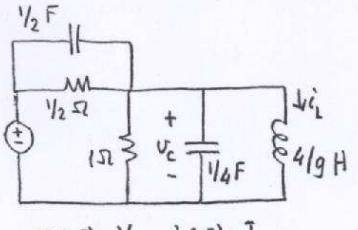
1) Solve the differential equation by Laplace transformation.

a) $\begin{bmatrix} D+4 & -3 \\ 2 & D-1 \end{bmatrix}\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}\begin{bmatrix} 6e^{t} \\ 12\cos(2t+75^\circ) \end{bmatrix}$, $\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$

b) $\begin{bmatrix} D+1 & 2 & 0 \\ -1 & D-1 & 1 \\ 0 & 0 & D+2 \end{bmatrix}\begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}\{4+3e^{2t}+2\cos(2t+30^\circ)\}$, $\begin{bmatrix} x_1(0) \\ x_2(0) \\ x_3(0) \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$

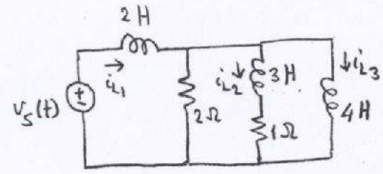
2) (i) Formulate the circuit by the indicated method.
(ii) Laplace transform the formulation equation.
(iii) Transform the circuit to the s-domain and formulate by the indicated method.
(iv) Express the Laplace transforms of formulation variables in terms of the Laplace transform of the input and the initial conditions.
(v) Find the zero input and impulse responses.



$v_c(0^-)=V_0$, $i_L(0^-)=I_0$

Modified node analysis

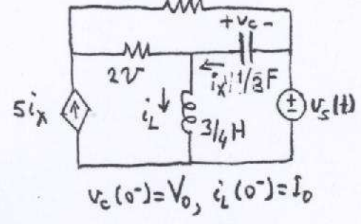
(a)



$i_{L_1}(0^-)=I_{01}$, $i_{L_2}(0^-)=I_{02}$, $i_{L_3}(0^-)=I_{03}$

Node analysis

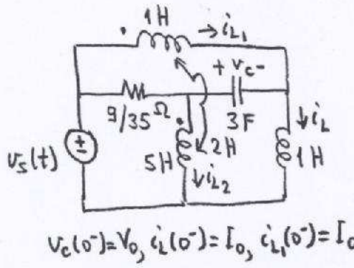
(b)



$v_c(0^-)=V_0$, $i_L(0^-)=I_0$

Node analysis

(c)

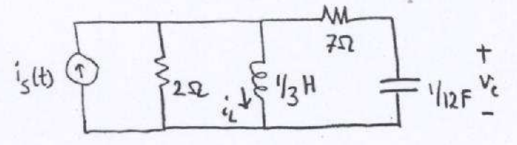


$v_c(0^-)=V_0$, $i_L(0^-)=I_0$, $i_{L_1}(0^-)=I_{01}$, $i_{L_2}(0^-)=I_{02}$

Mesh analysis

(d)

3)



$v_c(0^-)=V_0,\ i_L(0^-)=I_0$

a) Express $V_c(s)$ and $I_L(s)$ in terms of $I_s(s)$, V_0 and I_0.

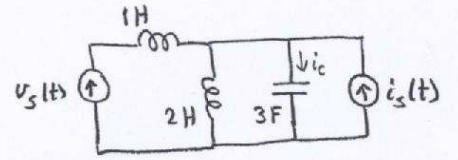
b) Find the differential equations satisfied by $v_c(t)$ and $i_L(t)$.

c) For $V_0=12$ V and $I_0=6$ A find the zero input responses for $v_c(t)$ and $i_L(t)$.

d) Find the impulse and step responses for $v_c(t)$ and $i_L(t)$.

e) For $i_s(t)=2\cos(4t+45°)$ A find the zero state responses for $v_c(t)$ and $i_L(t)$.

4)



The initial conditions are zero at $t=0^-$.

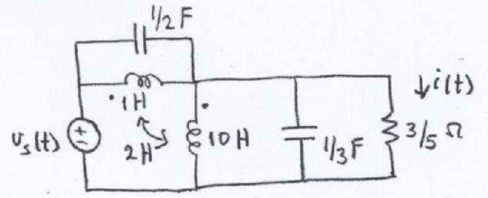
a) Express $I_c(s)$ in terms of $V_s(s)$ and $I_s(s)$.

b) Find the differential equation satisfied by $i_c(t)$.

c) For $v_s(t)=6\,\delta(t)$ V and $i_s(t)=2u(t)$ A find $i_c(0^+)$ directly from the circuit and also using the initial value theorem.

d) For $v_s(t)=6\delta(t)$ V and $i_s(t)=2u(t)$ A find $i_c(t)$ for $t\geq 0$.

5)



The initial conditions are zero at $t=0^-$.

a) Obtain the transfer function $Y_T(s)=I(s)/V_s(s)$.

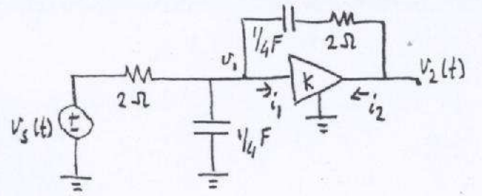
b) Plot the pole/zero diagram.

c) Find $i(0^+)$ and $i(\infty)$ directly from the circuit and also using the initial and final value theorems. for

(i) $v_s(t)=\delta(t)$ V, (ii) $v_s(t)=u(t)$ V.

d) Find the impulse and step responses.

6)



$$\begin{bmatrix} i_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ K & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ i_2 \end{bmatrix}$$

$K > 1$

For K (i) 2, (ii) 3, (iii) 4, (iv) 5 :

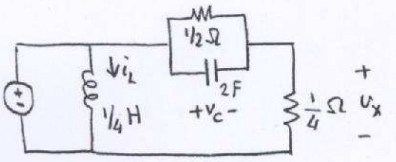
a) Find the transfer function $H(s) = V_2(s)/V_s(s)$.

b) Plot the pole/zero diagram.

c) Find the impulse and step responses.

d) Find the zero state responses for $v_s(t) = e^{2t}\ V$, $v_s(t) = \cos(3t)\ V$, $v_s(t) = \cos(2t)\ V$.

7) Find the indicated variables.

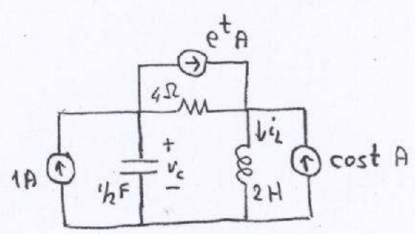


$i_s(t) = 4u(t) + 8\delta(t)$ A

$v_c(0^-) = 1$ V, $i_L(0^-) = 4$ A

$v_x(t)$

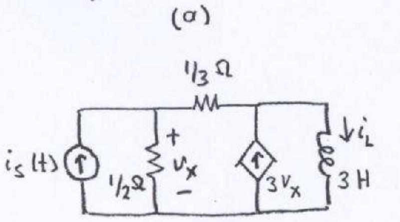
(a)



$v_c(0) = 6$ V, $i_L(0) = -1$ A

$v_c(t)$, $i_L(t)$

(b)

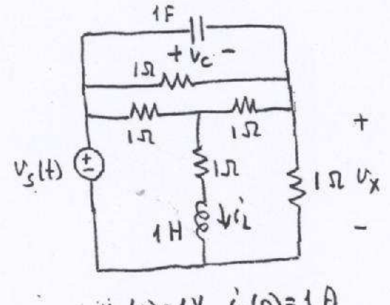


$i_s(t) = 5\cos(2t - 24°)$ A

$i_L(0) = 2$ A

$i_L(t)$, $v_X(t)$

(c)

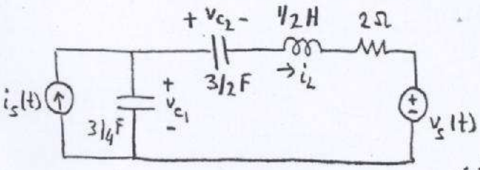


$v_c(0) = 1$ V, $i_L(0) = 1$ A

(i) $v_s(t) = e^{-3t}$ V, (ii) $v_s(t) = e^{-2t}$ V

$v_x(t)$

(d)

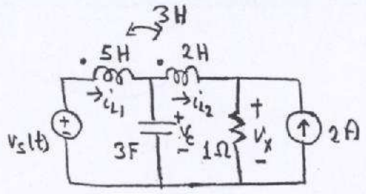


$i_s(t) = 4\sin(2t+30^\circ)\ A$, $v_s(t) = 3e^{-4t}\ V$

$v_{c_1}(0) = 2\ V$, $v_{c_2}(0) = 5\ V$, $i_L(0) = 3\ A$

$v_{c_1}(t)$, $i_L(t)$

(e)



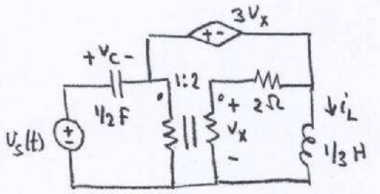
$i_{L_1}(0^-) = 2A$, $i_{L_2}(0^-) = -4A$, $v_c(0^-) = 2V$

(i) $v_s(t) = 2u(t) - 3\delta(t)\ V$

(ii) $v_s(t) = 4\sin(3t)\ V$

$v_x(t)$

(f)

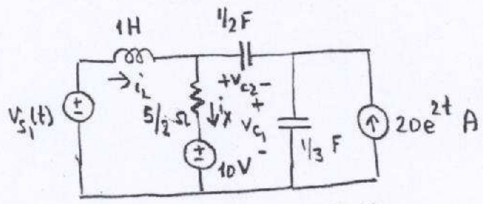


$v_s(t) = 6\cos(2t+10^\circ)\ V$

$v_c(0) = 4\ V$, $i_L(0) = -3\ A$

$v_x(t)$

(g)



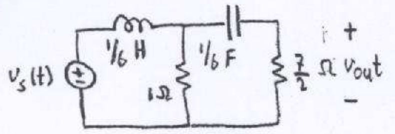
$v_{s_1}(t) = 10\cos(2t+45^\circ)\ V$

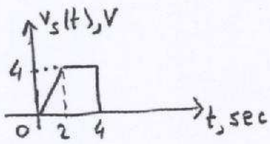
$i_L(0) = 2A$, $v_{c_1}(0) = 1\ V$, $v_{c_2}(0) = -4\ V$

$i_x(t)$, $v_{c_1}(t)$

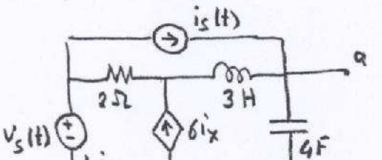
(h)

8) Find the zero state response.



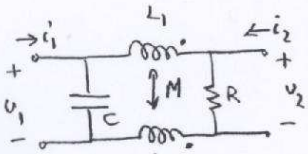


9)



Zero initial conditions.
Obtain the s-domain Thevenin and Norton equivalent circuits.

10)



Zero initial conditions.

$$\begin{bmatrix} V_1(s) \\ V_2(s) \end{bmatrix} = \begin{bmatrix} Z_{11}(s) & Z_{12}(s) \\ Z_{21}(s) & Z_{22}(s) \end{bmatrix} \begin{bmatrix} I_1(s) \\ I_2(s) \end{bmatrix}$$

Find the impedance functions $Z_{11}(s)$, $Z_{12}(s)$, $Z_{21}(s)$, $Z_{22}(s)$.