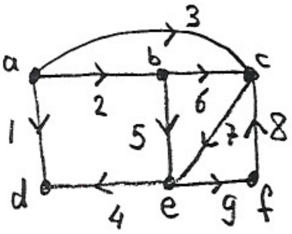
METU/EEED

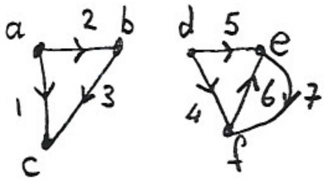
EE 201/ZPS I

Fall 2009

1)



(a)



(b)

Given the circuit graph:

(i) Write all the current and voltage equations.

(ii) Write the incidence and mesh matrices.

(iii) Pick a reference node (reference nodes) and write the reduced incidence matrix.

(iv) Pick a tree and write the fundamental loop and fundamental cutset matrices.

(v) Using the reduced incidence (fundamental cutset) matrix obtain a set of independent current equations.

(vi) Using the mesh (fundamental loop) matrix obtain a set of independent voltage equations.

(vii) Express the branch voltages in terms of the node (cutset) voltages.

(viii) Express the branch currents in terms of the mesh (loop) currents.

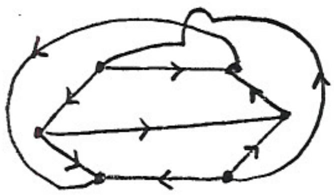
(ix) Assign arbitrary currents (voltages) to the branches so as to satisfy the KCL (KVL).

Verify the Tellegen's theorem.

2) Obtain the dual of the graph of Problem 1-a.

Repeat Problem 1 for this circuit graph.

3) Given the circuit graph:



Assign arbitrary currents (voltages) to the branches so as to satisfy the KCL (KVL).

Verify the Tellegen's theorem.

4) Given the circuit matrix. Draw the circuit graph.

(a)
$$A=\begin{bmatrix} 1 & 1 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & -1 & -1 & 0 \\ -1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

(b)
$$M=\begin{bmatrix} -1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & -1 \end{bmatrix}$$

(c)
$$B=\begin{bmatrix} 0 & -1 & 0 & -1 & 1 & 0 & 0 & 0 \\ 1 & -1 & 0 & -1 & 0 & 1 & 0 & 0 \\ 0 & -1 & -1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

(d)
$$Q=\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & -1 \end{bmatrix}$$

5) Classify the following resistors as linear or nonlinear; time-invariant or time-varying; bilateral or nonbilateral; passive or active; voltage-controlled, or current-controlled, or both voltage and current controlled or neighter voltage nor current controlled.

(a) $2v-3i=0$

(b) $2v-3i=4$

(c) $2v+3i=0$

(d) $i=(3\cdot\cos t)v$

(e) $v=[3+2\cos(4t+30^\circ)]i$

(f) $v=[2+\cos(3t)]i+4$

(g) $i=4e^{-v/6}$

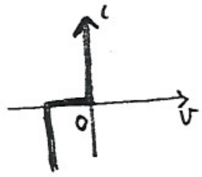
(h) $i=4[e^{v/6}-1]$

(i) $i=3v^4$

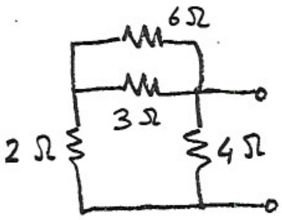
(j) $v=i^5$

(k) $i=\begin{cases} v^2, & v\geq 0 \\ 0, & v<0 \end{cases}$

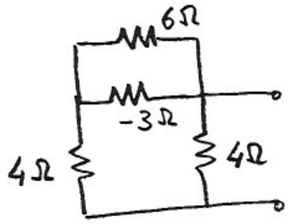
(l)



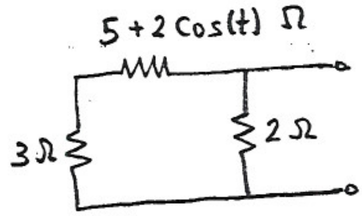
6) Obtain the port characteristics.



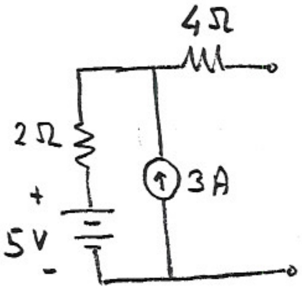
(a)



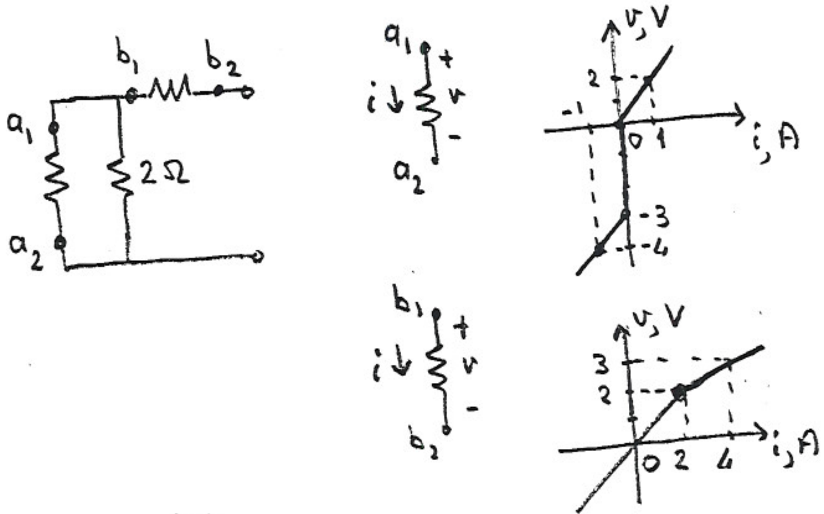
(b)



(c)

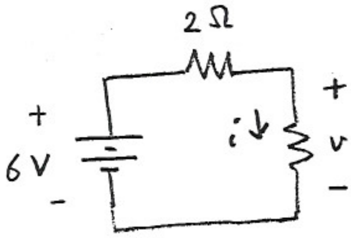


(d)



(e)

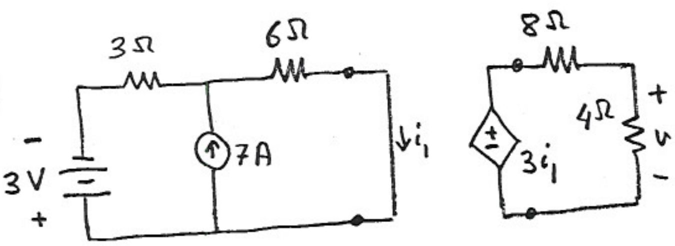
7)



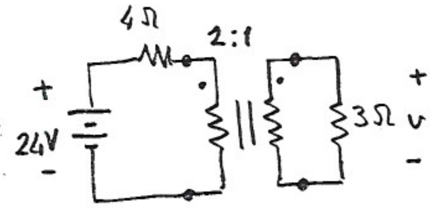
Classify the circuit and find v and i.

(a) $v = 4i$, (b) $v = -4i$, (c) $v = [2 + \cos(3t)]\,i$, (d) $i = \begin{cases} \frac{1}{2}v^2, & v \geq 0 \\ 0, & v < 0 \end{cases}$

8)



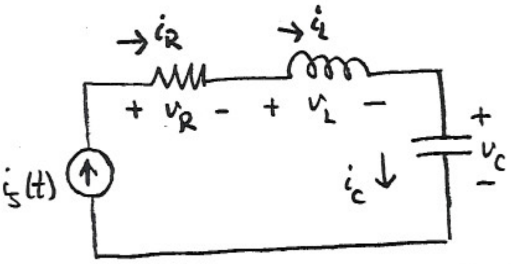
(a)

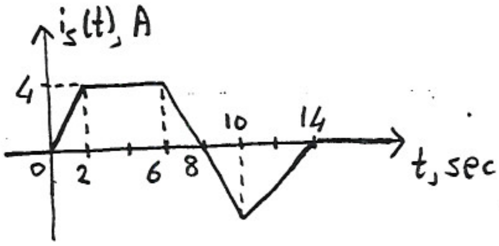


(b)

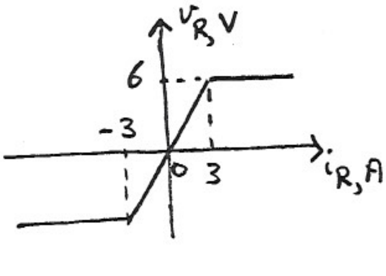
Find v. Compute the instantaneous powers delivered to (supplied by) the elements.

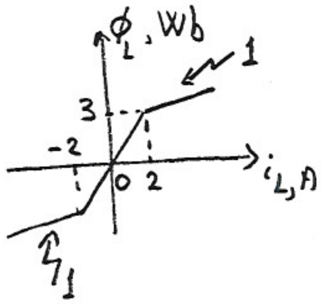
9)

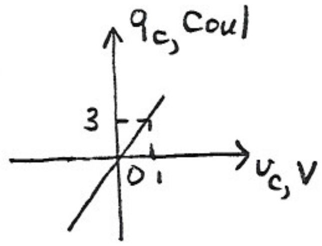




$q_c(0) = 0$ Coul

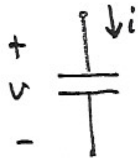


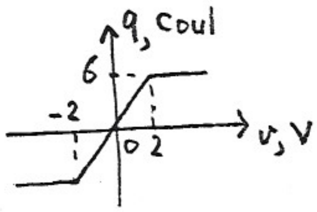


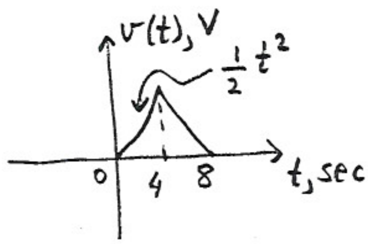


Sketch $v_R(t)$, $v_L(t)$ and $v_c(t)$.

10)



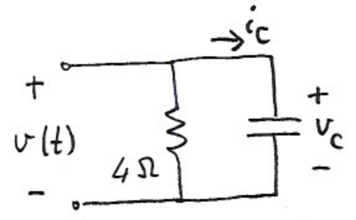




(a) Sketch the current waveform, $i(t)$.

(b) Compute the stored energies at $t = 6$ sec and $t = 7.5$ sec.

11)

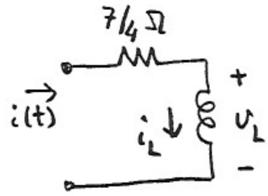


$v_c = 2\,q_c^{1/3}$

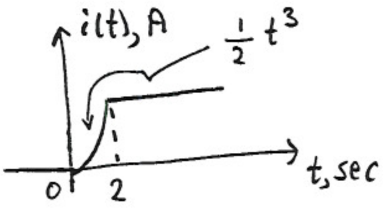
$v(t) = 2t + 4$ V

Compute the energy delivered to the one-port on the interval [2 sec, 3 sec].

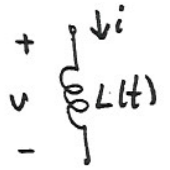
12)



$\phi_L = (2 i_L)^{1/3}$



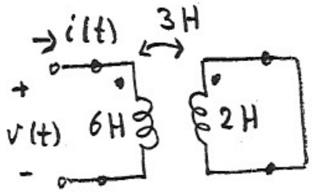
Compute the energy delivered to the one-port on the interval $(-\infty, 3$ sec$]$.

13) 

$L(t) = 2 + \cos(3t)$ H

$i(t) = 3e^{2t}$ A

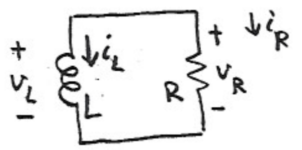
Find $v(t)$. Compute the (electrical) energy delivered to the inductor on the interval [2 sec, 3 sec].

14) 

$i(0) = 2$ A

$v(t) = 9\cos(2t + 30°)$ V

Find $i(t)$ for $t \geq 0$.

15) 

$R > 0$, $L > 0$

$i_L(0) = I_0$

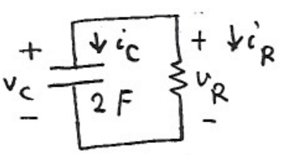
(a) Obtain the differential equation satisfied by $i_L(t)$.

(b) Solve this equation and find $i_L(t)$ for $t \geq 0$.

(c) Find $v_R(t), i_R(t), v_L(t)$ for $t \geq 0$.

(d) Compute the energy delivered to the resistor on the interval $[0, T]$. Compute the energies stored in the inductor at $t = 0$ and $t = T$. Comment.

Hint: The solution to the equation $\frac{dx(t)}{dt} + a\,x(t) = 0$ subject to the initial constraint $x(t_0) = X_0$ is $x(t) = X_0 e^{-a(t - t_0)}$.

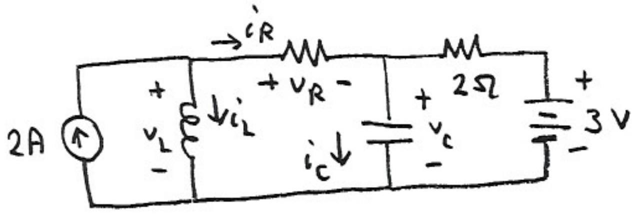
16) 

$q_c(2) = 6$ Coul

(i) Classify the circuit; obtain the differential equation satisfied by $q_c(t)$; classify the equation.

(ii) Find $v_c(t), v_R(t), i_R(t), i_c(t)$ for $t \geq 2$ sec.

(a) $v_R = 3 i_R$, (b) $v_R = -3 i_R$, (c) $v_R = i_R^{1/3}$, (d) $i_R = [2 + \cos(t)] v_R$

17) 

$\phi_L = \tanh(i_L)$

$v_R = [2 + \sin(3t)]\, i_R$

$q_c = v_c^3$

Obtain the dual circuit.