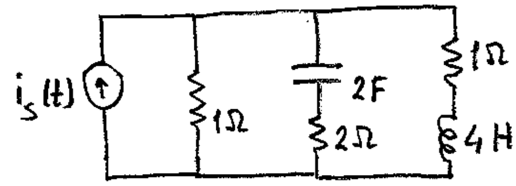
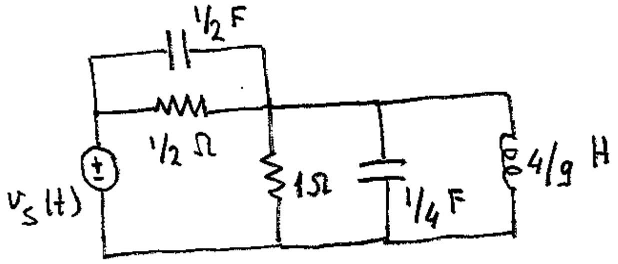
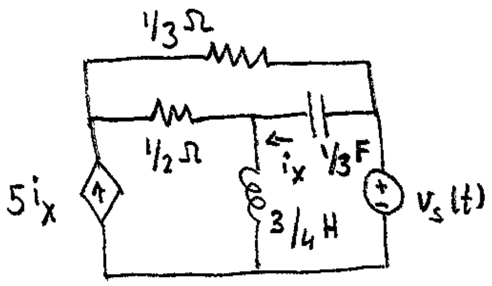
1) Obtain in matrix form (i) the polynomial node equation, (ii) the node equation, (iii) the mesh equation, (iv) the state equation.



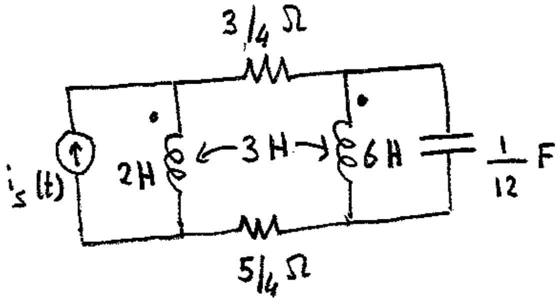
(a)



(b)

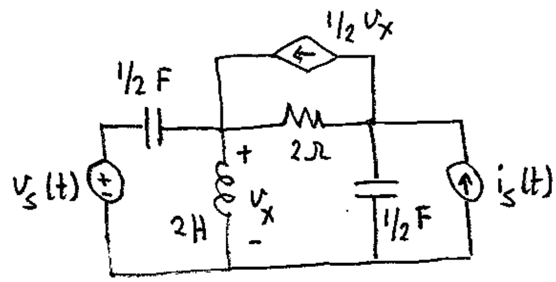


(c)

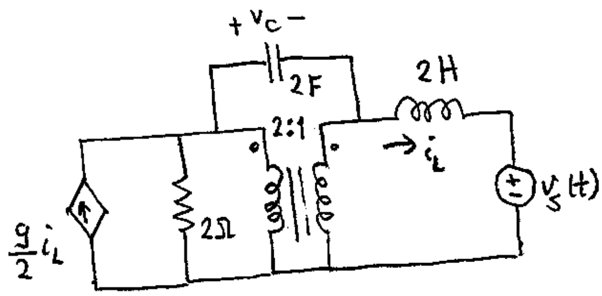


(d)

2) Obtain in matrix form (i) the polynomial node equation, (ii) the state equation.



(a)



(b)

3) Given the differential equation

$$(D^3+D^2+4D+4)\,x(t)=(2D+4)\,u_s(t)$$

{ $u_s(t)$ is the input. }

(a) Find the homogeneous solution.

(b) Find the zero-input solution given $x(0)=5$, $\dot{x}(0)=1$, $\ddot{x}(0)=-1$.

(c) Find the impulse and step responses.

(d) Find the particular solution for $u_s(t)$

(i) $3e^{2t}$, (ii) $3e^{-2t}$, (iii) $4e^{-t}$, (iv) $5\cos(t+20°)$, (v) $5e^{-2t}\cos(2t+20°)$.

3) Find the natural frequencies of the circuits of Problem 1.

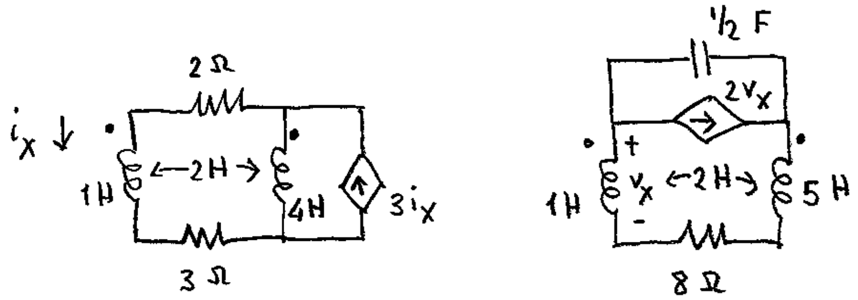
4) For each circuit of Problem 2

(a) Find the natural frequencies,

(b) Find sets of (real) initial conditions exciting the modes.
(Assume the inputs are deactivated.)

5) (a) Obtain in matrix form (i) the mesh equation, (ii) the state equation.

(b) The initial conditions are specified at $t=0$.
Find the indicated variable for $t \geq 0$.



$i_x(t)$
(c)

$v_x(t)$
(d)

6) For the circuit of Problem 2-(b) let $v_s(t)=8e^{2t}$ V.

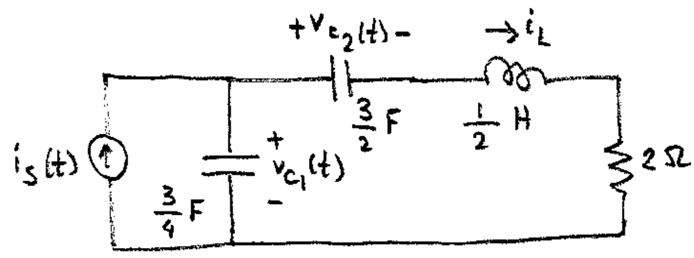
(a) Find the particular solutions for $v_c(t)$ and $i_L(t)$

(i) Using the state equation,

(ii) Solving the circuit in the phasor domain.

(b) Find the zero-state solutions for $v_c(t)$ and $i_L(t)$.

7)



(a) What are the natural frequencies of $v_{c_1}(t)$, $v_{c_2}(t)$ and $i_L(t)$?

(b) Find the homogeneous solutions for $v_{c_2}(t)$ and $i_L(t)$.

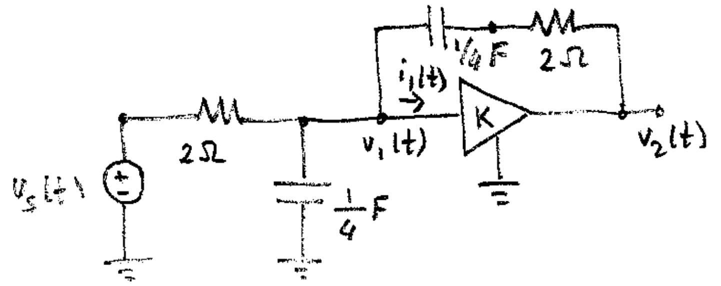
(c) Given $i_s(t) = 18\cos(2t)$ A.

Find the particular solutions for $v_{c_2}(t)$ and $i_L(t)$.

(d) Given $v_{c_1}(0) = 1$V, $v_{c_2}(0) = -2$V, $i_L(0) = 3$ A; $i_s(t) = 18\cos(2t)$ A.

Find the complete solutions for $v_{c_2}(t)$ and $i_L(t)$ for $t \geq 0$.

8)



$i_1(t) = 0$

$v_2(t) = Kv_1(t)$, $K > 1$

(a) Obtain the node equation in matrix form.

Find the natural frequencies in terms of K.

(b) Find the homogeneous solution for $v_2(t)$ when K is

(i) 2, (ii) 3, (iii) 4, (iv) 5, (v) 6.

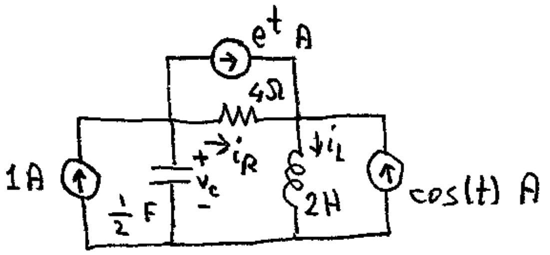
(c) Given $v_s(t) = V_m\cos(\omega t + \theta_s)$.

For each K value above discuss whether the steady-state is well defined or not.

(d) Find the steady-state solution for $v_2(t)$ when

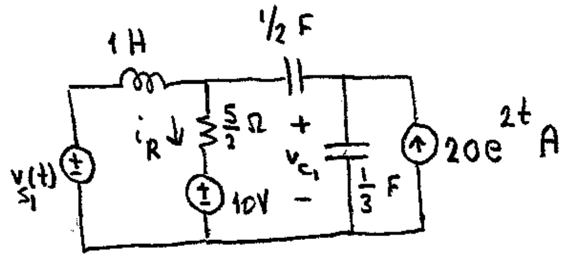
K=2 and $v_s(t) = 6\cos(4t + 30°)$ V

9) Find the homogeneous and the particular solutions for the indicated variables.



v_c, i_L, i_R

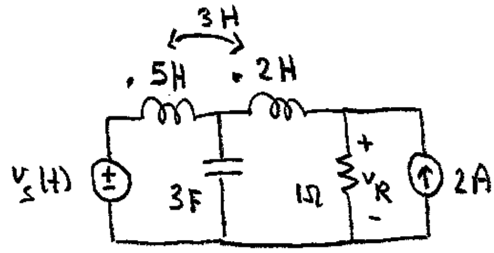
(a)



$v_{s_1}(t) = 10\cos(2t+45°)$ V

v_{c_1}, i_R

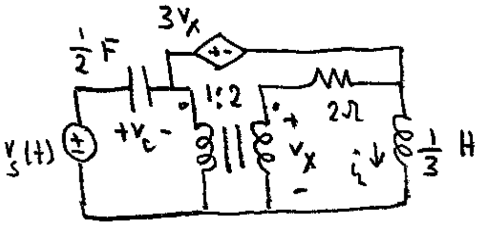
(b)



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

v_R

(c)



$v_s(t) = 6\cos(4t+10°)$ V

v_c, i_L

(d)

10) Given the state equation

$$\dot{\underline{x}}(t) = \begin{pmatrix} -2 & 1 \\ 2 & -3 \end{pmatrix} \underline{x}(t) + \begin{pmatrix} 3 \\ -3 \end{pmatrix} u_s(t)$$

(a) Find the zero-input solution given $\underline{x}(0) = \begin{pmatrix} 3 \\ 1 \end{pmatrix}$.

(b) Find the impulse response.

(c) Find the particular solution for $u_s(t) = 2\cos(2t+75°)$.

11) Given the state equation

$$\dot{\underline{x}}(t) = \begin{bmatrix} -4 & 3 \\ -2 & 1 \end{bmatrix} \underline{x}(t) + \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} 6e^t \\ 10\cos(2t+60°) \end{bmatrix}, \quad \underline{x}(0) = \begin{pmatrix} 2 \\ 3 \end{pmatrix}.$$

Find $\underline{x}(t)$ for $t \geq 0$.

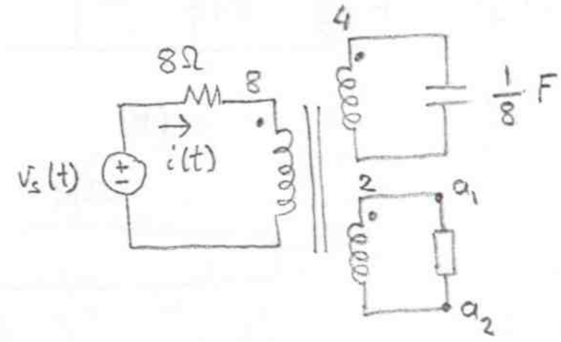
12) Given the state equation

$$\dot{\underline{x}}(t) = \begin{bmatrix} -1 & -2 & 0 \\ 1 & 1 & -1 \\ 0 & 0 & -2 \end{bmatrix} \underline{x}(t) + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u_s(t).$$

(a) Find the zero-input solution given $\underline{x}(0) = \begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$.

(b) Find the particular solution for $u_s(t) = 10e^{t}\cos(t+30^\circ)$.

13)



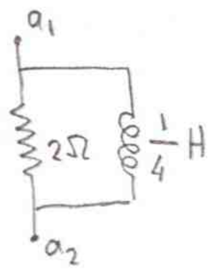
Obtain the state equation.

Find the homogeneous solution for $i(t)$.

Find the particular solution for $i(t)$ given $v_s(t) = \cos(t)$ V.

(a)

(b)



(c)