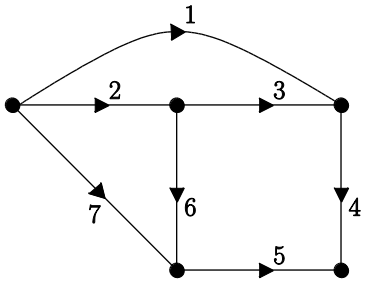
METU/EEED
EE 201

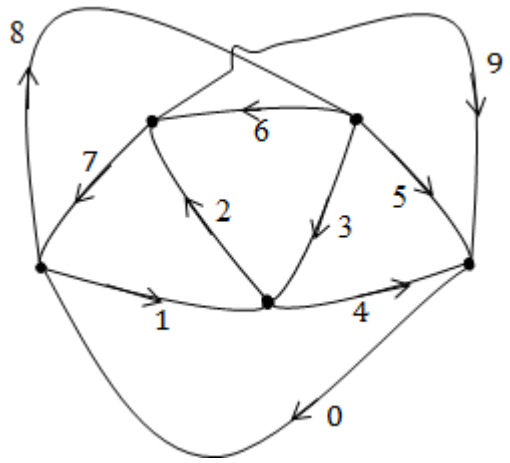
HOMEWORK I

Question 1 Consider the circuit graph below.



a) Pick a tree. Determine the fundamental cutsets and the fundamental loops.
b) Write the current equations on the fundamental cutsets and the voltage equations on the fundamental loops.
c) Assign arbitrary nonzero branch voltages to the tree branches.
Then compute the cotree-branch voltages.
d) Assign arbitrary nonzero branch currents to the cotree branches.
Then compute the tree-branch currents.
e) Verify Tellegen's Theorem using the numerical values in Part (b) and Part (c).

Question 2



The figure on the left is the oriented graph of a lumped circuit.

Some of the branch currents and voltages are given below.

Find the missing currents and voltages.

$i_0 = 5A$	$i_1 = 3A$	$i_2 = ?$	$i_3 = 4A$	$i_4 = ?$	$i_5 = -7A$	$i_6 = ?$	$i_7 = ?$	$i_8 = 2A$	$i_9 = -4A$
$v_0 = 4V$	$v_1 = 3V$	$v_2 = 6V$	$v_3 = ?$	$v_4 = ?$	$v_5 = -2V$	$v_6 = ?$	$v_7 = ?$	$v_8 = ?$	$v_9 = ?$

Answer: $i_2 = -9$ A, $i_4 = 16$ A $i_6 = 5$ A, $i_7 = 0$ A, $v_3 = 5$ V, $v_4 = -7$ V, $v_6 = 11$ V, $v_7 = -9$ V, $v_8 = -2$ V $v_8 = -2$ V, $v_8 = -13$ V

Question 3 For a lumped circuit N made up of single-branch elements, the reduced incidence matrix A is as given below.

$$A = \begin{array}{c} \begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{matrix} \\ \begin{bmatrix} -1 & 0 & 0 & 0 & 0 & -1 & 0 \\ 1 & 0 & 0 & 1 & -1 & 0 & -1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \end{bmatrix} \end{array}$$

a) Obtain the circuit graph.

b) Let the circuit $\hat{N}$ be the dual of N. Some of the branch currents and voltages for $\hat{N}$ are given below. Find the missing currents and voltages.

$\hat{i}_1 = ?$	$\hat{i}_2 = 3\,\text{A}$	$\hat{i}_3 = ?$	$\hat{i}_4 = 1\,\text{A}$	$\hat{i}_5 = 1\text{A}$	$\hat{i}_6 = 6\,\text{A}$	$\hat{i}_7 = ?$
$\hat{v}_1 = ?$	$\hat{v}_2 = -5\,\text{V}$	$\hat{v}_3 = -1\text{V}$	$\hat{v}_4 = ?$	$\hat{v}_5 = ?$	$\hat{v}_6 = ?$	$\hat{v}_7 = 3\,\text{V}$

Question 4 Certain measurements are performed on four different lumped circuits. All four circuits have the same graph *G* with six branches. For the first three circuits, the branch voltage readings (in Volts) are recorded in the following table.

	v_1	v_2	v_3	v_4	v_5	v_6
Circuit #1	2	5	–3	–1	3	2
Circuit #2	1	–5	6	2	–1	–4
Circuit #3	9	8	1	?	5	3

For the fourth circuit, the branch current readings (in Amps) are provided below.

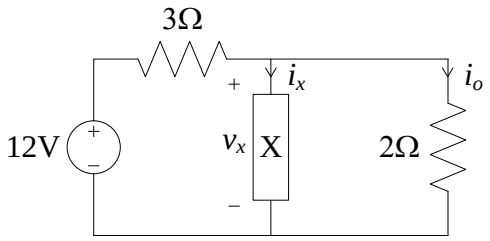
	i_1	i_2	i_3	i_4	i_5	i_6
Circuit #4	?	?	2	1	–3	–4

a) Find the missing current values, i_1 and i_2, for the Circuit #4.

b) Find the missing voltage value v_4 for the Circuit #3.

Answer: a) i_1 = - 3 A, i_2 = 6 A b) 4 V

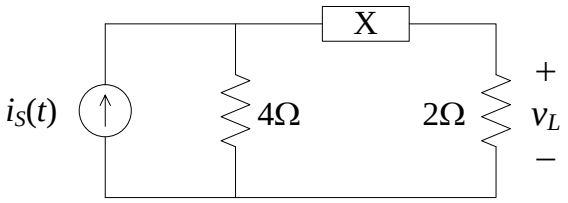
Question 5 Consider the circuit shown below where "X" is a resistive element. The current through the 2 Ω resistor is measured to be $i_o(t) = 1.5\cos(t)$ A.



a) Find the current $i_x(t)$.
b) Find the instanteneous power delivered to X.
c) Is X a time-invariant element? Explain.
d) Is X a passive element? Explain.

Answer: $i_x(t) = 4 - 2.5\cos(t)$ *A*

Question 6 Consider the circuit shown below where "X" is a time-invariant resistive element.



When $i_S(t) = 6 + \cos(\omega t)$ A, the voltage across the 2 Ω resistor is measured to be $v_L(t) = 6 - 2\cos(\omega t)$ V.

a) Find the instanteneous power delivered to X.
b) Is X a linear element? Explain.
c) Is X a passive element? Explain.
d) Find a possible branch relation for X.

Answer: $P_x(t) = 18 + 24\cos(\omega t) - 10\cos^2(\omega t)$ *W*
$V_x = -10\, i_x + 36$

Question 7

In the circuit shown below, "X" is a resistive element. The results of two different experiments are shown in the table where P_s is the power supplied by the voltage source.

a) Determine the value of R.
b) Find i_x when V_s is 13 V.
c) Is the element X linear or non-linear? Explain.
d) Is the element X active or passive? Explain.

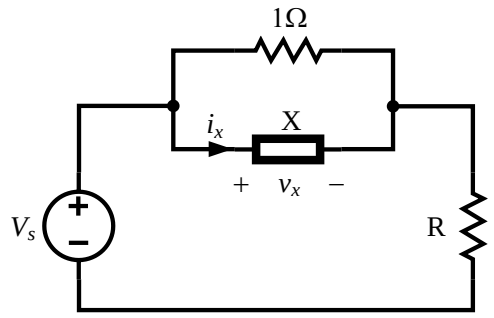


Table: Experiment results

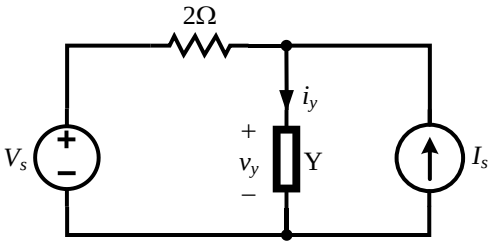
V_s	P_s	i_x
5 V	5 W	2A
13 V	26 W	?

Answer: a)6 Ω b)1 A

Question 8

In the circuit shown below, "Y" is a non-linear element whose branch relation is $v_y = 3i_y^3$. The following are given:

a) $V_s > 0$.
b) The power absorbed by the 2 Ω resistor is 18 W.
c) The power absorbed by Y is 48 W.
d) The voltage source is absorbing power.



Find the power delivered by the current source.

Answer: 120 W