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Sub: Electric Network Analysis

To: Sir Shehryar

Q1. For the circuit in Fig. 1, if $v = 10e^{-4t}$ V and $I = 0.2e^{-4t}$, $t>0$

(a) Find R and C.

(b) Determine the time constant.

(c) Calculate the initial energy in the capacitor.

(d) Obtain the time it takes to dissipate 50 percent of the initial energy.

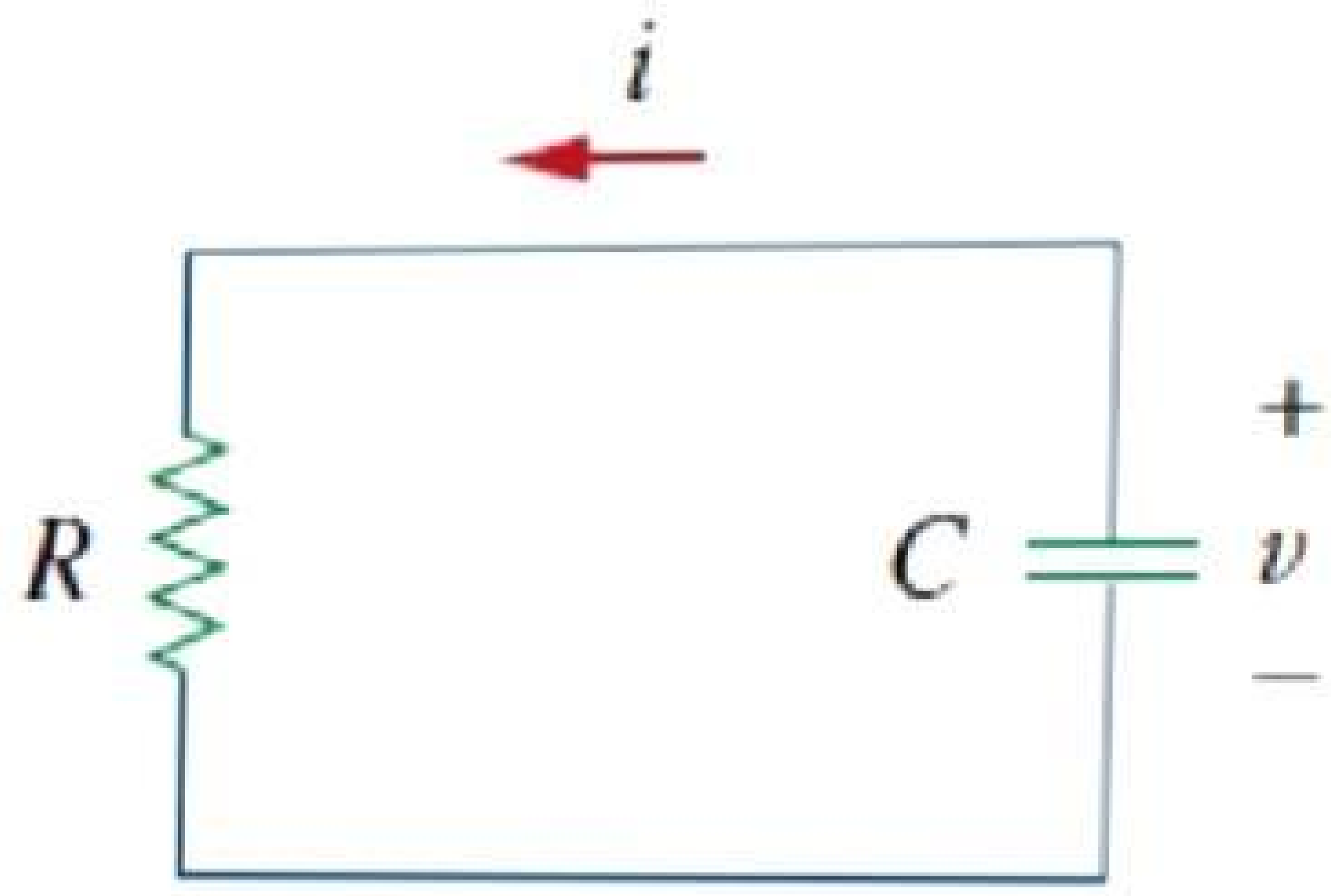
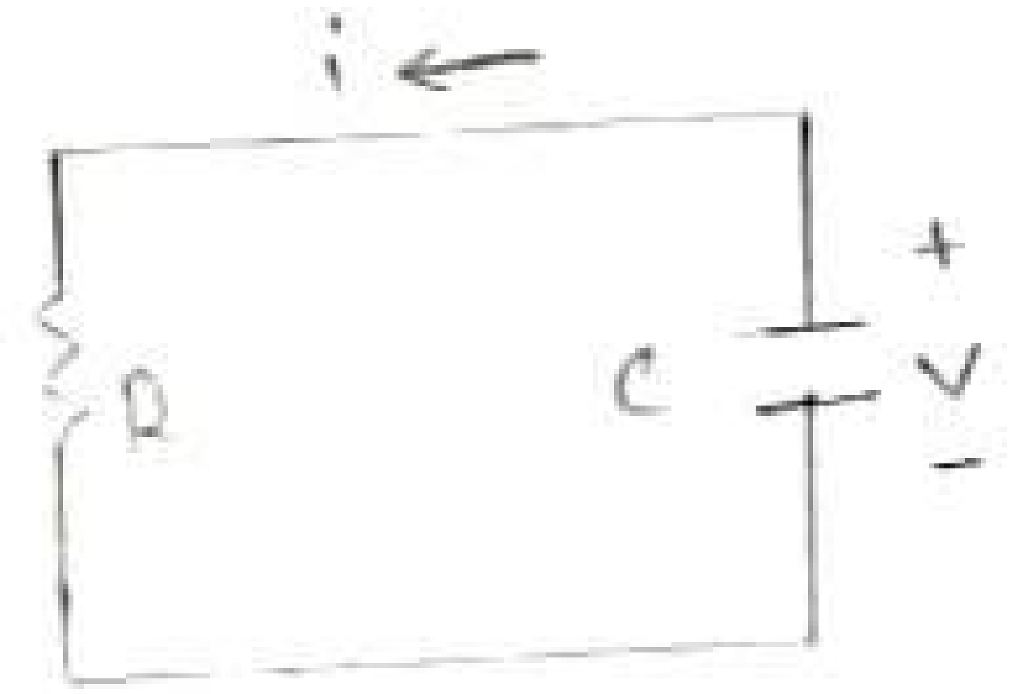


Figure 1

Q1: For the circuit in Fig 1, if $V = 10e^{-4t}$ & $0.2e^{-4t}$ $t > 0$

(a) Find R & C (b) ... (c) ... (d) ...

50 % of the initial energy.



Step 1

(A) $\tau = RC = \frac{1}{4}$

$\Rightarrow \quad -i = C\frac{dv}{dt}$

$\Rightarrow \quad -0.2e^{-4t} = C(10)(-4)e^{-4t}$

$\Rightarrow \quad C = 5mF$

$R = \frac{1}{4C} = 50\Omega$

Step 2

(B) $\tau = RC = \frac{1}{4} = 0.250$

Step 3

(C) $W_c(0) = \frac{1}{2}CV^2$

$\Rightarrow \quad \frac{1}{2}(5\times10^{-3})(100)$

$\Rightarrow \quad 250 \text{ mJ}.$

Step 4

(D) $W_R = \frac{1}{2} \times \frac{1}{2} CV_0^2$

$$\Rightarrow \frac{1}{2} CV_0^2 \left(1 - e^{-2t_0}\right)$$

$$0.5 = 1 - e^{-8t} \Rightarrow e^{-8t_0} = \frac{1}{2}$$

OR

$$e^{8t_0} = 2$$

$$t_0 = \frac{1}{8} \ln(2)$$

$$\Rightarrow 88.6\,ms$$

Q2. A 120-V dc generator energizes a motor whose coil has an inductance of 50 H and a resistance of 100 Ω. A field discharge resistor 400 Ω of is connected in parallel with the motor to avoid damage to the motor, as shown in Fig. 2. The system is at steady state. Find the current through the discharge resistor 100 ms after the breaker is tripped.

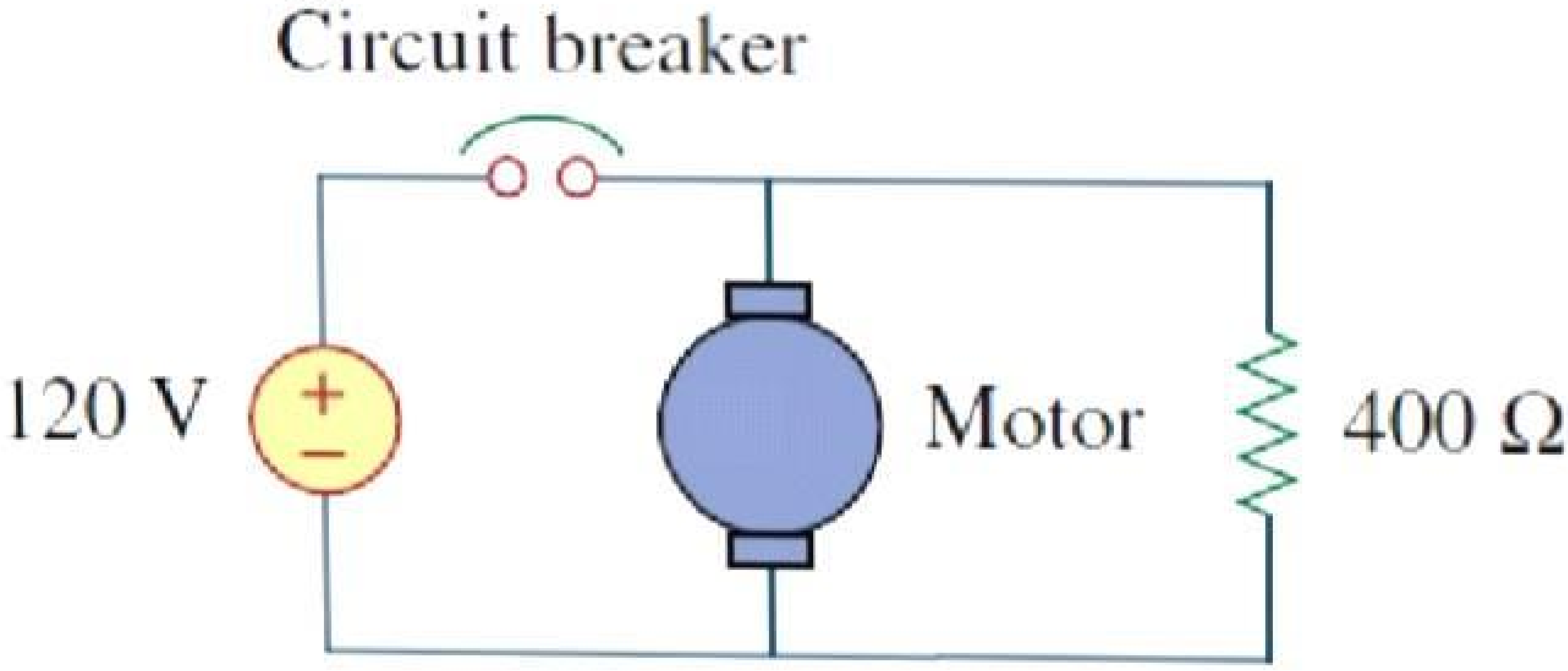
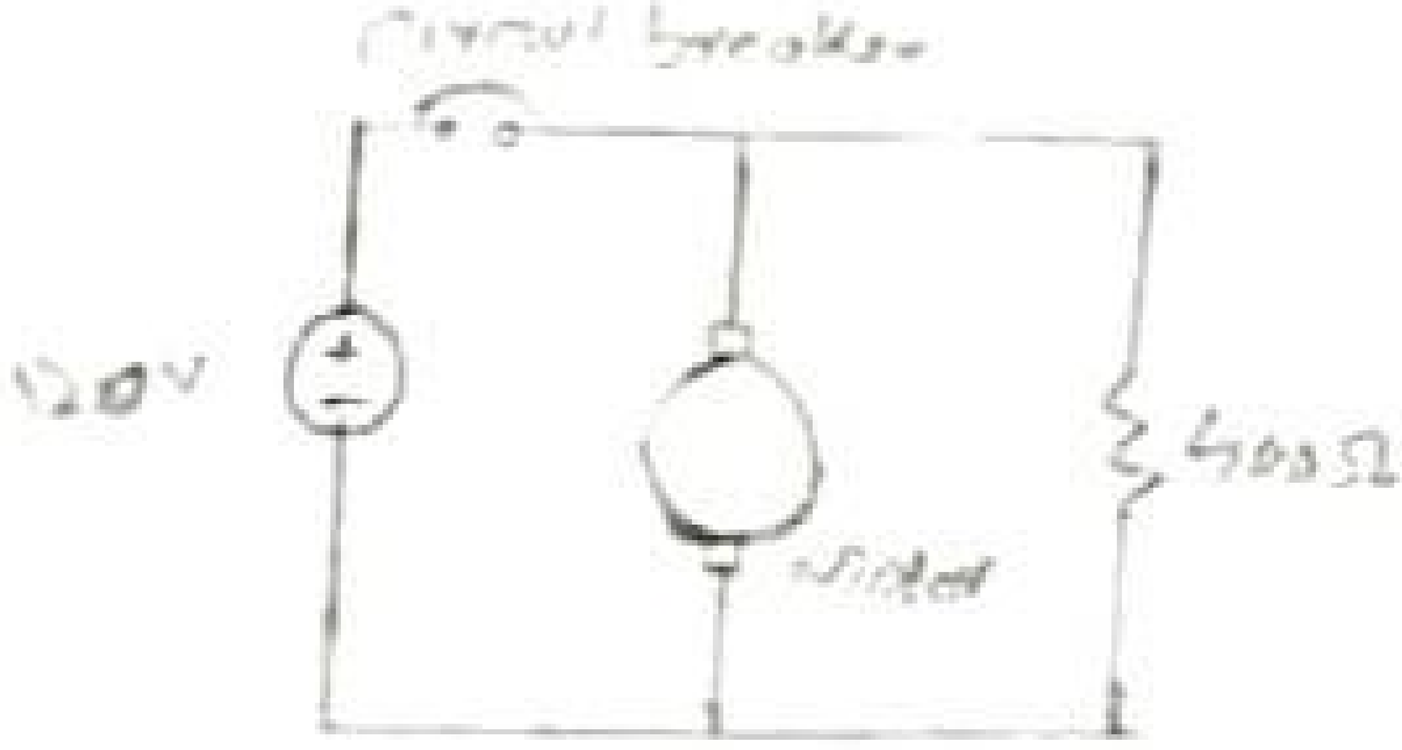


Figure 2

A 120-V dc generator energize a motor whose coil

the breaker is tripped.



Let the inductor current.

For $t < 0$

$$i(0) = \frac{12\cancel{0}}{10\cancel{0}} = \frac{12}{10}$$

$$\Rightarrow \frac{6}{5} = 1.2\,A$$

For $t > 0$ We have an RL circuit

$$\tau = \frac{L}{R} = \frac{50}{100+400}$$

$$\Rightarrow \frac{5\cancel{0}}{50\cancel{0}} \Rightarrow \frac{5}{50}$$

$$\Rightarrow \frac{1}{10} = 0.1$$

$$i(\infty) = 0$$

$$i(t) = i(\infty) + [i(0) - i(\infty)]\, e^{-t/\tau}$$

$$i(t) = 1.2\, e^{-10t}$$

At $t = 100\,ms = 0.1\,s$

$$i(0.1) = 1.2\, e^{-1} = 0.441\,A$$

which is the same as the current through the resistor

(B)

$$\tau = R_C m S = 60 \mu s$$

An integrator

$$T < 0.1 \quad \tau = 6 \mu s$$

$$T_{max} = 6 \mu s$$

Q3. The responses of a series *RLC* circuit are

$v_c(t) = 30 - 10e^{-20t} + 30e^{-10t}$ V

$i_L(t) = 40e^{-20t} - 60e^{-10t}$ mA

where v_c and i_L are the capacitor voltage and inductor curren respectively. Determine the values of R, L, C

Q3

The Response of ~~RLC~~ series RLC circuit . Determine the value of R, L, C

Series RLC Circuit

$$V_c(t) = 30 - 10e^{-20t} + 30e^{-10t} \text{ V}$$

$$V(t) = V_s + A_1e^{s_1t} + A_2e^{s_2t} \quad [\alpha > \omega]$$

$$40e^{-20t} - 60e^{-30t} \text{ mA}$$

$$\Leftrightarrow \quad i(t) = A_1e^{s_1t} + A_2e^{s_2t} \quad [\alpha > \omega_0]$$

Camparing these equ... we get

$V_s = 30$

$A_1 = -10$; $A_2 = 30$;

$S_1 = -20$; $S_2 = -10 \longrightarrow (a)$

$A_1' = 40$; $A_2' = -60$;

$S_1' = -20$; $S_2' = -10 \rightarrow (b)$

Step 2

Now Equ (a) & (b)

$S_1 = -\alpha + \sqrt{\alpha^2 + \omega_0^2}$ And $S_2 = -\alpha - \sqrt{\alpha^2 - \omega_0^2}$

$S_1 + S_2 = -2\alpha$ & $S_1S_2 = \omega_0^2$

$\left[\text{Where } \alpha = \frac{R}{2L} ; \omega_0 = \frac{1}{\sqrt{LC}}\right]$

$\Rightarrow \quad -30 = -2\alpha$

$\Rightarrow \quad \alpha = 15$

$\Rightarrow \quad \dfrac{R}{2L} = 15 \rightarrow (c)$

$200 = \omega_0^2 \Rightarrow \dfrac{1}{LC} = 200 \rightarrow (d)$

Step 3

$i(t) = C\dfrac{dv(t)}{dt} = C\left[200e^{-20t} - 300\,e^{-30t}\right]$

$\left(A_1' e^{s_1 t} + A_2' e^{s_2 t}\right) \times 10^{-3} A = C\left\{\left[200e^{-20t} - 300e^{-30t}\right]V\right.$

OR

$[s_1 = s_1' \quad s_2 = s_2']$

$\Rightarrow \quad 200C = A_1' = 40 \times 10^{-3}$

$\Rightarrow \quad C = 200 \times 10^{-6} F \Rightarrow C = 200 \mu F$

Using Equ (c) & (d)

$L = \dfrac{1}{200C} F = \dfrac{1}{200 \times 200 \times 10^{-6}} \Rightarrow L = 25 H$

& $\quad R = 30L = 30 \times 25 = 750 \Omega$

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Q4. The circuit in Fig. 3 is the electrical analog of body functions used in medical schools to study convulsions. The analog is as follows:

C_1 = Volume of fluid in a drug

C_2 = Volume of blood stream in a specified region

R_1 = Resistance in the passage of the drug from the input to the blood stream

R_2 = Resistance of the excretion mechanism, such as kidney, etc.

$v0$ = Initial concentration of the drug dosage

$v(t)$ = Percentage of the drug in the blood stream

Find v(t) for t>0 given that $C_1 = 0.5\mu F$, $C_2 = 5\mu F$, $R_1 = 5M\Omega$, $R_2 = 2.5\ M\Omega$ and $v_0 = 60u(t)$ V

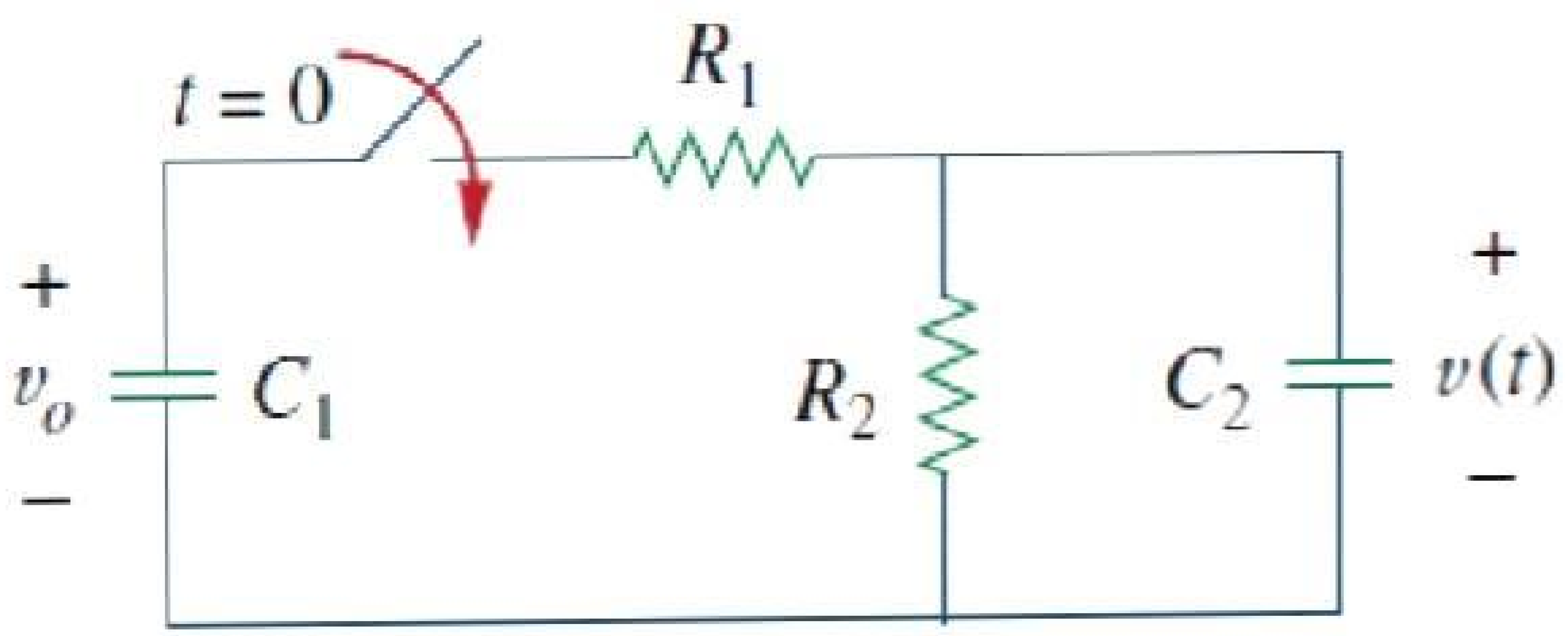
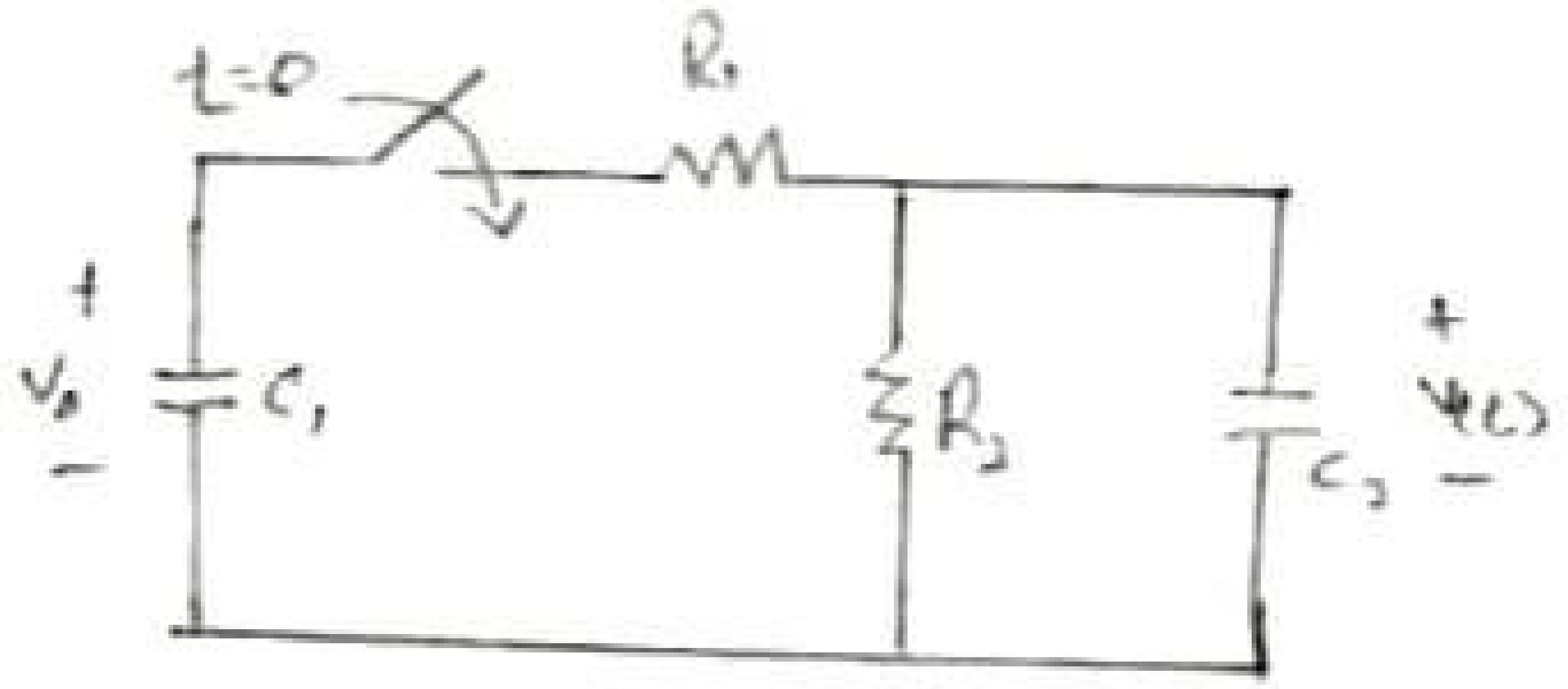


Figure 3

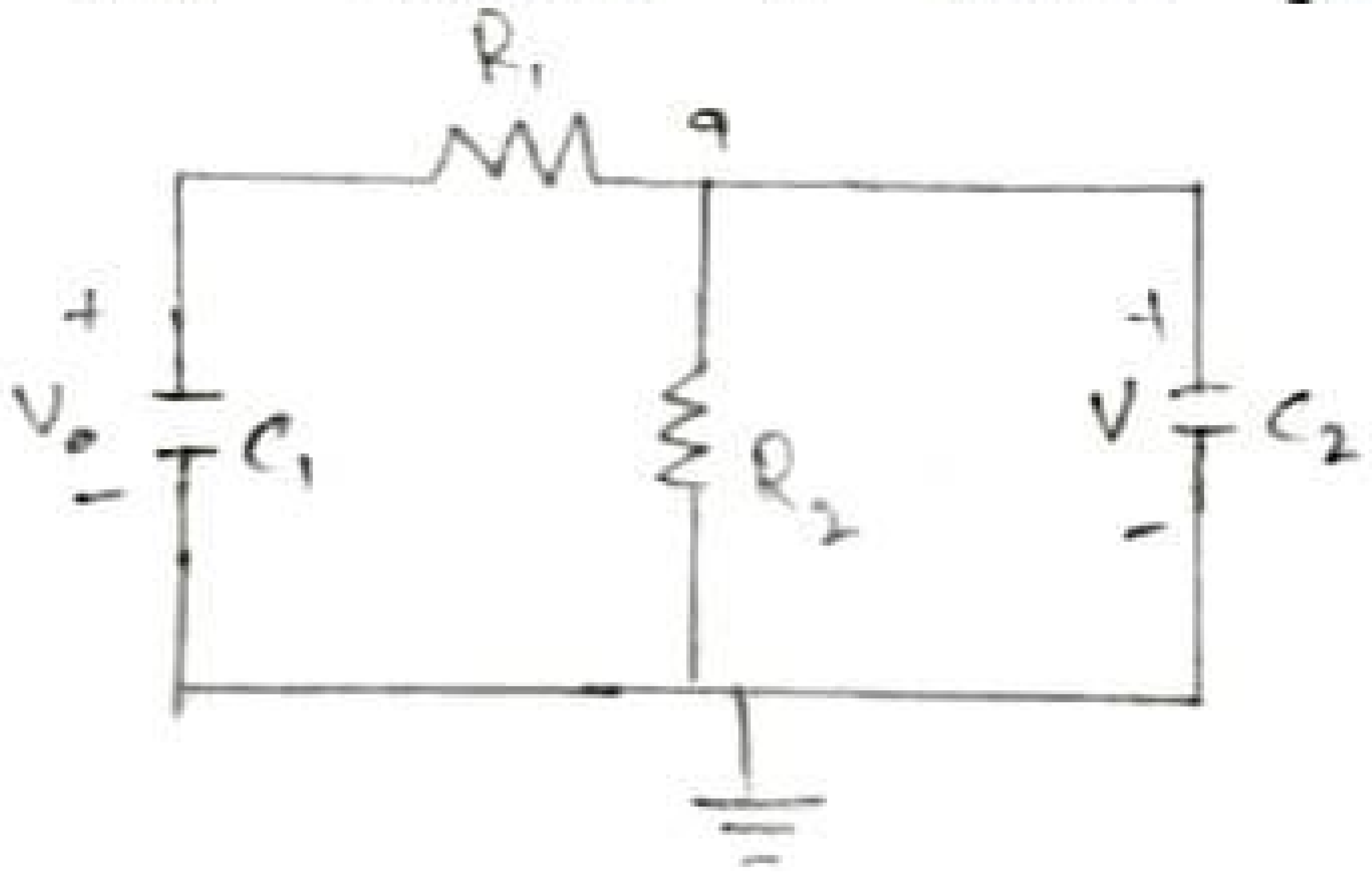
Qu

The circuit in Fig. 3 is the electrical analog of body Function



For $t = 0-$, $v(0) = 0$

For $t > 0$ the circuit is shown below.



$$V_0 - v/R_1 = (v/R_2) + C_2 \, dv/dt$$

$$V_0 = v(1 + R_1/R_2) + R_1 C_2 \, dv/dt$$

$$60 = (1 + 5/2.5) + (5 \times 10^6 \times 5 \times 10^{-6}) dv/dt$$

$$60 = 3v + 25 \, dv/dt$$

$$v(t) = V_s + [A e^{-3t/25}]$$

Where

$3V_s = 60$ Yields $V_s = 20$

$$v(0) = \quad 0 = 20 + A \text{ or } A = -20$$

$$v(t) = \quad 20\left(1 - e^{-3t/25}\right) \text{V}.$$

Q5. A power transmission system is modeled as shown in Fig. 4. Given the source voltage and circuit elements

Source voltage $V_s = 115 \angle 0$ V,

Source impedance $Z_s = 1 + j0.5\ \Omega$,

Line impedance $Z_l = 0.4 + j0.3\ \Omega$,

Load impedance $Z_L = 23.2 + j18.9\ \Omega$,

find the load current I_L

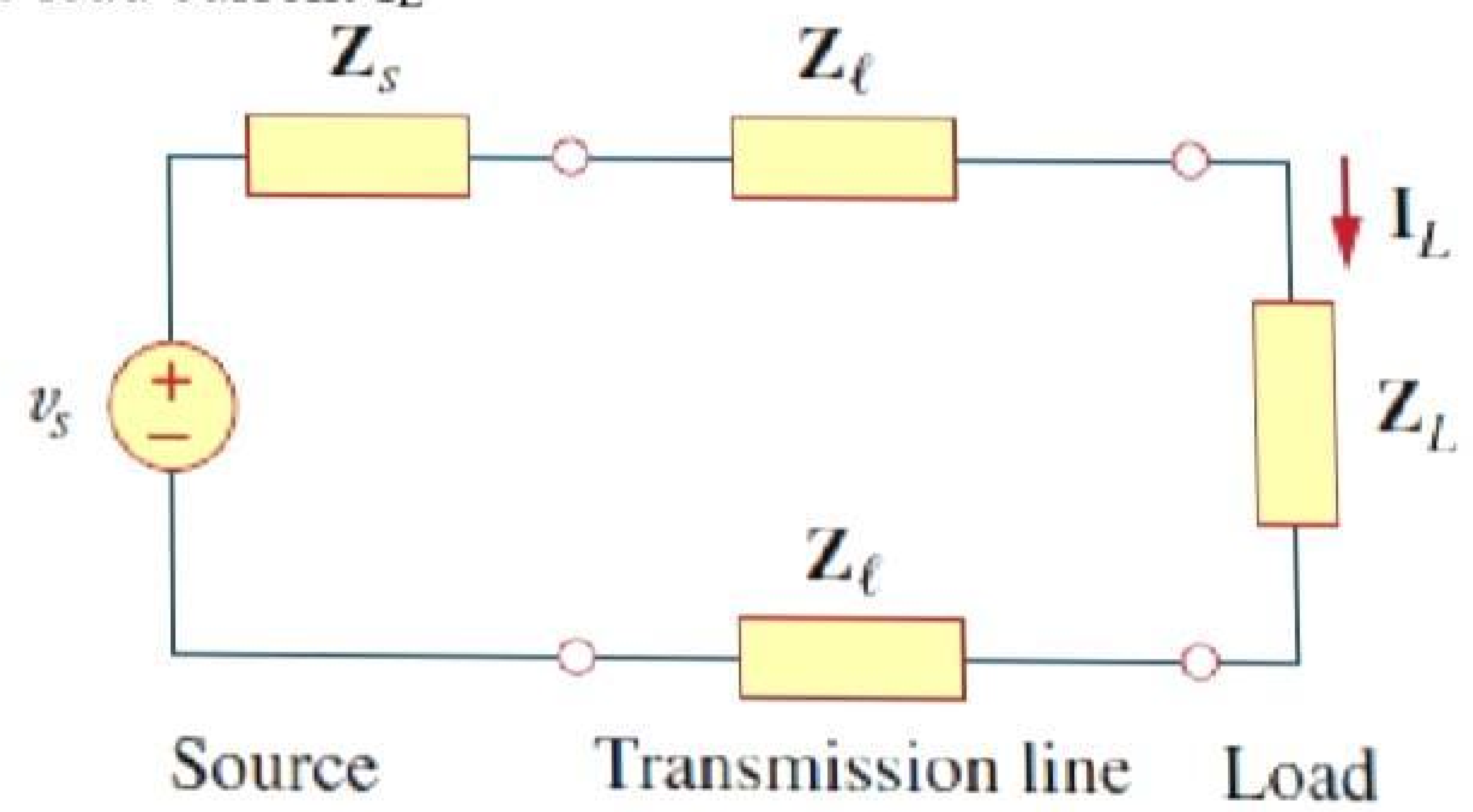
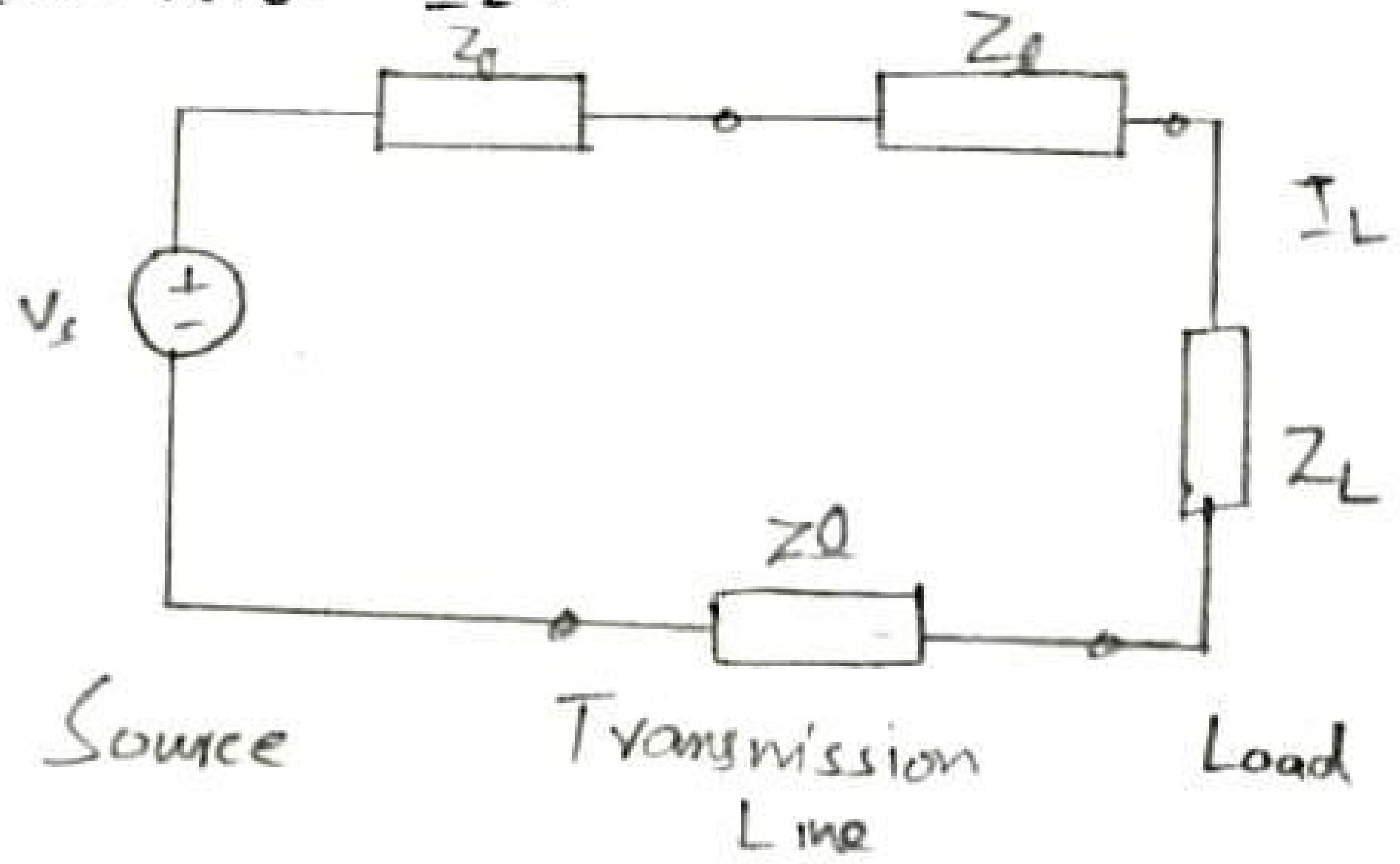


Figure 4

P5

A power transmission system is modeled as shown. . . - - - - Find the load current I_L.



$$Z = Z_a + 2Z + Z_e$$

$$= (1+0.8+23.2) + j(0.5+0.6+18.9)$$

$$Z = 25 + j20$$

$$I_L = \frac{V_s}{Z} = \frac{115\angle 0}{32.02\angle 38.66^\circ}$$

$$I_L = 3.592\angle -38.66^\circ \text{ A}$$

Q 6	For the circuit in Fig. 5, find the average, reactive, and complex power delivered by the dependent current source.

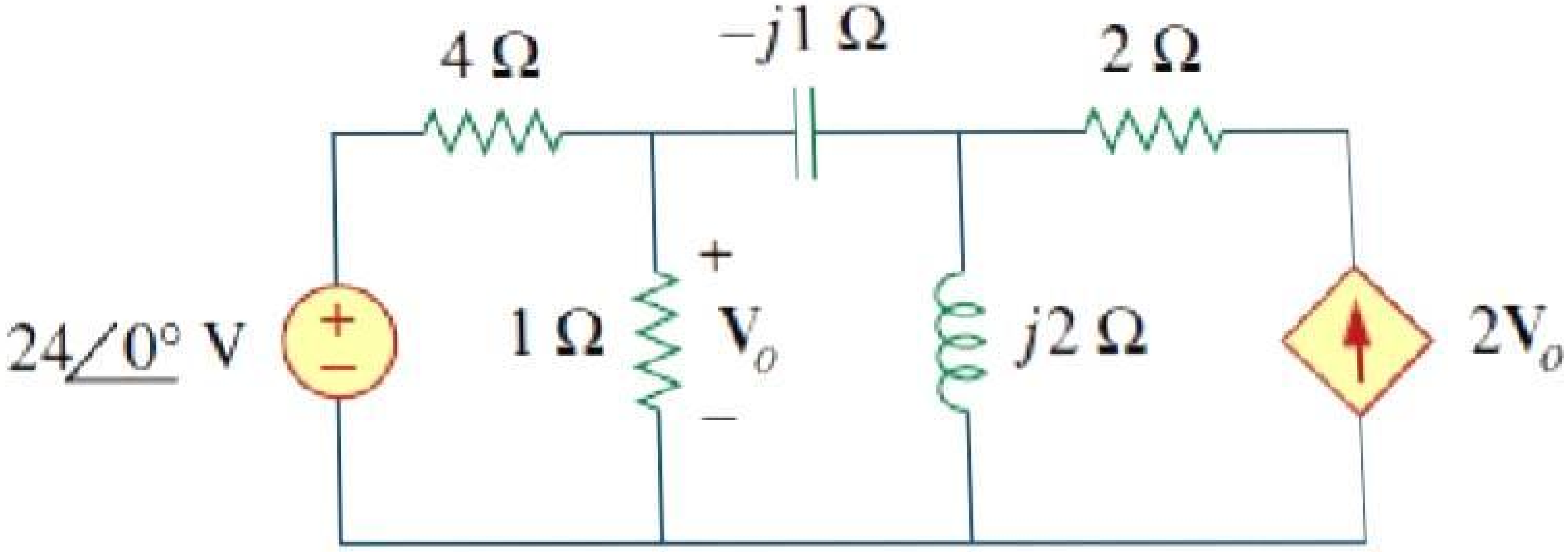
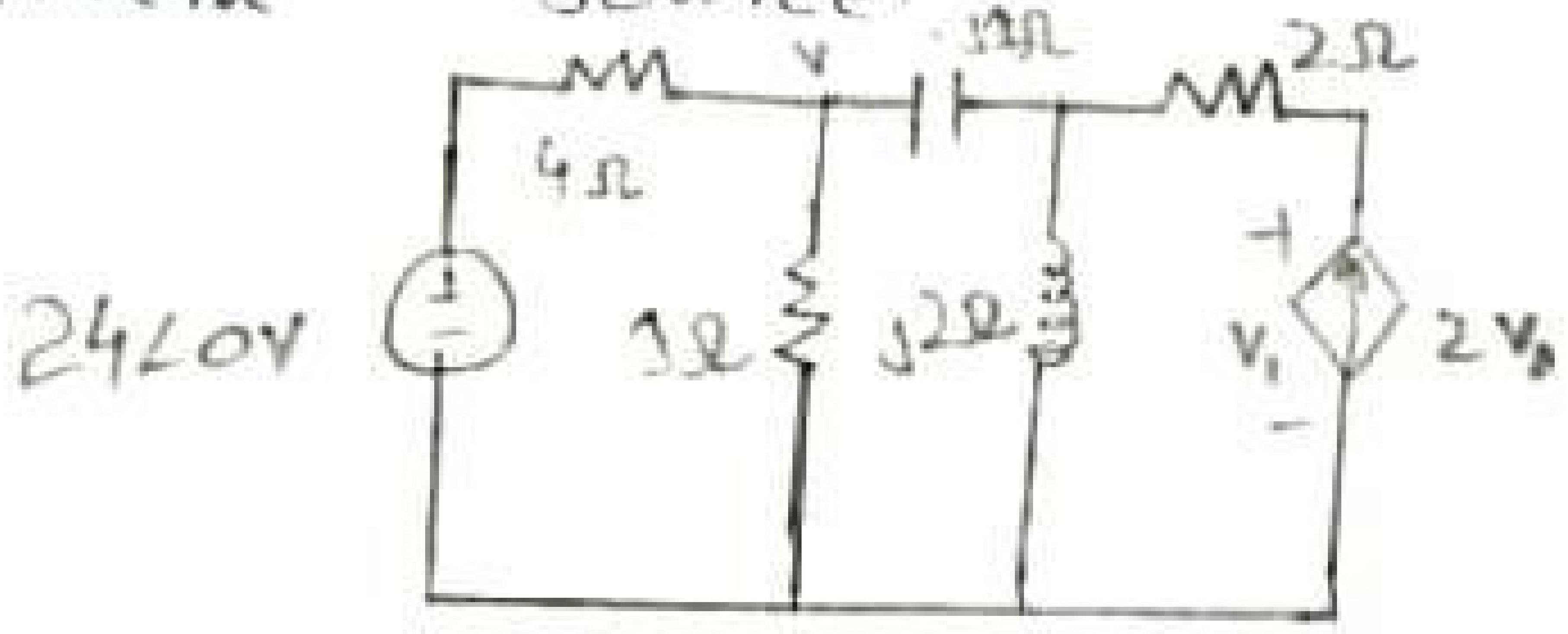


Figure 5

For the circuit in (4b) Fig. 5 find the
ave dependent
current source.



Consider the circuit as shown

At node 0

$$\frac{24-V_0}{4} = \frac{V_0}{1} + \frac{V_0-V_1}{-j}$$

$$24 = (5+j4)V_0 - j4V_1 \quad \rightarrow (1)$$

At node 1

$$\frac{V_0 - V_1}{-j} + 2V_0 = \frac{V_1}{j2}$$

$$V_1 = (2-j4)V_0 \quad \rightarrow (2)$$

Substituting (2) into (1)

$$24 = (5+j4-j8-16)V_0$$

$$V_0 = \frac{-24}{11+j4}, \quad V_1 = \frac{(-24)(2-j4)}{11+j4}$$

Voltage across the dependent
Source is

$$V_2 = V_1 + (2)(2V_0) = V_1 + 4V_0$$

$$V_2 = \frac{-24}{11+j4}\left(2-\cancel{48}\,j4+\right) = \frac{(-24)(6-j4)}{11+j4}$$

$$S = \frac{1}{2}V_2 I^* = \frac{1}{2}V_2\left(2V_0^*\right)$$

$$S = \frac{(-24)(6-j4)}{11+j4}\cdot\frac{-24}{11-j4}$$

$$= \left(\frac{576}{137}\right)(6-j4)$$

$$S = 25.23 - j16.82 \text{ VA.}$$

Q 7		A balanced Y-load is connected to a 60-Hz three-phase source with $V_{ab} = 240 \angle 0° $ V. The load has pf = 0.5 lagging and each phase draws 5 kW. (a) Determine the load impedance Z_Y . (b) Find I_a, I_b, and I_c.

A balanced Y- load to a 60Hz three phase

(a) Determine the load impendence

(b) Find I_a I_b & I_c.

(a)

$$|V_{ab}| = \sqrt{3}V_p = 240 \rightarrow V_p = \frac{240}{\sqrt{3}} = 138.56$$

$$V_{an} = V_p \angle -30^\circ$$

$$Pf = 0.5 = \cos\theta \rightarrow \theta = 60^\circ$$

$$P = S\cos\theta \rightarrow S = \frac{P}{\cos\theta} = \frac{5}{0.5} = 10KVA$$

$$Q = S\sin\theta = 10\sin 60 = 8.66$$

$$S_p = 5 + j8.66KVA$$

But

$$S_p = \frac{V_p^2}{Z_p} \rightarrow Z_p^* = \frac{V_p^2}{S_p} = \frac{138.56^2}{(5+j8.66)\times 10^3}$$

$$= 0.96 - j1.663$$

$$Z_p = 0.96 + j1.663\,\Omega$$

(b) $$I_a = \frac{V}{Z_Y} = \frac{138.56\angle -30^\circ}{0.96 + j1.6627} = 72.17\angle -90^\circ A$$

$$I_b = I_a \angle -120^\circ = 72.17\angle -210^\circ A$$

$$I_c = I_a \angle +120 = 72.17\angle 30^\circ A.$$