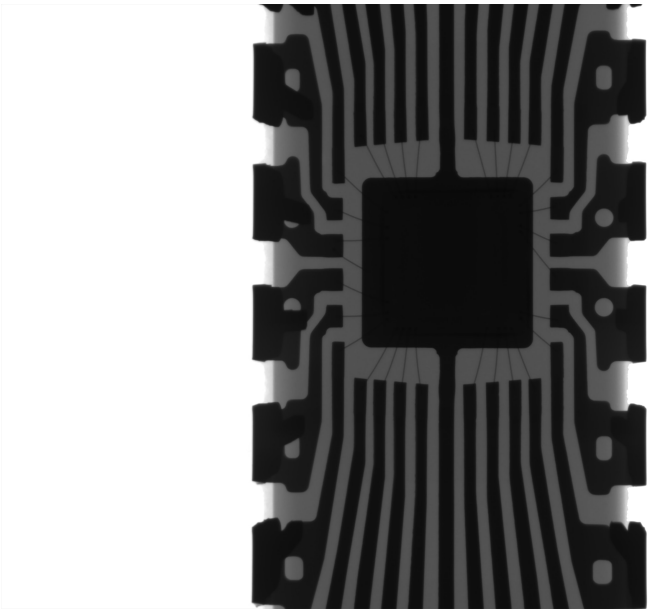
Electric Circuits Exercises



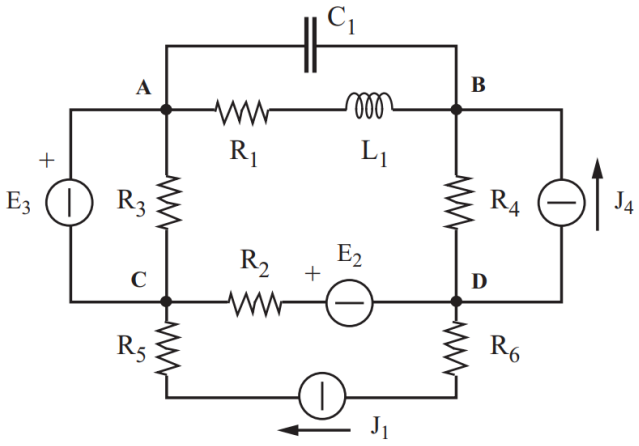
GitHub: https://github.com/klaids

Last Update on: 27/05/2021

Indice

1 DC CIRCUIT

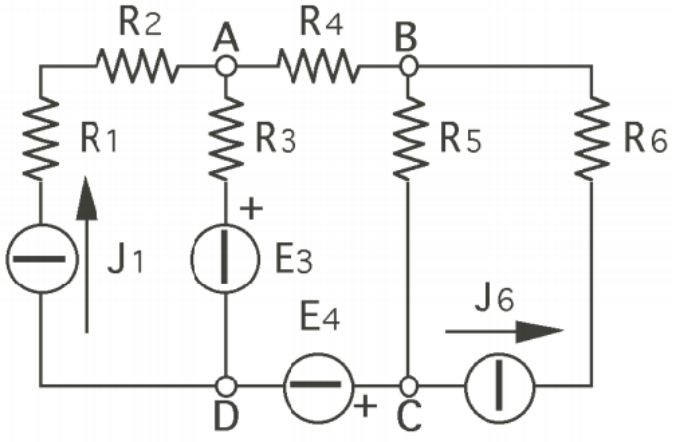
1.1 DC-01



$R_1 = 2\ \Omega$	$R_2 = 2\ \Omega$	$R_3 = 5\ \Omega$	$R_4 = 1\ \Omega$
$R_5 = 2\ \Omega$	$R_6 = 1\ \Omega$	$C_1 = 200\ \mu F$	$L_1 = 10\ mH$
$E_3 = 40\ V$	$J_1 = 20\ A$	$J_4 = 5\ A$	$P_{R2} = 0\ W$

Solution:
I_{R3}=8 A, I_{E3}=28 A, I_{R4}=25 A, U_{J4}=25 V
I_{R1}=20 A, U_{C1}=40 V, E_2=25 V, U_{J1}=85 V
P_{R3}=320 W, P_{R4}=625 W, P_{E3}=1120 W, P_{J4}=125 W
W_{C1}=0.16 J, W_{L1}=2 J, P_{J1}=1700 W

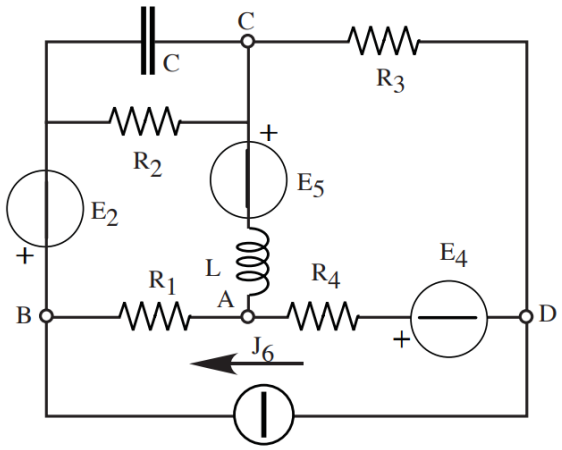
1.2 DC-02



$R_1 = 1.5\ \Omega$	$R_2 = 2.5\ \Omega$	$R_3 = 4\ \Omega$	$R_4 = 5\ \Omega$	$R_5 = 8\ \Omega$
$R_6 = 3.5\ \Omega$	$J_1 = 5\ A$	$E_3 = 100\ V$	$E_4 = 50\ V$	$P_{J1} = 100\ W$

Solution:
U_{J1} = 20 V, U_{AD} = 0 V, J_6 = -55 A, U_{J6} = -392.5 V, P_{R3} = 2500 W
I_{E4} = -30 A, P_{R4} = 4500 W, P_{J6} = 21587.5 W, U_{BC} = -200 V

1.3 DC-03



$$R_1 = 20\ \Omega \quad R_2 = 40\ \Omega \quad R_3 = 50\ \Omega \quad R_4 = 20\ \Omega \quad L = 10\ mH$$
$$C = 20\ \mu F \quad E_2 = -900\ V \quad E_4 = 100\ V \quad E_5 = 800\ V \quad J_6 = 25\ A$$

Assuming $\mathrm{V_A} = 0$, **determine**:

- $\mathrm{V_B}$,$\mathrm{V_C}$,$\mathrm{V_D}$ potentials.
- The values of the stored energies $\mathrm{W_L}$ and $\mathrm{W_C}$ respectively from the inductor and capacitor.
- The value of the power $\mathrm{P_{R_3}}$ absorbed by resistor $\mathrm{R_3}$.

Solution:

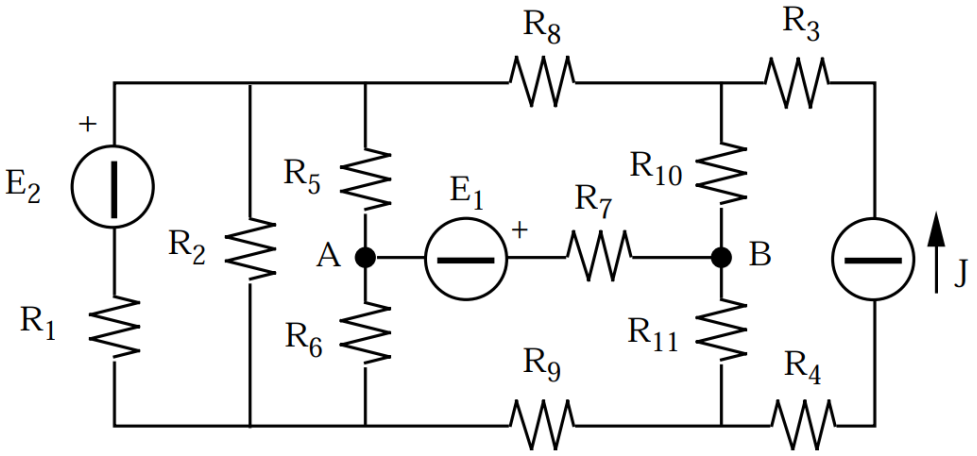
$$J_2 = \tfrac{E_2}{R_2} = -22,5\ A \qquad G_2 = \tfrac{1}{R_2} = 1/40\ S$$
$$J_4 = \tfrac{E_4}{R_4} = 5\ A \qquad G_4 = \tfrac{1}{R_4} = 1/20\ S$$

$$\begin{cases} J_6 + J_2 = V_\mathrm{B}\ (G_1 + G_2) - V_\mathrm{C} G_2 \\ I_{\mathrm{E_5}} - J_2 = -V_\mathrm{B} G_2 + V_\mathrm{C}\ (G_2 + G_3) - V_\mathrm{D} G_3 \\ -J_4 - J_2 = -V_\mathrm{C} G_3 + V_\mathrm{D}\ (G_3 + G_4) \\ V_\mathrm{C} - V_\mathrm{A} = E_5 \end{cases}$$

$$\begin{cases} V_\mathrm{B} = \dfrac{J_2 + J_6 + E_5 G_2}{G_1 + G_2} = 300\ V \\ V_\mathrm{C} = E_5 = 800\ V \\ V_\mathrm{D} = \dfrac{-J_4 - J_6 + E_5 G_3}{G_3 + G_4} = -200\ V \\ I_{\mathrm{E_5}} = J_2 - V_\mathrm{B} G_2 + V_\mathrm{C}(G_2 + G_3) - V_\mathrm{D} G_3 = 10\ A \end{cases}$$

$$U_\mathrm{C} = E_2 + (V_\mathrm{C} - V_\mathrm{B}) = -400\ V$$
$$W_\mathrm{C} = \frac{1}{2} C U_\mathrm{C}^2 = 1,6\ J$$
$$W_\mathrm{L} = \frac{1}{2} L I_\mathrm{L}^2 = \frac{1}{2} L I_{\mathrm{E_5}}^2 = 0,5\ J$$
$$P_{\mathrm{R_3}} = (V_\mathrm{C} - V_\mathrm{D})^2\ G_3 = 20\ \mathrm{kW}$$

1.4 DC-04



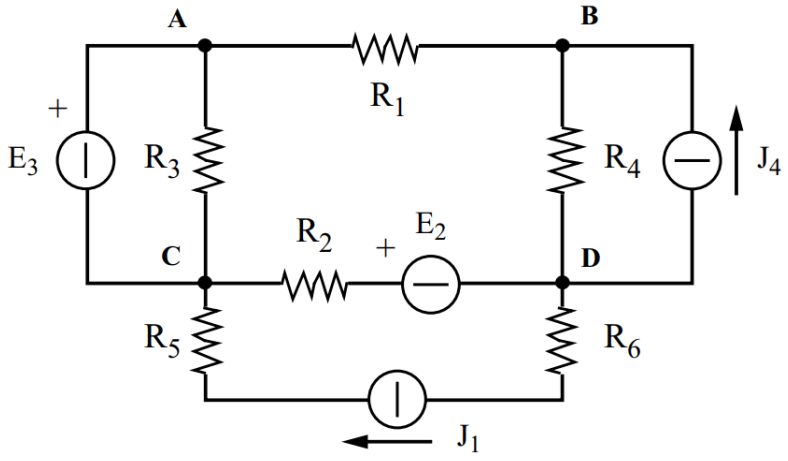
$R_1 = 60\ \Omega$	$R_2 = 60\ \Omega$	$R_3 = 15\ \Omega$	$R_7 = 50\ \Omega$	$R_4 = 15\ \Omega$
$R_5 = 15\ \Omega$	$R_6 = 15\ \Omega$	$R_8 = 6\ \Omega$	$R_9 = 4\ \Omega$	$R_{10} = 10\ \Omega$
$R_{11} = 10\ \Omega$	$E_2 = 180\ V$	$J = 9\ A$	$P_{R7} = 0\ W$	

Determine:

- E_1.
- P_{J1}, P_{E2}.
- P_{R8}, P_{R9}.

Solution:
$E_1 = 3$ V, $P_{J1} = 3510$ W, $P_{E2} = 270$ W, P_{R8} 54 W, $P_{R9} = 36$ W

1.5 DC-05



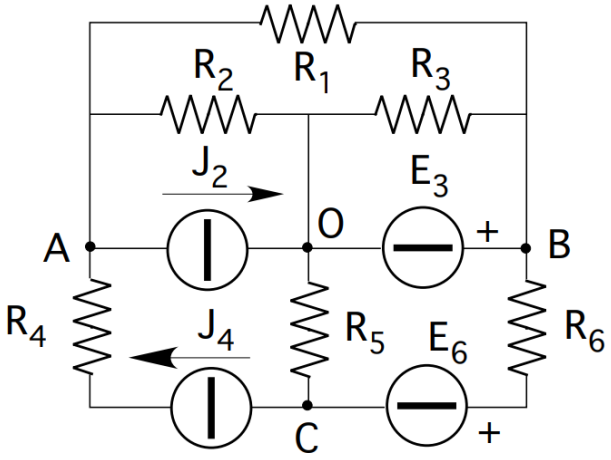
$R_1 = 2\ \Omega$	$R_2 = 2\ \Omega$	$R_3 = 5\ \Omega$	$R_4 = 1\ \Omega$	$R_5 = 2\ \Omega$
$R_6 = 1\ \Omega$	$E_3 = 80\ V$	$J_1 = 40\ A$	$J_4 = 10\ A$	$P_{R2} = 0\ W$

Determine:

- P_{R3}, P_{R4}
- P_{E3}, P_{J4}.
- E_2.
- P_{J1}.

Solution:
$P_{R3} = 1280$ W, $P_{R4} = 2500$ W, $P_{E3} = 4480$ W, $P_{J4} = 500$ W, $E_2 = 50$ V, $P_{J1} = 6800$ W

1.6 DC-06



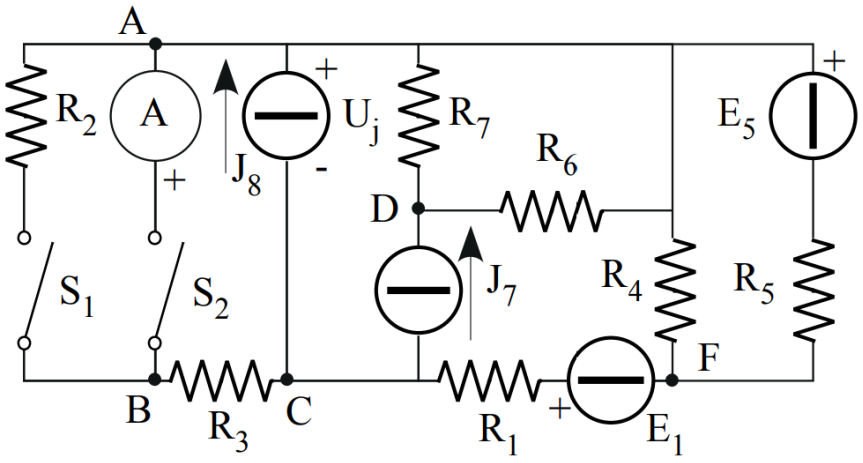
$R_1 = 20\ \Omega$ $R_2 = 30\ \Omega$ $R_3 = 30\ \Omega$ $R_4 = 30\ \Omega$ $R_5 = 20\ \Omega$
$R_6 = 12\ \Omega$ $J_2 = 17.5\ A$ $J_4 = 4\ A$ $E_3 = 120\ V$ $E_6 = -168\ V$

Assuming $V_O = 0$ V, **determine**:

- V_A,V_B,V_C potentials.
- P_{J2}, P_{E3}, P_{J4}, P_{E6}.

Solution:
V_A = -90 V, $V_B = 120$ V, $V_C = 150$ V, $P_{J2} = 1575$ W, $P_{E3} = 3120$ W, P_{J4} = -480 W
$P_{E6} = 1932$ W.

1.7 DC-07



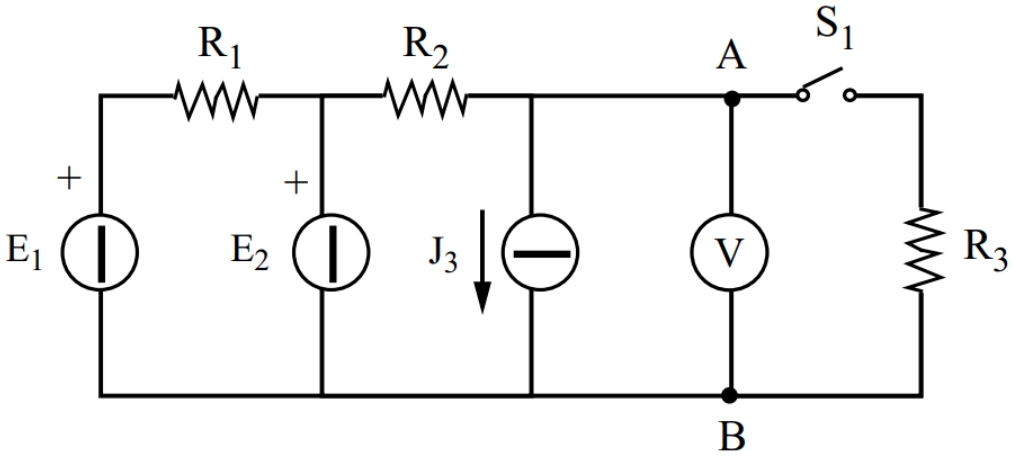
$I_A = 20\ A \quad P_{R2} = 5120\ W \quad R_2 = 20\ \Omega\ R_3 = R_5 = R_1 \quad R_4 = R_6 = R_7 = 2R_1$

I_A when S1 open and S2 close. P_{R2} when S1 close and S2 open, **determine**:

- R_1.
- U_J when both switches are open.
- P'_{R3} and U'_j when S1 close and S2 open.

Solution:
$R_1 = 30\ \Omega$, U_J = -1600 V, P'_{R3} = 7680 W, U'_j = -800 V.

1.8 DC-08



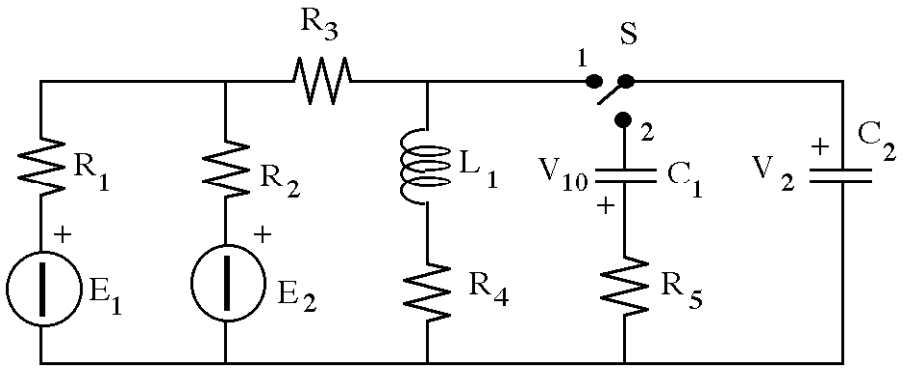
$E_1 = 120\ V \quad J_3 = 4\ A \quad R_1 = 10\ \Omega$
$R_2 = 10\ \Omega \quad R_3 = 20\ \Omega \quad U_V = 60\ V$

U_V measured when S_1 opened. **Determine**:

- E_2.
- P_{E_1}, P_{E_2} and P_{J_3} when S_1 opened.
- $U_V^{'}$ when S_1 closed.
- $P_{E_1}^{'}$, $P_{E_2}^{'}$ and $P_{J_3}^{'}$ when S_1 closed.

Solution:
$E_2 = 100\ V$, P_{E_1} = 240 W, P_{E_2} = 200 W, P_{J_3} = -240 W, $U_V^{'}$ = 40 V, $P_{E_1}^{'}$ = 240 W
$P_{E_2}^{'}$ = 400 W, $P_{J_3}^{'}$ = -160 W.

1.9 DC-09



$E_1 = 100\ V$	$E_2 = 200\ V$	$V_{10} = 150\ V$	$R_1 = 30\ \Omega$
$R_2 = 20\ \Omega$	$R_3 = 13\ \Omega$	$R_4 = 75\ \Omega$	$R_5 = 75\ \Omega$
$L_1 = 0.8\ H$	$C_1 = 200\ \mu F$	$C_2 = 100\ \mu F$	

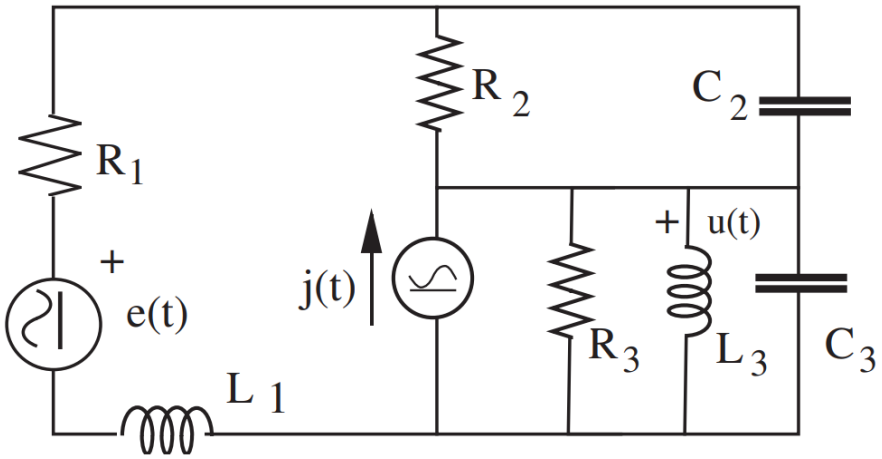
The circuit is in steady state when S is in 1. The capacitor C_1 is charged to voltage V_{10}. Then the switch is switched to the position 2. **Determine**:

- The energy W_0 stored overall by the circuit.
- The voltage $V_2^{'}$ at the ends of C_1 when S is in position 2.
- The electric work $\mathcal{L}_{R5}$ absorbed by resistor R_5 when S switched from 1 to 2.

Solution:
$W_0 = 4.25\ J$, $V_2^{'}$ = -60 V, $\mathcal{L}_{R5}$ = 2.43 J.

2 AC CIRCUIT

2.1 AC-01



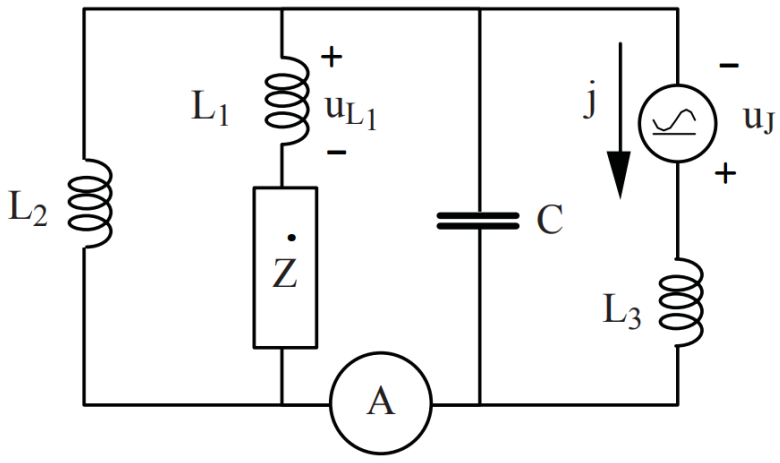
$j(t) = 30\ \sin(100t + \frac{\pi}{4})$ $e(t) = 300\sqrt{2}\ \sin(100t + \frac{\pi}{2})$ $R_1 = R_3 = 10\ \Omega$
$R_2 = 20\ \Omega$ $L_1 = 400\ mH$ $L_3 = 400\ mH$
$C_2 = 500\ \mu F$ $C_3 = 250\ \mu F$

Determine:

- $u(t)$
- P_{j} and Q_{j}
- P_{e} and Q_{e}

Solution:
$u(t) = 250\sqrt{2}\ \sin(100t + 0.9273)$, $P_{\mathrm{j}} = 5250\ W$, $Q_{\mathrm{j}} = 750\ var$, $P_{\mathrm{e}} = 1500\ W$
$Q_{\mathrm{e}} = 3.3448\ \cdot 10^{-13}\ var$

2.2 AC-02



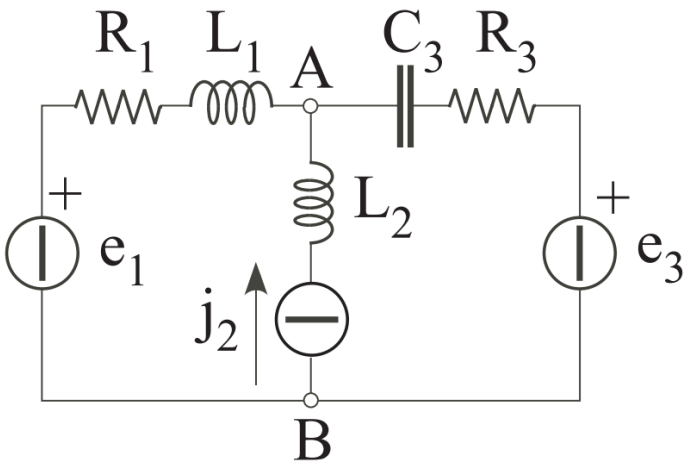
$$L_1 = 10\ mH \qquad L_2 = 15\ mH \quad L_3 = 15\ mH \quad C = 25\ \mu F$$
$$u_{\mathrm{L}_1}(t) = 320\ \cdot\ \sin\left(1000t + \frac{\pi}{4}\right) \qquad I_A = 0\ A$$

Determine:

- $\dot{Z} = R + jX$
- Q_{L_2}
- $j(t)$ and $u_{\mathrm{j}}(t)$
- Q_{L_3}

Solution:
$\dot{Z} = -25i,\ Q_{\mathrm{L}_2} = 7680\ var,\ j(t) = 12\ \cdot\ \sin\left(1000t + \frac{3}{4}\,\pi\right),\ u_{\mathrm{j}}(t) = 300\ \cdot\ \sin\left(1000t + \frac{\pi}{4}\ \right),$
$Q_{\mathrm{L}_3} = 1080\ var$

2.3 AC-03



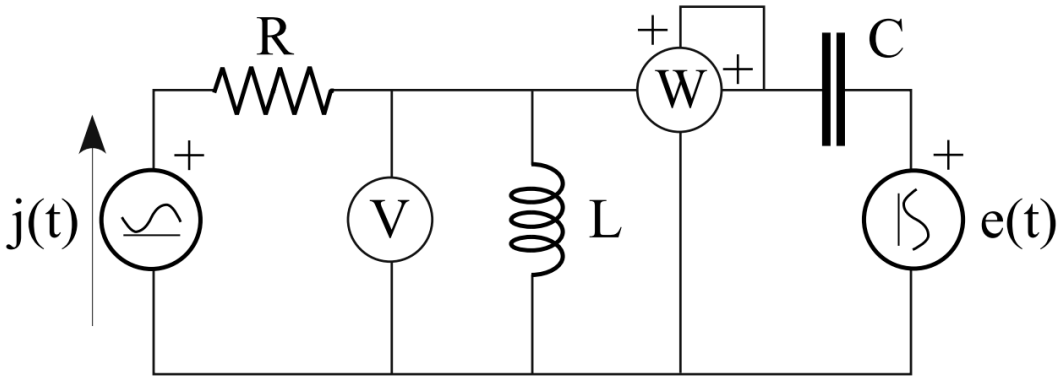
$$e_1(t) = 100\ \sin(1000t) \quad j_2(t) = 8\ \cos(1000t) \quad e_3(t) = 200\ \sin(1000t)$$
$$R_1 = 5\ \Omega \qquad R_3 = 10\ \Omega \qquad L_1 = 5\ mH$$
$$L_2 = 10\ mH \qquad C_3 = 100\ \mu F$$

Determine:

- P_{R_1} and P_{R_3}
- P_{E_1}, P_{J_2} and P_{E_3}
- S_{J_2}
- $i_{\mathrm{e}_3}(t)$

Solution:
$P_{\mathrm{R}_1} = 776\ W,\ P_{\mathrm{R}_3} = 848\ W,\ P_{\mathrm{E}_1} = -920\ W,\ P_{\mathrm{J}_2} = 704\ W,\ P_{\mathrm{E}_3} = 1840\ W,\ S_{\mathrm{J}_2} = 729.71$ VA,
$i_{\mathrm{e}_3}(t) = 13.023\ \sin(1000t + 0.043451)$

2.4 AC-04



$$e(t) = 100 \cdot \sqrt{2}\ \sin(200t) \quad j(t) = 10 \cdot \sqrt{2} \sin(200t + \pi) \quad R = 5\ \Omega$$
$$L = 100\ mH \qquad C = 500\ \mu F$$

Determine:

- The indication of the voltmeter U_V
- P_{W}
- $u_{\mathrm{j}}(t)$
- $i_{\mathrm{e}}(t)$
- P_{j} and Q_{j}

Solution:
$U_V = 282.84\,V$, $P_{\mathrm{W}} = 2000\,W$, $u_{\mathrm{j}}(t) = 353.55 \cdot \sin(200t + 0.9273)$, $i_{\mathrm{e}}(t) = 31.623 \cdot \sin(200t - 0.46365)$
$P_{\mathrm{j}} = -1500\ W$, $Q_{\mathrm{j}} = -2000\ var$