Week 2

S3 - Linearity and Superposition

S4 - Static Discipline and Boolean Logic

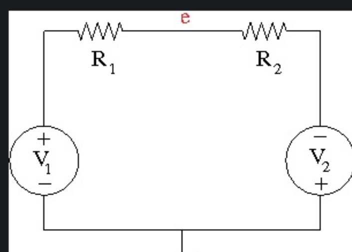
Lectures

S3E1: Node Equation Review

0 points possible (ungraded)

This is just a quick review of the node equation idea.

In the following circuit there is one unknown node potential, labeled e. The device parameters are: $R_1 = 6800.0\Omega$, $R_2 = 5600.0\Omega$, $V_1 = 5.0$V, $V_2 = -7.2$V.



What is the unknown potential e (in Volts)?

6.20645 ✔ **Answer:** 6.2064516129032254

Explanation

The following explanation was contributed as a forum post by Grove in a previous run of the course. Many students found this to be extremely helpful. The instructors also found it to be potentially funny.

The term voltage can be used to mean two things - potential and potential difference.

Below are three diagrams showing voltage sources.

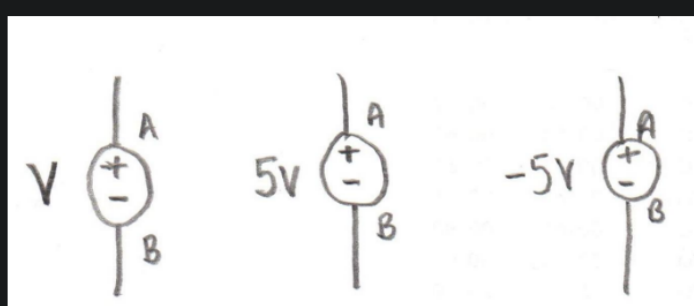


Figure 1

By convention the diagram on the left is to be interpreted as follows:

The potential (voltage) of terminal A (the terminal labelled positive) relative to terminal B (the terminal labelled negative) is V volts.

So moving from the negative terminal B to the positive terminal A there is a change of potential of V volts.

So in the middle diagram terminal A has a potential that is $+5$ volts relative to that of terminal B. Going from terminal B to terminal A the voltage rises by 5 volts.

terminal A the voltage **rises** by 5 volts.
For the right hand diagram terminal A has a potential that is -5 volts relative to that of terminal B. Going from terminal B to terminal A the voltage **falls** by 5 volts.
Note that all of the above statements are to do with potential difference and there has been no mention of reference node or zero of potential.
Now when dealing with circuits rather than having to keep saying the potential (voltage) of A relative to the potential of B one chooses a node which is at a potential of zero volts. This is called the reference node.
The diagrams below show how a choice of reference node influences various situations. (Note that the left hand and middle diagrams in Figure 2 represent the same situation as the corresponding diagrams in Figure 1, while the right hand diagram in Figure 2 represents a different situation than the right hand diagram in Figure 1.)

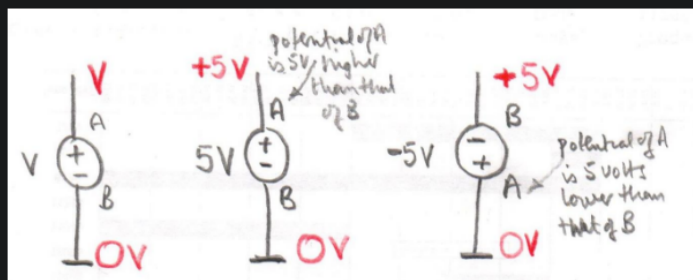


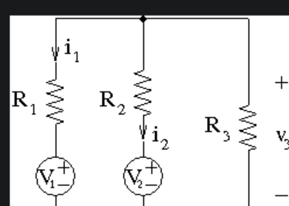
Figure 2

The middle diagram is easy to interpret since the label $5V$ indicates that the potential of A is $+5$ volts above that of the negative terminal B which in turn has been chosen to be at zero volts. So the voltage of terminal A (relative to the reference node) is $+5$ volts.
The potentially (excuse the pun) confusing diagram is the right hand one.
Note that in that diagram the label -5 volts means that the potential of terminal A is 5 volts **below** that of terminal B.
Put another way the potential of terminal B is 5 volts **above** that of terminal A. But terminal A is at zero volts and so terminal B is at a voltage (relative to the reference node) of $+5$ volts.

S3E2: Circuit Voltages and Currents are Linear Combinations of Source Strengths

0 points possible (ungraded)

Consider the following network containing two voltage sources and three resistors. The device parameters are V_1, V_2, R_1, R_2, and R_3.



The voltage v across resistor R_3 and the currents i_1 and i_2 can be expressed as a linear combinations of V_1 and V_2:

$$v_3 = a_1 * V_1 + a_2 * V_2$$

$$i_1 = b_1 * V_1 + b_2 * V_2$$

$$i_2 = c_1 * V_1 + c_2 * V_2$$

In each of the following, write algebraic expressions for the coefficients in terms of R_1, R_2, and R_3.

a_1 =

R2*R3/(R1*R2+R1*R3+R2*R3)

✔ **Answer:** R2*R3/(R1*R2+R1*R3+R2*R3)

a_2 =

R1*R3/(R1*R2+R1*R3+R2*R3) ✔ **Answer:** R1*R3/(R1*R2+R1*R3+R2*R3)

b_1 =

-(R2+R3)/(R1*R2+R1*R3+R2*R3) ✔ **Answer:** -(R2+R3)/(R1*R2+R1*R3+R2*R3)

b_2 =

R3/(R1*R2+R1*R3+R2*R3) ✔ **Answer:** R3/(R1*R2+R1*R3+R2*R3)

c_1 =

R3/(R1*R2+R1*R3+R2*R3) ✔ **Answer:** R3/(R1*R2+R1*R3+R2*R3)

c_2 =

-(R1+R3)/(R1*R2+R1*R3+R2*R3) ✔ **Answer:** -(R1+R3)/(R1*R2+R1*R3+R2*R3)

Explanation

We first note that the voltage across all three branches must be equal, so we can write the following two expressions for v_3 using Ohm's Law and KVL:

$$v_3 = V_1 + i_1 \cdot R_1$$

$$v_3 = V_2 + i_2 \cdot R_2$$

Next we focus on the top node and note that by KCL the sum of all currents leaving must be equal to zero. Then we can write the following:

$$v_3 = -(i_1 + i_2) \cdot R_3$$

Rewriting the first two equations to get expressions for i_1 and i_2, we get:

$$i_1 = \frac{v_3 - V_1}{R_1}$$

$$i_2 = \frac{v_3 - V_2}{R_2}$$

Substituting these expressions into the third equation, we get:

$$v_3 = -\left(\frac{v_3 - V_1}{R_1} + \frac{v_3 - V_2}{R_2}\right) \cdot R_3$$

$$v_3 = \left(\frac{V_1 - v_3}{R_1}\right) \cdot R_3 + \left(\frac{V_2 - v_3}{R_2}\right) \cdot R_3$$

$$v_3 \cdot R_1 \cdot R_2 = (V_1 - v_3) \cdot R_2 \cdot R_3 + (V_2 - v_3) \cdot R_1 \cdot R_3$$

Collecting all terms containing v_3 to the left hand side:

$$v_3 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3) = V_1 \cdot R_2 \cdot R_3 + V_2 \cdot R_1 \cdot R_3$$

$$v_3 = V_1 \cdot \frac{R_2 \cdot R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \frac{R_1 \cdot R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

We can then substitute this expression for v_3 into the first equation to get the expression for i_1:

$$i_1 = \frac{v_3}{R_1} - \frac{V_1}{R_1}$$

$$i_1 = V_1 \cdot \frac{R_2 \cdot R_3}{R_1 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} + V_2 \cdot \frac{R_1 \cdot R_3}{R_1 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} - \frac{V_1}{R_1}$$

$$i_1 = V_1 \cdot \left(\frac{R_2 \cdot R_3}{R_1 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} - \frac{1}{R_1}\right) + V_2 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

$$R_2 \cdot R_3 - (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3) \qquad R_3$$

$$i_1 = V_1 \cdot \frac{R_2 \cdot R_3 - (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)}{R_1 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} + V_2 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

$$i_1 = V_1 \cdot \frac{-R_1 \cdot (R_2 + R_3)}{R_1 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} + V_2 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

$$i_1 = V_1 \cdot \frac{-(R_2 + R_3)}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

The expression for i_2 can likewise be found by sustitution:

$$i_2 = \frac{v_3}{R_2} - \frac{V_2}{R_2}$$

$$i_2 = V_1 \cdot \frac{R_2 \cdot R_3}{R_2 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} + V_2 \cdot \frac{R_1 \cdot R_3}{R_2 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} - \frac{V_2}{R_2}$$

$$i_2 = V_1 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \left(\frac{R_1 \cdot R_3}{R_2 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)} - \frac{1}{R_2} \right)$$

$$i_2 = V_1 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \frac{R_1 \cdot R_3 - (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)}{R_2 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)}$$

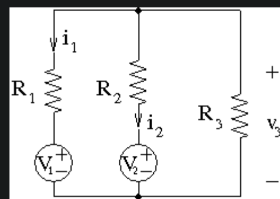
$$i_2 = V_1 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \frac{-R_2 \cdot (R_1 + R_3)}{R_2 \cdot (R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3)}$$

$$i_2 = V_1 \cdot \frac{R_3}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3} + V_2 \cdot \frac{-(R_1 + R_3)}{R_1 \cdot R_2 + R_1 \cdot R_3 + R_2 \cdot R_3}$$

S3E3: Circuit Variables are Superpositions of values due to each source separately

0 points possible (ungraded)

Consider the familiar network containing two voltage sources and three resistors. You are given that $R_1 = 7.0\Omega$, $R_2 = 3.0\Omega$. $R_3 = 5.0\Omega$, $V_1 = 2.0$V, and $V_2 = 8.0$V.



The voltage v_3 across resistor R_3 can be expressed as the sum of the voltage x_1 due to V_1 acting alone and the voltage x_2 due to V_2 acting alone.

The value (in Volts) of x_1 is:

0.422535 ✔ **Answer:** 0.4225352112676056

The value (in Volts) of x_2 is:

3.94366 ✔ **Answer:** 3.943661971830986

Similarly, the current i_1 into the resistor R_1 can be expressed as the sum of the current y_1 due to V_1 acting alone and the current y_2 due to V_2 acting alone. (**NOTE**: y_1 and y_2 are not labeled in the diagram, but $i_1 = y_1 + y_2$.)

The value (in Amperes) of y_1 is:

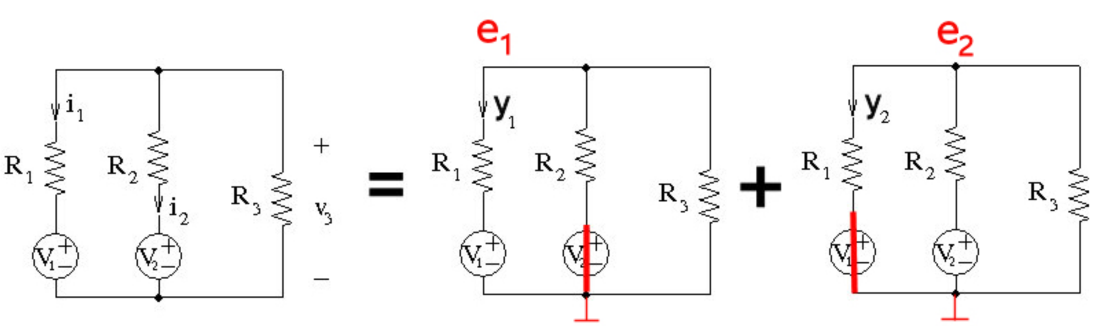
-0.225352 ✔ **Answer:** -0.22535211267605634

The value (in Amperes) of y_2 is:

0.56338 ✔ **Answer:** 0.5633802816901409

Surely this is true of every other circuit voltage and current, such as i_2 (but NOT device parameters).

We will not plague you with working them all out. :-)



In[]:=
```
Rs[r_List] := Total[r];
Rp[r_List] := 1 / Total[1 / r];
r1 = 7; r2 = 3; r3 = 5; v1 = 2; v2 = 8;
Solve[(x1 - v1)/r1 + x1/r2 + x1/r3 == 0, x1] // N
Solve[x2/r1 + (x2 - v2)/r2 + x2/r3 == 0, x2] // N
y1 = (x1 - v1)/r1 /. {x1 → 0.4225352112676056`}
y2 = x2/r1 /. {x2 → 3.943661971830986`}
```

Out[]= {{x1 → 0.422535}}

Out[]= {{x2 → 3.94366}}

Out[]= -0.225352

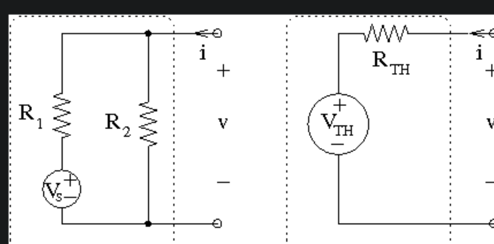
Out[]= 0.56338

S3E4: Simple Thevenin

0 points possible (ungraded)

Given the circuit below with the indicated terminals, you will construct a Thevenin equivalent circuit.

The device parameters of the circuit to be modeled are $V_S = 5.0$V, $R_1 = 56000.0\Omega$, and $R_2 = 18000.0\Omega$.



What is the Thevenin open-circuit voltage V_{TH} (in Volts)?

1.21622 ✔ **Answer:** 1.2162162162162162

What is the Thevnin equivalent resistance R_{TH} (in Ohms)?

13621.6 ✔ **Answer:** 13621.621621621622

```
Vs = 5; r1 = 56 000; r2 = 18 000;
(*Here VTH is actually the voltage portion in R2=Vs*(R2/(R1+R2)).*)
Vth = Vs * (r2 / (r1 + r2)) // N
rth = Rp[{r1, r2}] // N
```

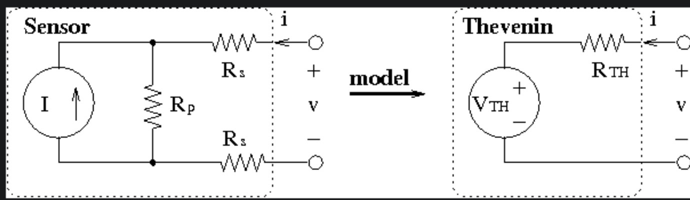
Out[]= 1.21622

Out[]= 13 621.6

S3E5: Thevenin Model

0 points possible (ungraded)

A certain light sensor is modeled as a current source that produces a current proportional to the intensity of light falling on it. There is leakage through the sensor, modeled by a resistor $R_p = 1.8\text{M}\Omega$ in parallel with the current source. There is resistance in the contacts to the sensor, modeled by the series resistances $R_s = 17.0\text{k}\Omega$. In this experiment the light produces a current of $I = 1.4300000000000002\mu\text{A}$.



It is useful to summarize this model by constructing a Thevenin equivalent circuit for it.

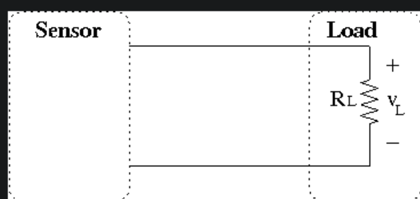
What is the Thevenin voltage V_{TH} of the sensor (in Volts)?

2.574 ✔ **Answer:** 2.5740000000000003

What is the Thevenin resistance R_{TH} of the sensor (in MΩ)?

1.836 ✔ **Answer:** 1.834

The sensor is intended to be used in a light meter. In this application the output of the sensor is connected to a system that amplifies the signal and displays it, scaled to appropriate units.



The amplifier is designed to present a resistance of $R_L = 100.0\text{k}\Omega$. So, from the point of view of the sensor we can model it as just a resistor.

What is the voltage V_L presented to the amplifier (in Volts)?

0.133092 ✔ **Answer:** 0.1330920372285419

Note that the circuit connecting the sensor to the amplifier and display does not care about the insides of either the sensor or of the the amplifier and display. So we don't have to consider those complications to compute the properties of their interconnection. This is the modeling power of the Thevenin idea!

In[ ]:=
```
rp = 1.8*^6; rs = 17*^3; i = 1.4300000000000002*^-6;
(*When you calculate VTH,note that you need to assume an "open circuit".Thus
 there will be NO current in the two resistors (Rs).Therefore,VTH=I*Rp*)
vth = i * rp
rth = rp + 2 rs
rl = 100*^3;
(*There is a series circuit consisting of a voltage source Vth
 and two resistors Rth and Rl. Find the current in this circuit
 and hence Vl or treat the circuit as a potential divider.*)
Icircuit = vth / (rth + rl);
vl = Icircuit * rl
```

Out[ ]= 2.574

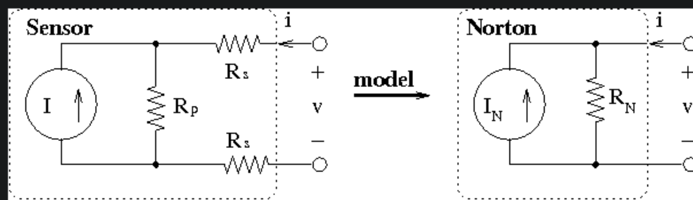
Out[ ]= 1.834×10^{6}

Out[ ]= 0.133092

S3E6: Norton Model

0 points possible (ungraded)

This is the same circuit as in the Thevenin exercise, with $R_p = 1.8\text{M}\Omega$, $R_s = 17.0\text{k}\Omega$, and $I = 1.4300000000000002\mu\text{A}$.



In this case, we want to summarize the circuit with a Norton model.

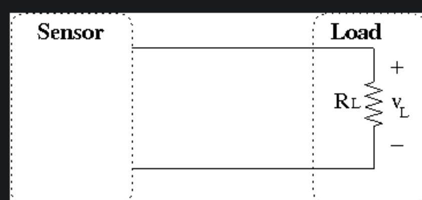
What is the Norton current I_N of the sensor (in μA)?

1.40349 ✔ **Answer:** 1.4034896401308616

What is the Norton resistance R_N of the sensor (in MΩ)?

1.834 ✔ **Answer:** 1.834

Again, we present a load as a resistance $R_L = 100.0\text{k}\Omega$.



What is the voltage V_L presented to the amplifier (in Volts)?

0.133092 ✔ **Answer:** 0.1330920372285419

```
rp = 1.8*^6; rs = 17*^3; i = 1.4300000000000002*^-6;
vth = i * rp;
rth = rp + 2 rs;
in = vth / rth
rth
(*Potential divider*)
vl = (vth * rl) / (rl + rth)
```

Out[•]= 1.40349×10^{-6}

Out[•]= 1.834×10^{6}

Out[•]= 0.133092

S4E2: Boolean Functions

0 points possible (ungraded)

How many distinct values can be represented with two boolean-valued signals?

4 ✔ **Answer:** 4

How many distinct boolean-valued functions are there of two boolean-valued signals?

16 ✔ **Answer:** 16

How many distinct values can be represented with three boolean-valued signals?

8 ✔ **Answer:** 8

How many distinct boolean-valued functions are there of three boolean-valued signals?

256 ✔ **Answer:** 256

In[ ]:=

```
(*Number of bits*)
n = 2;
(*Number of outputs*)
```

2^n

```
(*Number of boolean functions mapping input→output*)
```

2^{2^n}

```
n = 3;
2^n
2^(2^n)
```

Out[ ]= 4

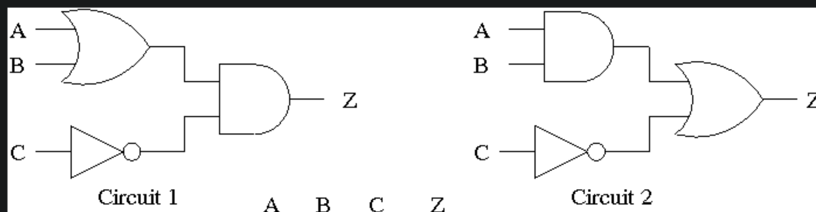
Out[ ]= 16

Out[ ]= 8

Out[ ]= 256

S4E3: Truth Table

0 points possible (ungraded)



A	B	C	Z
0	0	0	1
0	0	1	a
0	1	0	b
0	1	1	c
1	0	0	d
1	0	1	e
1	1	0	f
1	1	1	g

In the figure above there are two circuits and a partially filled in truth table. From the information in the truth table you can decide which circuit is described by that truth table. Enter the number of the chosen circuit:

2 ✔

What is the entry in the box labeled a?

0 ✔

What is the entry in the box labeled f?

1 ✔

What is the entry in the box labeled d?

1 ✔

What is the entry in the box labeled b?

1 ✔

In[∘]:=
```
c1 = Boole[BooleanTable[{a, b, c, (a || b) && ! c}, {a, b, c}]] // TableForm
c2 = Boole[BooleanTable[{a, b, c, (a && b) || ! c}, {a, b, c}]] // TableForm
```

Out[∘]//TableForm=

1	1	1	0
1	1	0	1
1	0	1	0
1	0	0	1
0	1	1	0
0	1	0	1
0	0	1	0
0	0	0	0

Out[∘]//TableForm=

1	1	1	1
1	1	0	1
1	0	1	0
1	0	0	1
0	1	1	0
0	1	0	1
0	0	1	0
0	0	0	1

Homework

MITx 6.002.1x
Circuits and Electronics 1: Basic Circuit Analysis

Help venkatn93

Course Progress Dates Discussion Notes FAQ

Course / Week 2 / Homework 2

Previous Next

Homework 2

Bookmark this page

Homework due Jul 22, 2022 22:34 +04 Completed

H2P1: Current Divider

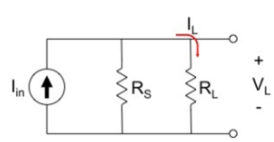
4/4 points (graded)

The resistances of commercially-available discrete resistors are restricted to particular sets. For example, the available values of resistors with 10% tolerance are selections from the $E12$ set multiplied by a power of ten from 10^0 through 10^5. The $E12$ set is:

$$E12 = \{10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82\}$$

Thus, you can buy 10% resistors with a nominal resistance of 330Ω or $33k\Omega$, but not 350Ω. Furthermore, the "tolerance" means that if you buy a 10% 390Ω resistor you can be sure that its resistance is between 351Ω and 429Ω.

In this problem we need to choose 10% resistors to make a current divider that meets a given specification.



We are given an input current $I_{in} = 100\mu A$ and a linear resistive load represented by the resistor R_L . Our resistive load is not regulated for the high current provided by our current source, so we add a resistor R_S in parallel to divide the current such that $I_L \approx 40\mu A$. An additional requirement is that the Thevenin resistance as seen from the load terminals (with both R_S and R_L connected) is between $60k\Omega$ and $80k\Omega$. Assume first that the resistors have their nominal resistance. Come up with resistors R_S and R_L such that the divider ratio $I_{L,nom}/I_{in}$ is within 10% of the requirement, where $I_{L,nom}$ is the load current using the nomainal resistance values.

Of course, the resistances you chose are just nominal. Given that they are only guaranteed to have resistances within 10% of the nominal value, what is the largest and smallest value that I_L may have?

Enter your values below. (**NOTE**: Both resistor values are needed for a correct answer.)

RS (in Ohms):

100000

RL (in Ohms):

150000

ILmax (in Amps):

0.000044898

ILmin (in Amps):

0.0000352941

Explanation:
For this solution, we are given that $I_{in} = 100\mu A, I_L = 40\mu A, 60k\Omega \leq R_{TH} \leq 80k\Omega$.
We apply the current divider equation:

$$I_L = \frac{I_{in} R_S}{R_S + R_L} \rightarrow 40\mu A = 100\mu A \frac{R_S}{R_S + R_L}$$
$$\therefore \frac{100 R_S}{40} = R_S + R_L, \text{ or } 3R_S = 2R_L$$

Since we know that the chosen resistors must obey the ratio 3:2, we choose resistances from the list of nominal resistances.
Choosing $R_S = 120k\Omega$ and $R_L = 180k\Omega$, we approximately observe this resistor ratio.
To verify that the equivalent thevenin resistance is within the required limit, we simply calculate the equivalent resistance of these two resistors as if they were in parallel, which is given by $R_{TH} = \frac{R_S R_L}{R_S + R_L} = 72k\Omega$
Finally, to calculate the maximum and minimum voltages, we apply the following formula:

$$I_{L,max} = \frac{I_{in} \times (1.1)(R_S)}{(0.9)(R_L) + (1.1)(R_S)} = 44.8\mu A$$
$$I_{L,min} = \frac{I_{in} \times (.9)(R_S)}{(1.1)(R_L) + (.9)(R_S)} = 35.2\mu A$$

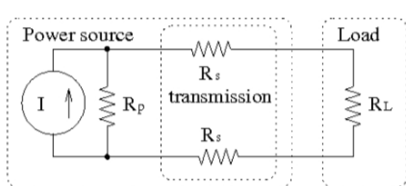
Submit You have used 1 of 25 attempts Save Show answer

Answers are displayed within the problem

H2P2: Solar Power

3/3 points (graded)

A simple model of a photovoltaic solar cell is a current source, with the current proportional to the amount of sunlight falling on it. A more accurate model includes a diode (a nonlinear element we will see later). There is some leakage current that we can model with a parallel resistor, and there is a voltage drop in the interconnect that we can model with series resistances connecting to the load resistor. So a crude model of a complete system might be the circuit shown below.



In this system we have $I = 0.2$A, $R_p = 3.0\Omega$, and $R_s = 1.8\Omega$.

You are to determine the load resistance, R_L, for which the maximum power is transferred to the load. (Hint: remember your calculus!)

What is this optimum load resistance (in Ohms)?

6.6 ✔ **Answer:** 6.6

What is the power (in Watts) that is delivered to this best load resistance?

0.0136364 ✔ **Answer:** 0.01364

What is the Thevenin equivalent resistance (in Ohms) of the power source as seen by the load resistance?

6.6 ✔ **Answer:** 6.6

Hmmmmmm.

Explanation:
The optimum load resistance occurs when the maximum power is transferred. To find that point, we take the derivative of an expression for power with respect to the load resistance.
But first, we can convert the Norton sub-circuit on the left side of the circuit diagramto its Thevenin equivalent, which gives us a voltage $V_{R_p} = (0.2)\,(3.0) = 0.6\ V$.The R_{THnew} of the entire new circuit will be: $R_s + R_p + R_s + R_L$. The equation for power consumed by the load is $P = I^2 R_L$, where:

$$I = \frac{V}{R_{THnew}} = \frac{0.6}{R_s + R_p + R_s + R_L}$$

Setting the derivative of the expression for power equal to zero and solving for the load resistance will give us the optimal load resistance for maximum power transfer.

$$\frac{dP}{dR_L} = \frac{d([\frac{0.6}{R_s+R_p+R_s+R_L}]^2 \times R_L)}{dR_L} = 0$$

Simplifying the power expression by substituting known variables and re-naming R_L as x :

$$\frac{d}{dx}\left(\frac{0.36x}{(6.6+x)^2}\right) = 0$$

$$= 0.36\left(\frac{d}{dx}\left[\frac{x}{(x+6.6)^2}\right]\right)$$

Applying product rule:

$$= 0.36\left(x\left(\frac{d}{dx}\left[\frac{1}{(x+6.6)^2}\right]\right) + \frac{\frac{d}{dx}(x)}{(x+6.6)^2}\right)$$

$$= 0.36\left(x\left(\frac{d}{dx}\left[\frac{1}{(x+6.6)^2}\right]\right) + \frac{1}{(x+6.6)^2}\right)$$

$$= 0.36\left(x\left[\frac{-2}{(x+6.6)^3}\right] + \frac{1}{(x+6.6)^2}\right)$$

$$= 0.36\left(\frac{-2x}{(x+6.6)^3} + \frac{1}{(x+6.6)^2}\right)$$

Equating the expression to zero, we solve for x:

$$0 = \frac{-2x}{(x+6.6)^3} + \frac{1}{(x+6.6)^2}$$

$$\therefore \frac{1}{(x+6.6)^2} = \frac{2x}{(x+6.6)^3}$$

$$\therefore x + 6.6 = 2x$$

$$\therefore x = R_L = 6.6\Omega$$

To solve for power consumed, we simply use the following expression:

$$P = I^2 R_L \rightarrow I = \frac{0.6V}{13.2\Omega} \text{ and } R_L = 6.6\Omega$$

$$= 0.01364\ W$$

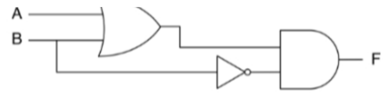
R_{TH} seen by the load resistance is: $R_s + R_p + R_s = 6.6\Omega$
Note that the optimum load resistance is the same as the thevenin equivalent resistance.

Submit You have used 1 of 25 attempts Save Show answer

Answers are displayed within the problem

H2P3: Logic Circuits

5/5 points (graded)



Circuit 1

In the figure above, Circuit 1 is a two-input single-output logic circuit. The truth table for a two-input function has four rows as shown below:

A	B	F
0	0	w
0	1	x
1	0	y
1	1	z

Fill in the values of F in the truth table for Circuit 1.
What is the entry in the box labeled w?

0 ✔ **Answer:** 0

What is the entry in the box labeled x?

0 ✔ **Answer:** 0

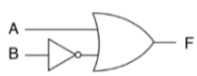
What is the entry in the box labeled y?

1 ✔ **Answer:** 1

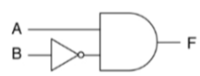
What is the entry in the box labeled z?

0 ✔ **Answer:** 0

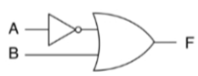
The figure below shows four additional two-input single-output logic circuits. One of these circuits is equivalent to Circuit 1; i.e., they compute the same logic function.



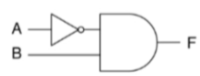
Circuit 2



Circuit 3



Circuit 4



Circuit 5

Which of these circuits is equivalent to Circuit 1? (Enter the number of the circuit)

3 ✔ **Answer:** 3

We see there are many different logic circuits that can implement the same functionality. Using equations instead of truth tables help us simplify logic circuits. You can write an equation from Circuit 1 and simplify the equation to obtain the simpler equivalent logic circuit found in Circuits 2-5.

Explanation:
Circuit 1 displays a circuit which evaluates the boolean expression $F = (A + B) \cdot \bar{B}$
Let's evaulate this boolean expression using a truth table in steps:

1. evaluate $(A + B)$
2. evaluate $\bar{B}$
3. evaluate $(A + B) \cdot \bar{B}$

$\mathbf{A}$	$\mathbf{B}$	$(\mathbf{A}+\mathbf{B})$	$\bar{\mathbf{B}}$	$(\mathbf{A}+\mathbf{B}) \cdot \bar{\mathbf{B}}$
0	0	0	1	0
0	1	1	0	0
1	0	1	1	1
1	1	1	0	0

Thus, we find that w = 0, x= 0, y = 1, z = 0
Now we determine which of the remaining four circuits is equivalent to circuit 1. In circuits 2 and 4, the signal 'F' corresponds to the output of an 'or' gate, while 'F' in circuits 3 and 5 correspond to the output of an 'and' gate. We can rule out 2 and 4 because the desired F only has one '1' value, which corresponds to the output of an 'and' gate.
In order to pick from circuits 3 and 5, let's evaluate the boolean expression for each:

- Circuit 3: $F = A \cdot \bar{B}$
- Circuit 5: $F = \bar{A} \cdot B$

We can simplify our original expression from circuit 1 using boolean logic:

$$(A+B)\cdot\bar{B}$$
$$A\cdot\bar{B}+B\cdot\bar{B}\ (distributive\ property)$$
$$A\cdot\bar{B}+0\ (complement\ law - i.e.\ A\cdot\bar{A}=0)$$
$$A\cdot\bar{B}\ (identity\ law - i.e.\ A+0=A)$$

Thus, we see the boolean expression of circuit 1 simplifies to the boolean expression of circuit 3. They must be equivalent circuits.
As an alternative way to see the equivalence, let's make a truth table for circuit 3:

A	B	$\bar{B}$	$A\cdot\bar{B}$
0	0	1	0
0	1	0	0
1	0	1	1
1	1	0	0

We see that Circuit 3 evaluates to the same final column (the signal F) in the truth table, and thus is an equivalent circuit

Submit You have used 1 of 25 attempts Save Show answer

Answers are displayed within the problem

Discussion

Hide Discussion

Topic: Week 2 / Homework 2

Add a Post

Show all posts by recent activity

H2P2 13

H2P2
I can get VTH= **xxxx** V, RTH=**xxxx** , IL= **xxxx** , but I don't know how to use Thevenin Method to determine RL, I'm stuck. **Please do... 2

H2P1: Current Divider
Sorry i dont get it: First i made a Norton circuit And i Use RN the values 60kohm and 80 Kohm and i get 2 values of VN, with that values i get 2 v... 3

Need advise for this problem.
Need help with implementation of variables. Thank you. 2

ILmax vs ILmin
I got ILmax and ILmin correctly after I switched them. My ILmax was accepted correctly in the ILmin box and vice versa. I don't know why this is ... 2

H2P3
F= **[xxxxx]** but the answer was **[xxxxx]**? **Please do not post answers.** 4

PRACTICE QUESTIONS
Are there similar practice questions with answers we ca practice before we attempt the homework??, I struggling to find the answers and I'm bur... 2

H2P2 resistor
Not to sure how to get RL in this question, is it okay if someone could help? 1

H2P1 via Voltage
Hi all! I got the right answers for IL max and min, but I am wondering if there is another way to do it. I set up a Norton equation with IN=Iin and R... 3

H2P@
I really tried a lot in this question. but still didn't got ? What I am suppose to do 2

[STAFF] H2P2 Question
Why can't I use P=V_L^2/R_L to determine maximum power, where R_L is optimum load resistance? 9

[Staff] Can the course director provide explanations for each question?
I would really like to know the detailed answer and explanation for each question. It would be helpful for me to understand which step I've done ... 2

Forgot about calculus and couldn't get the MAX power. Couldn't see the answers either
Can anyone gives a hint about how to calculate dp/drL=0?

Calculator Hide Notes

< Previous Next >

Affiliates
edX for Business
Open edX
Careers
News

Privacy Policy
Accessibility Policy
Trademark Policy
Sitemap

Contact Us
Help Center
Media Kit

Google play App Store