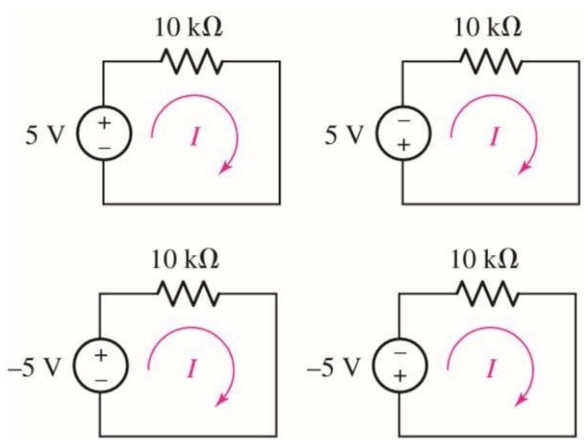
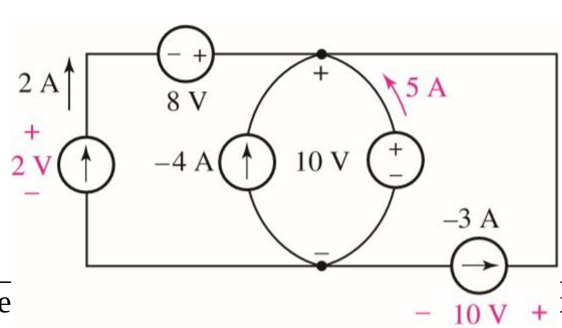
**Department of Electrical Engineering**
**Assignment**
**Date: 13/04/2020**

## Course Details

**Course Title:** Linear Circuit Analysis **Module:** 2
**Instructor:** Dr. Sohail Imran **Total Marks:** 30

**Name:** Ali Raza **Student ID:16309**

## Student Details

<table>
<tr><td rowspan="6">Q1.</td><td rowspan="2">(a)</td><td rowspan="2">For each of the circuits in figure, find the current I and compute the power absorbed by the resistor<br></td><td>Marks 3</td></tr>
<tr><td>PLO1</td></tr>
<tr><td rowspan="2">(b)</td><td rowspan="2">Determine the power supplied by the leftmost element in the circuit of following figure<br></td><td>Marks 4</td></tr>
<tr><td>PLO1</td></tr>
<tr><td rowspan="2">(c)</td><td rowspan="2">Following figure : of three different resistive elements. Determine the resistance of each, assuming the voltage and current are defined in accordance with the passive sign convention.</td><td>Marks 3</td></tr>
<tr><td>PLO1</td></tr>
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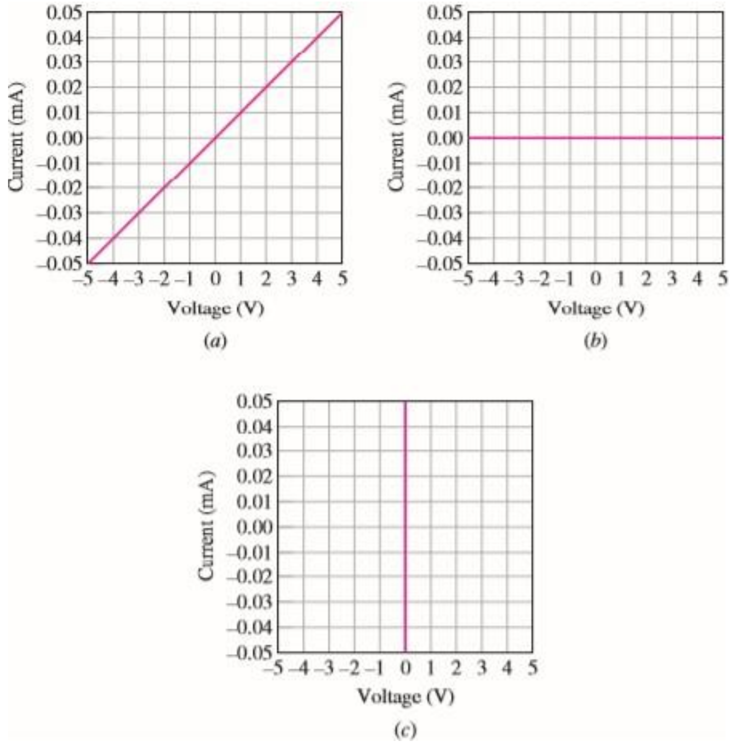
<tr><td></td><td></td><td>
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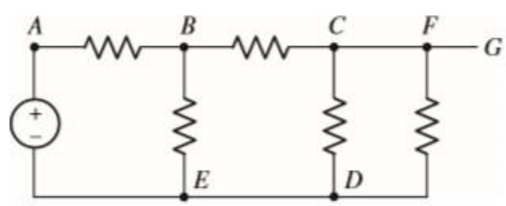
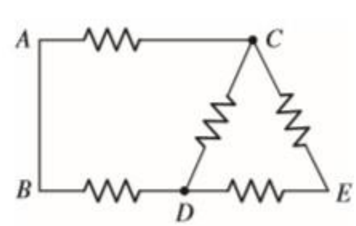
<tr><td>Q2.</td><td>(a)</td><td>Refer to the circuits of following figures, and answer the following:<br>1. How many distinct nodes are contained in the circuit?<br>2. How many elements are contained in the circuit?<br>3. How many branches does the circuit have?<br>4. Determine if each of the following represents a path, a loop, both, or neither:<br>i. A to B<br>ii. B to D to C to E<br>iii. C to E to D to B to A to C<br>iv. C to D to B to A to C to E<br>


</td><td>Marks 4<br>PLO2</td></tr>
<tr><td></td><td>(b)</td><td>For the circuit of following figure (which is a model for the dc operation of a bipolar junction transistor biased in forward active region), $I_B$ is measured to be 100 μA. Determine $I_C$ and $I_E$</td><td>Marks 6<br>PLO2</td></tr>
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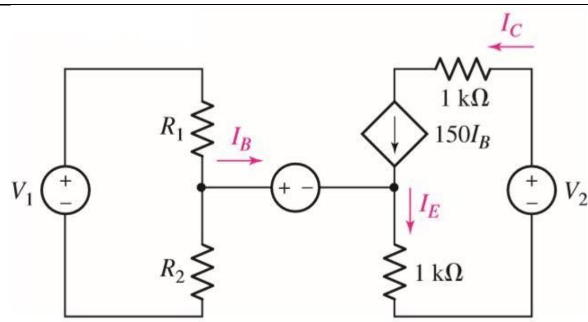
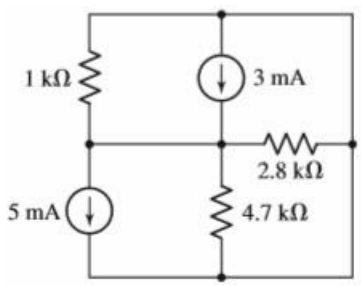
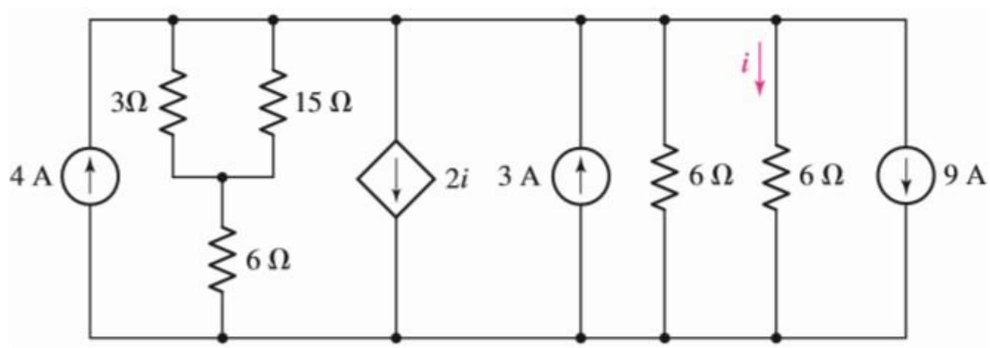
| | |  | |
| Q3. | (a) | Although drawn so that it may not appear obvious at first glance, the circuit of following figure is in fact a single-node-pair circuit.<br>a. Determine the power absorbed by each resistor.<br>b. Determine the power supplied by each current source.<br>c. Show that the sum of the absorbed power calculated in (a) is equal to the sum of the supplied power calculated in (b).<br> | Marks 5<br>PLO1 |
| | (b) | Determine the power absorbed by the 15 Ω resistor in the circuit of following figure<br> | Marks 5<br>PLO1 |

Question 1)
Part (A)
SOLUTION:
Finding current(I)
a)
Ohm's law state that
V=I×R
I=$\frac{V}{R}$
I= $\frac{5V}{10K\Omega}$
I=0.5mA
b)
Solution:-
V=I×R
I=$\frac{V}{R}$
I= $\frac{-(5V)}{10K\Omega}$
I=-0.5mA

c)
solution :-
I=$\frac{V}{R}$
I= $\frac{-5V}{10K\Omega}$
I=-0.5mA
d)
solution:-
I=$\frac{V}{R}$
I= $\frac{-(-5V)}{10K\Omega}$
I=0.5mA
Now finding Power,
Power absorbed by all the resistors is
$P_R = I^2 \times R$
Putting values
$P_R = ((\pm 0.5)^2 \times 10^{-3}) \times (10 \times 10^3)$
$P_R = 2.5mW$

PART (B)
Solution:-
Since we know both the value of I and V is the left most element we can calculate,
$P = VI$
P=(2v× 2A)
P=4W
Because of the direction of current through the element we know that the power is supplied.

PART (C)
Ohm's law states that
V=IR
R=$\frac{V}{I}$
So we can calculate R from the slope on the graph
We can take any point on line to get the value of I and V.
a)
R=$\frac{V}{I}$

R=$\frac{2}{0.02\times 10^{-3}}$
R=100kΩ

b)
I=0A, V=1v
R=$\frac{V}{I}$
R=$\frac{1}{0}$
R=∞Ω
c)
I=0.03mA , V=0v
R=$\frac{V}{I}$
R=$\frac{0}{0.03\times10^{-3}}$
R=0 Ω

QUESTION 2
SOLUTION:-

1. If we look at the given figure we get,

a) Nodes =4

b)
now if we start at point A and move to point B we move to another node and that means we formed a path but we visited each node only once so there is no loop,
Path=yes
Loop=No
c)
And we do the same for part. After moving from C to F ,F to G. we are still in the same node. Therefore ,
Path =No
Loop = No

2. Number of elements in the circuit are 6

Part B($2^{nd}$ diagram)

a) As seen in the given circuit point B to A and Care the the same node additionally we have other 2 nodes E and D. Thus the number of node is 3.

b) We have 4 resistors in the given circuit thus the number of elements is 4.

c) We define a branch as a single path in a network, composed of one simple element and the node at each end of that element. Thus we have 4 branches in the given circuit.

d)
i) This is neither a path nor a loop nor both. This is because point A and B are the same (considered as a single node).
ii) This is a path because no node was encounter more than once.
iii) This is both a path and a loop because the node at which we started (C) is the same as the node on which we ended (C),then this path is by definition a closed path or a loop.
iv) This is neither a path nor a loop nor both,because the node C was encountered twice but the path was ended at the node E not C.

QUESTION 2
PART (B)

SOLUTION:-
Applying KCL
$I_B + I_C = I_E$
So,
$I_c = 150 \times I_B$
$I_c$ =150 $\times 100 \times 10^{-6}$

$I_c = 15mA$
Now we can find $I_E$
$I_E = I_c + I_B$
$I_E = 15 \times 10^{-3} + 100 \times 10^{-6}$
$I_E = 15.1mA$

QUESTION 3)
PART (A)
We can find V by combining similar elements
V=IR
V=$2 \times 10^{-3} \times 637$
=1.274v
Now lets find I of each
$I_X = \frac{1.274}{1000}$
=1.274mA
$I_Y = \frac{1.274}{2800}$
=0.455mA
$I_Z = \frac{1.274}{4700}$
=0.271mA
Now finding Power
P=VI
$P_{(2.8K)}$=(1.274)(0.455)
=0.5792mW
$P_{(4.7k)} = (1.274)(1.271)$
=1.623mW
$P_{(1k)}$ =(1..274)(1.274)
=1.523mW
$P_{(5mA)} = (1.274)(-5)$
=6.37mW
$P_{(3mA)} = (1.274)(3)$
=3.822mW

PART B
SOLUTION:-
$R_{(X)} = [(3 \,||15) + 6] \,||\, 6$
=[2.5+6] || 6
=8.5|| 6
=$\frac{8.5\times6}{8.5+6}$
=$\frac{102}{29}\,\Omega$
The equivalent current source,
$I_T = -4 + 2i - 3 + 9$
=2+2i (downward)

Applying KCL
2+2i + $\frac{v_x}{\frac{102}{29}} + i = 0$
2+3$(\frac{v_x}{6}) + \frac{v_x}{\frac{102}{29}} = 0$
Solving this equation, We obtain
$v_x = -2.55v$
(a) The equivalent resistance of the parallel two resistors

3 || 15 =$\frac{3\times15}{3+15}$=2.5 Ω

(b) Using ohm's law, we obtain

$i6 = \frac{v_x}{2.6+6} = \frac{-2.55}{8.5}$

=-0.3A

Thus,

$v_{15} = 2.5 \times i6$

=(2.5)(-0.3)

=0.75v

Therefore, the power absorbed by the 15 Ω is

$$P_{15\Omega} = \frac{v^2{}_{15}}{15}$$

$$\frac{(-0.75)^2}{15}$$

$= 37.5$mW

First, we will simplify the circuit by calculating source and resistor equivalences

$I_{eq}$ =4-2i+3-9

$= -2 - 2i$

$R_{eq} = (6 + 3\ ||15)\ ||6\ ||6$

$R_{eq} = 8.5\ ||3$

$= 2.2174\ \Omega$

Now , can calculate voltage v as,

V= $i_{eq} \times R_{eq}$

V = (-2-2i)$\times$ 2.2174 Ω

And from the diagram we can see that,

V=6i

6i = (-2-2i)$\times$ 2.2174

10.4348i = -4.4348

i =-0.425A

V =-2.55v

To get the power consumed by the 15 ohm resistor will need the voltage on that resistor two,

P=$\frac{V^2}{R}$

$$P_{15\Omega} = \frac{V^2{}_{15\Omega}}{15\Omega}$$

$$V_{15\Omega} = \frac{6}{6 + 2.5} \times v$$

$$V_{15\Omega} = 1.8\ v$$

And the power is,

$$P_{15\Omega} = \frac{1.8^2}{15\Omega}$$

$$P_{15\Omega} = 0.216W$$

For calculating equivalent resistance we use the following expressions,

Series $(R_1 + R_2)$

$$R_{eq} = R_1 + R_2$$

$$Parallel(R_1||R_2)$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2}$$

*Now we can calculate the equivalnces as,*

$$R_{eq} = 1\Omega + 2\Omega||2\Omega$$

$$R_{eq} = 1\Omega + \frac{2\Omega \times 2\Omega}{2\Omega + 2\Omega}$$

$$R_{eq} = 1\Omega + 1\Omega$$

$$R_{eq} = 2\Omega$$

*b*)

$$R_{eq} = 4\Omega + \frac{1\Omega \times 2\Omega}{1\Omega + 2\Omega} + 3\Omega$$

$$R_{eq} = 7.667\Omega$$