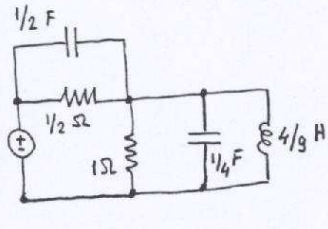
Spring 2009

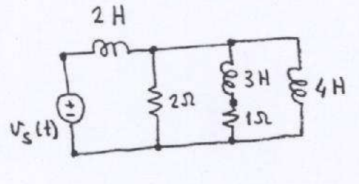
METU/EEED

EE 202/ZPS I

1) Obtain in matrix form (i) the modified node equation, (ii) the node equation, (iii) the mesh equation.
Find the natural frequencies of the circuit.



(a)



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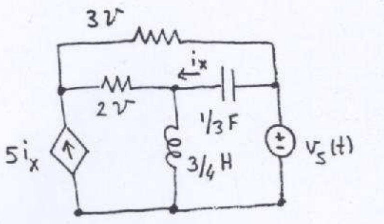
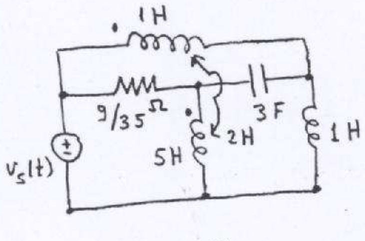
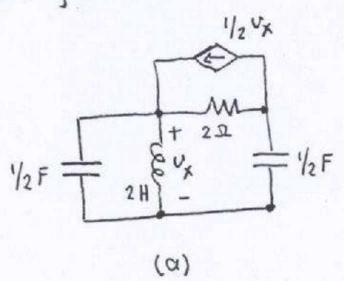


(c)

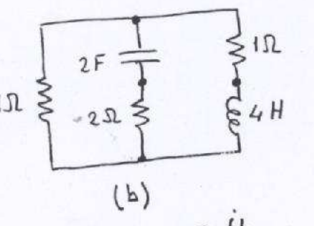


(d)

2) Find the natural frequencies and sets of (real) initial conditions exciting the modes.



(a)



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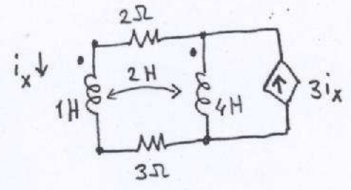
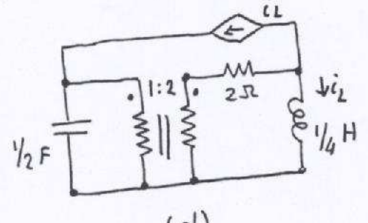
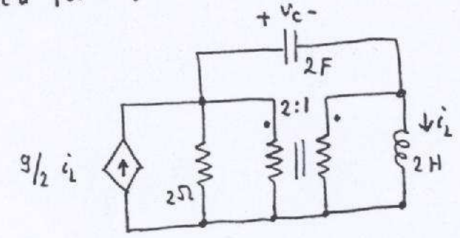


(c)



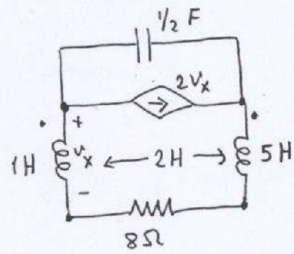
(d)

3) Obtain the modified node equation in matrix form.
Find the natural frequencies.
Determine V_o and I_o so that the currents and voltages are bounded for $t \geq 0$.

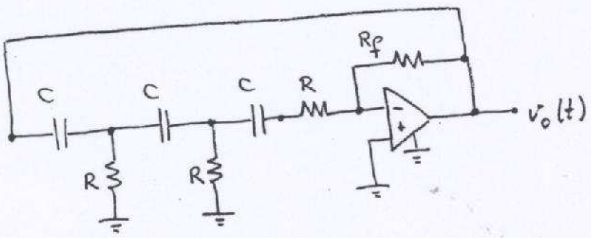


$v_C(0) = V_o$
$i_L(0) = I_o$

4) Obtain the mesh equation in matrix form.
Express $v_x(t)$ in terms of the initial values of dynamic elements specified at $t=0$.



5)



The op-amp is ideal and operating in the linear region.

(a) Obtain the node equation in matrix form.

(b) Let $R = 1\,\Omega$ and $C = 1\,F$. Find R_f so that the circuit has a natural frequency at $-1/6$. Find the other natural frequencies. Is the circuit stable? Discuss.

(c) Let $R = 1\Omega$, $C = 1F$ and the initial time be zero.

Find R_f so that $v_o(t)$ is a sinusoid for large values of t.

What is the frequency f_o of this sinusoid?

Scale the circuit (find R_f and C) so that $R = 10\ K\Omega$ and $f_o = 4\ KHz$.

6) Given the differential equation

$$\left(D^3 + D^2 + 2D + 2 \right) x(t) = (3D + 6)\, u_s(t).$$

(a) Find the homogeneous solution.

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

(i) $3e^{2t}$, (ii) $4e^{-t}$, (iii) $5e^{-2t}$, (iv) $5\cos(2t + 30^\circ)$,

(v) $5e^{-t}\cos(t + 30^\circ)$, (vi) $\delta(t)$, (vii) $u(t)$.

7) Given the matrix differential equation

$$\begin{bmatrix} D+1 & -1 \\ 1 & D+3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \end{bmatrix} u_s(t), \quad u_s(t) = 2\cos(2t)$$

(a) Find the homogeneous solution.

(b) Find the particular solution.

(c) Find $\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix}$ so that the solution has no transient part.

8) Given the matrix differential equation

$$\underbrace{\begin{bmatrix} D+4 & -3 \\ 2 & D-1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}}_{} = \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} \underline{u}_s(t), \quad \underline{u}_s(t) = \begin{bmatrix} 6e^{t} \\ 12\cos(2t + 75^\circ) \end{bmatrix}$$

where $\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \underline{x}(t)$.

Find $\underline{x}(t)$ for $t \geq 0$ given $\underline{x}(0) = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$.

9) Given the matrix differential equation

$$\begin{bmatrix} D+1 & 2 & 0 \\ -1 & D-1 & 1 \\ 0 & 0 & D+2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u_s(t)$$

(a) Find the homogeneous solution.

(b) Let $u_s(t)=0$.

Determine real initial values $x_1(0), x_2(0), x_3(0)$ so that $x_1(t), x_2(t), x_3(t)$ are sinusoids for $t \geq 0$.

(c) Let $u_s(t)=0$.

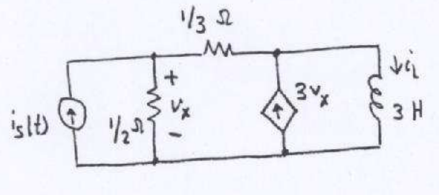
Given $x_1(0)=1$, $x_2(0)=-2$, $x_3(0)=3$, find $x_1(t), x_2(t), x_3(t)$ for $t \geq 0$.

(d) Let $x_1(0)=0$, $x_2(0)$, $x_3(0)=0$.

Find $x_1(t), x_2(t), x_3(t)$ for $t \geq 0$ when

$u_s(t) = 4 + 3e^{2t} + 2\cos(2t+30°)$.

10)

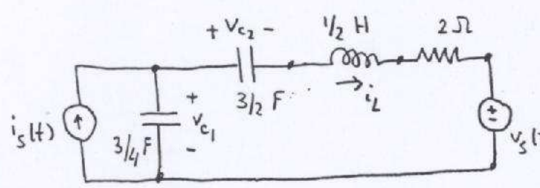


$i_s(t) = 5\cos(2t-24°)$ A

$i_L(0) = 2$ A

Find $i_L(t)$ and $v_x(t)$ for $t \geq 0$.

11)



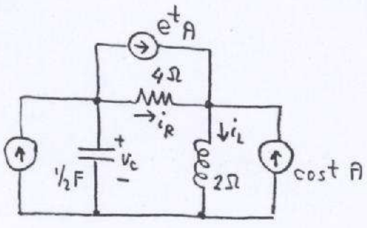
$i_s(t) = 4\sin(2t+30°)$ A

$v_s(t) = 3e^{-4t}$ V

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

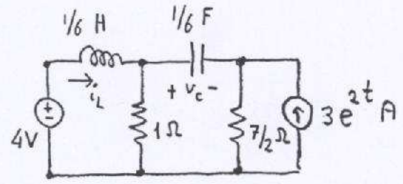
Find $v_{c_1}(t)$ and $i_L(t)$ for $t \geq 0$.

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



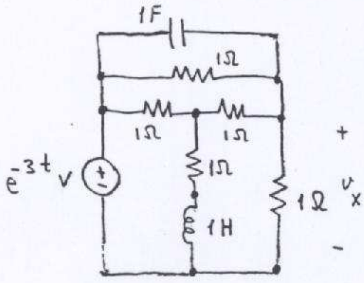
v_c, i_L, i_R

(a)



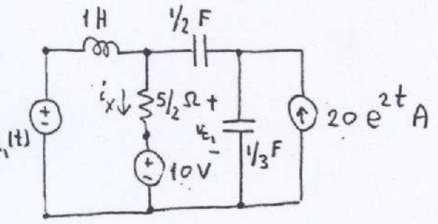
v_c, i_L

(b)



v_x

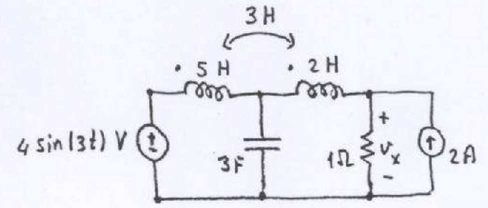
(c)



$v_{s_1}(t) = 10\cos(2t+45°)$ V

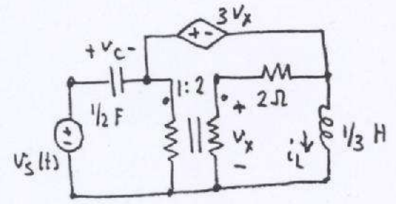
i_x, v_{c_1}

(d)



v_x

(e)



$v_s(t) = 6\cos(2t+10°)$ V

v_c, i_L

(f)