MATHEMATICAL QUESTIONS

Question 1

Find the equivalent resistance of the ladder network in Fig. 1.

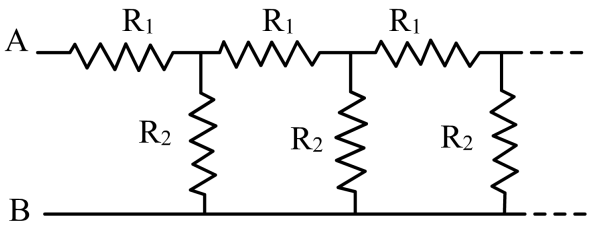

Figure 1: Ladder resistor network.

Question 2

How are Δ and T resistor networks in Fig. 2 equivalent? (Hint: If two circuits are equivalent, the terminal voltages and currents must be equal.)

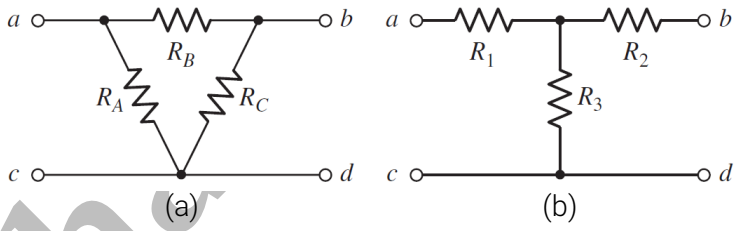

Figure 2: Two well-known equivalent resistor circuits. (a) Δ network. (b) T network.

Question 3

Determine the Thevenin equivalent seen by $-j10\ \Omega$ impedance of Fig. 3 and use this to compute V_1.

Question 3 continued on next page...

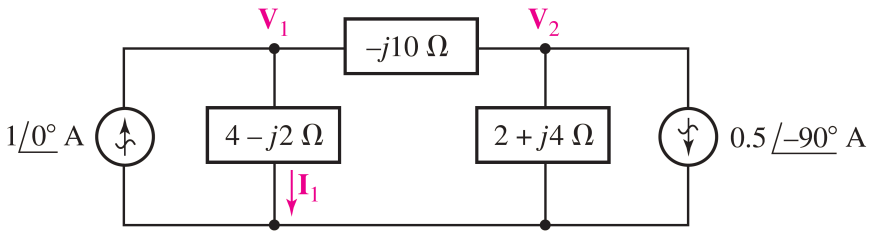

Figure 3: A circuit for which Thevenin equivalent seen by $-j10\ \Omega$ impedance is desired.

Question 4

Household electrical voltages are typically quoted as 220 V in Iran. However, these values do not represent the peak ac voltage. Rather, they represent what is known as the root mean square of the voltage, defined as

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V_m^2 \cos^2(\omega t)dt}$$

where $T = \frac{1}{f}$ is the period of the waveform, V_m is the peak voltage, and $\omega = 2\pi f$ is the waveform angular frequency, where $f = 50$ Hz in Iran.

(a) Perform the indicated integration, and show that for a sinusoidal voltage $V_{rms} = \frac{V_m}{\sqrt{2}}$.

(b) Compute the peak voltages corresponding to the rms voltage 220 V.

Question 5

Consider the circuit shown in Fig. 4, where V_{ref} is provided by a regulated voltage source. Show that the circuit can act like a current source and find the constant current I_s flowing to the resistive load R_L.

Question 5 continued on next page...

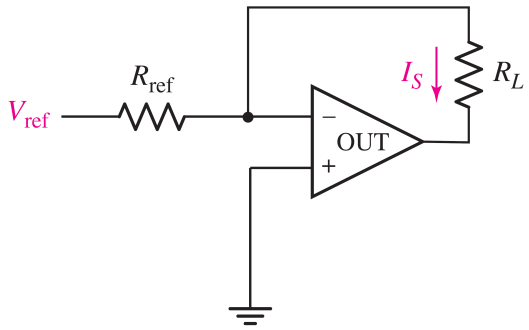

Figure 4: An Op Amp-based current source.

Question 6

Find the differential equation relating $i_x(t)$ to $v_s(t)$ for the circuit displayed in Fig. 5 and obtain the corresponding impulse and step responses.

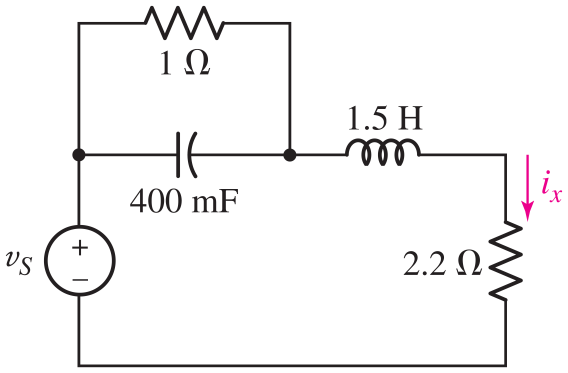

Figure 5: A circuit whose impulse and step responses are intended.

Question 7

Consider a series RL circuit driven with the voltage source $v(t)$, where the loop current $i(t)$ should be calculated.

(a) Find the zero-input response if the initial current is $i(0) = I_0$.

Question 7 continued on next page...

(b) Find the step response.

(c) Find the impulse response.

(d) Find the zero-state response if $v(t) = V_0 e^{-t} u(t)$.

(e) Find the complete response if $v(t) = V_0 e^{-t} u(t)$ and $i(0) = I_0$.

(f) Find the complete response if $v(t) = V_0 \cos(\omega t + \theta) u(t)$ and $i(0) = I_0$. How does the complete response relate to the sinusoidal steady state response?

SOFTWARE QUESTIONS

BONUS QUESTIONS

Question 8

Return your answers by filling the LaTeXtemplate of the assignment.