)}$ *and the corresponding amplitude and phase responses.*

(c) Plot the amplitude and phase response of $H(j\omega)$ *calculated in part (b).*

Question 2

Calculate the Thevenin and Norton equivalent circuits seen from port ab in Fig. 2,

Question 2 continued on next page. . .

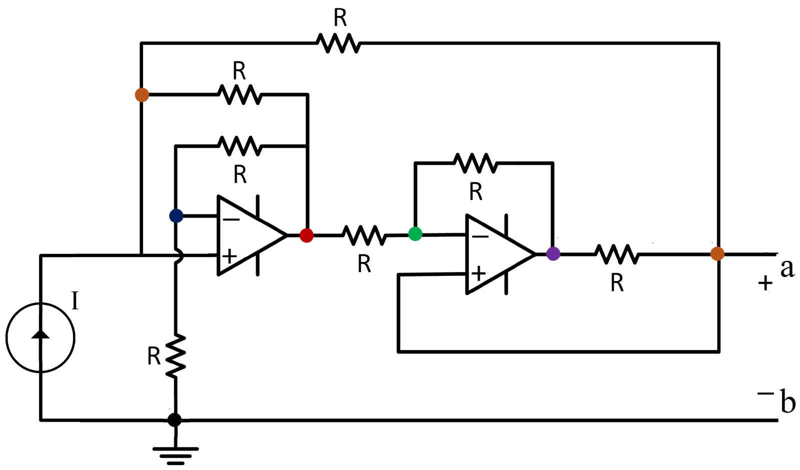

Figure 2: An op-amp circuit.

Question 3

The zero-state response of an LTI circuit to the input $x(t) = \big(e^{-t} - \cos(t) + \sin(t)\big)u(t)$ **is** $y(t) = 2\sin(t)u(t)$**. Find the impulse response, step response, and zero-state response to the input** $x_1(t) = e^{-2t}\sin(3t)u(t)$**.**

Question 4

The one ports $\mathcal{N}_1$ **and** $\mathcal{N}_2$ **in Fig. 3 are in sinusoidal steady state. When the one-ports are connected as Fig. 3(a),** $V_{aa'} = \sqrt{2}\underline{/-45^\circ}, I_{ab} = 1\underline{/0^\circ}$ **while** $V_{aa'} = \sqrt{2}\underline{/45^\circ}, I_{ab'} = 3\underline{/0^\circ}$ **when the one-ports are connected as Fig. 3(b).**

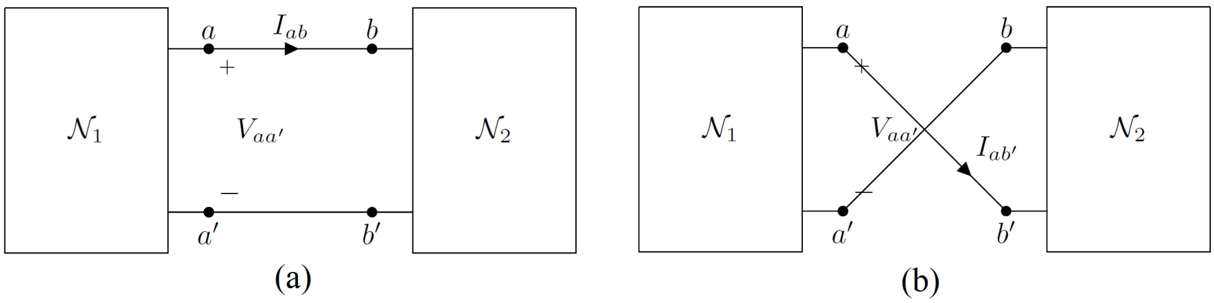

Figure 3: Two one-ports in sinusoidal steady state.

Question 4 continued on next page...

(a) Find the Thevenin equivalent circuits of the two one-ports.

(b) Find the resitance of the resistive load R_L connected between a and a' in Fig. 3(a) that absorbs the maximum average power.

(c) Find the maximum power absorbed by the resistive load R_L calculated in the previous part.

Question 5

Let $R_1 = 3\Omega$, $R_2 = 6\Omega$, and $L = \frac{2}{3}$H in the first order RL circuit shown in Fig. 4.

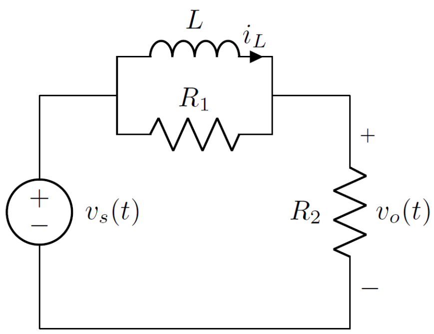

Figure 4: An RL circuit.

(a) Assume that $v_s(t) = e^{-\frac{9}{2}t}u(t)$. Calculate the initial current I_0 of the inductor such that $v_o(t) = 0, t > 0$.

(b) Assume that $v_s(t) = 8\cos(\sqrt{3}t + \phi)u(t)$ V and let the inductor initial current $i_L(0) = I_0 = 1$ A. Calculate the phase ϕ such that no transient response appears in $i_L(t), t > 0$.