7. What is the value of resistance between \( a \) and \( b \)?

a. \( R = 9 \ \Omega \)
b. \( R = 16 \ \Omega \)
c. \( R = 24 \ \Omega \)
d. \( R = 35 \ \Omega \)
e. \( R = 70 \ \Omega \)

8. What is the expression for resistance between \( a \) and \( b \)?

a. \[ R = R_1 \left( \frac{R_2}{R_1 + R_2} + \frac{R_3}{R_1 + R_3} \right) \]
b. \[ R = R_1 + R_2 + R_3 + R_4 \]
c. \[ R = \frac{(R_1 + R_2)(R_1 + R_3)}{2R_1 + R_2 + R_3} \]
d. \[ R = \frac{R_1(R_2 + R_3)}{2R_1 + R_2 + R_3} \]
e. \[ R = \frac{R_2 R_3}{R_2 + R_3} \]

9. What are the voltages \( V_1 \) and \( V_2 \) in the circuit below?

a. \( V_1 = 10 \ V \) and \( V_2 = 5 \ V \)
b. \( V_1 = 9 \ V \) and \( V_2 = 6 \ V \)
c. \( V_1 = 7.5 \ V \) and \( V_2 = 7.5 \ V \)
d. \( V_1 = 6 \ V \) and \( V_2 = 9 \ V \)
e. \( V_1 = 5 \ V \) and \( V_2 = 10 \ V \)
10. What are the voltages $V_1$ and $V_2$ in the circuit below?
   
   a. $V_1 = 2$ V and $V_2 = 4$ V  
   b. $V_1 = 3$ V and $V_2 = 3$ V  
   c. $V_1 = 4$ V and $V_2 = 2$ V  
   d. $V_1 = 6$ V and $V_2 = 3$ V  
   e. Not enough info to tell

11. What are the values of the currents $I_1$ and $I_2$ in the circuit below?
   
   a. $I_1 = 30$ mA and $I_2 = 10$ mA  
   b. $I_1 = 10$ mA and $I_2 = 30$ mA  
   c. $I_1 = 45$ mA and $I_2 = 15$ mA  
   d. $I_1 = 15$ mA and $I_2 = 45$ mA  
   e. $I_1 = 15$ mA and $I_2 = 5$ mA

12. What is the value of resistance $R$ needed to make $V_o = 4$ V?
   
   a. 1 kΩ  
   b. 1.2 kΩ  
   c. 1.5 kΩ  
   d. 2 kΩ  
   e. 3 kΩ

Now, repeat problem 12, but use Thevenin equivalent of everything but $R$ to solve!

14. How can one describe the IV characteristics line of an ideal ammeter (aka ideal current meter)?
   
   a. Horizontal line going through the origin  
   b. Vertical line going through the origin  
   c. Any line going through the origin  
   d. Any horizontal line  
   e. Any vertical line
15. Which is the correct IV equation for the circuit below?

a. \( I = -\frac{1}{5} V + 0.60 \)
b. \( I = -\frac{1}{5} V + 0.20 \)
c. \( I = -\frac{1}{20} V + 0.20 \)
d. \( I = -\frac{1}{20} V + 0.15 \)
e. \( I = 0.20 \)

16. If the open circuit voltage of a circuit containing a source and some resistors is measured at 15 V, while the current through the short circuit across the circuit is 300 mA, what would be the power absorbed by a 100 \( \Omega \) resistor placed across the terminals?

a. 0.5 W
b. 1.0 W
c. 1.2 W
d. 1.5 W
e. 4.5 W

17. What is the resistance, represented by the dashed line, which intersects the IV line of the circuit C at the voltage value of 12 V?

a. 300 \( \Omega \)
b. 450 \( \Omega \)
c. 600 \( \Omega \)
d. 900 \( \Omega \)
e. 1200 \( \Omega \)
18. Find the Thevenin equivalent of the circuit below.

   a. \( V_T = 9 \text{ V}, \ R_T = 900 \ \Omega \)
   b. \( V_T = 9 \text{ V}, \ R_T = 200 \ \Omega \)
   c. \( V_T = 6 \text{ V}, \ R_T = 300 \ \Omega \)
   d. \( V_T = 4 \text{ V}, \ R_T = 200 \ \Omega \)
   e. \( V_T = 2 \text{ V}, \ R_T = 200 \ \Omega \)

19. What is the node voltage \( V_A \)?

   a. 6.0 V
   b. 4.2 V
   c. 3.0 V
   d. 2.4 V
   e. 2.0 V

20. What is the node voltage \( V_A \) if \( V_1 = 15 \text{ V} \)?

   a. 8.5 V
   b. 8.0 V
   c. 7.5 V
   d. 7.0 V
   e. 6.5 V
21. What is the current, $I_S$, going through both voltage sources, given $V_S = 4.5\, V$?

- a. 0 A
- b. 0.5 A
- c. 1 A
- d. 1.5 A
- e. 2 A

![Circuit Diagram]

22. If a certain PWM waveform with a 20% duty cycle has an RMS voltage of 3 V, what will be the RMS voltage if the duty cycle increases to 40%?

- a. 3 V
- b. $3\sqrt{2} V$
- c. $3\sqrt{3} V$
- d. 6 V
- e. 12 V

23. What is the approximate resistance of a light bulb which consumes 40 W when the AC voltage (in volts) is given by $v(t) = 200\sqrt{2}\, \cos(100\pi t)$?

- a. 1.0 kΩ
- b. 1.4 kΩ
- c. 2.0 kΩ
- d. 2.4 kΩ
- e. 4.0 kΩ
24. If a light-emitting diode (LED) has the turn on voltage $V_{ON} = 2\ V$, what is the resistance $R$ needed to set the current through the LED to $50\ mA$ (assuming the offset ideal model)?

a. 20 $\Omega$
b. 30 $\Omega$
c. 40 $\Omega$
d. 50 $\Omega$
e. 60 $\Omega$

25. Assuming an offset ideal model, what is the current, $I$, through the voltage source if the diodes have the turn on voltage $V_{ON} = 0.7\ V$?

a. 120 mA
b. 50 mA
c. 40 mA
d. 30 mA
e. 10 mA
2. If the light-emitting diode (LED) has the turn on voltage $V_{on} = 2 \, V$, what is the resistance $R$ needed to set the electrical power consumed by the LED to 100 mW (assuming the offset ideal model)?
   a. 20 $\Omega$
   b. 40 $\Omega$
   c. 60 $\Omega$
   d. 80 $\Omega$
   e. 100 $\Omega$

3. If $V_{on} = 0.7 \, V$ for both diodes, what is the minimum voltage $V_2$ which will turn on the diode on the right?
   a. 0.75 V
   b. 1.1 V
   c. 1.45 V
   d. 1.8 V
   e. 2.9 V

4. What are the minimum and maximum values of $V_{out}$ assuming the offset ideal model for a diode with $V_{on} = 0.7 \, V$ for the input signal shown below?
   a. minimum -3 V, maximum 3 V
   b. minimum -3 V, maximum 0.7 V
   c. minimum -3 V, maximum 1.4 V
   d. minimum 0.7 V, maximum 3 V
   e. minimum 1.4 V, maximum 3 V
5. How many of the light-emitting diodes are ON in the diagram below, assuming an offset ideal model with $V_{ON} = 2$ V?

a. 1  
b. 2  
c. 3  
d. 4  
e. 6

From Hour Exam 1, Fall 2014

17. How much power is absorbed by the 6 Ω resistor if the voltage source supplies 60 W when it is connected to the resistors as shown?

a. 15 W  
b. 20 W  
c. 30 W  
d. 40 W  
e. 60 W

19. Which is the correct IV equation for the circuit below?

a. $I = \frac{1}{600} V - 0.02$  
b. $I = -\frac{1}{600} V + 0.02$  
c. $I = \frac{1}{200} V - 0.02$  
d. $I = -\frac{1}{200} V + 0.02$  
e. $I = -0.02$
20. If the open circuit voltage of a circuit containing a source and some resistors is measured at 8 V, while the current through the short circuit across the circuit is 400 mA, what would be the power absorbed by a 20 Ω resistor placed across the terminals?

a. 3.2 W  
b. 1.6 W  
c. 0.8 W  
d. 0.4 W  
e. 0.2 W

21. What is the resistance of the Thevenin or Norton equivalent of the circuit C, which IV characteristics are plotted below?

a. 45 Ω  
b. 200 Ω  
c. 500 Ω  
d. 2000 Ω  
e. 5000 Ω
9. What is the value of resistance between \( a \) and \( b \)?

a. \( R = 160 \, \Omega \)
b. \( R = 80 \, \Omega \)
c. \( R = 60 \, \Omega \)
d. \( R = 24 \, \Omega \)
e. \( R = 16 \, \Omega \)

10. What is the expression for resistance between \( a \) and \( b \)?

a. \( R = R_1 + R_2 + R_3 + R_4 \)
b. \( R = R_1 + R_2 + \frac{R_3 R_4}{R_2 + R_4} \)
c. \( R = \frac{(R_1 + R_2)R_2}{R_1 + R_2 + R_4} + R_4 \)
d. \( R = \frac{(R_1 + R_2)R_3 R_4}{R_1 + R_2 + R_3 + R_4} \)
e. \( R = \frac{R_1 [R_2 (R_3 + R_4) + R_3 R_4]}{(R_1 + R_2) (R_3 + R_4) + R_3 R_4} \)

11. What are the voltages \( V_1 \) and \( V_2 \) in the circuit below?

a. \( V_1 = 2 \, V \) and \( V_2 = 4 \, V \)
b. \( V_1 = 3 \, V \) and \( V_2 = 3 \, V \)
c. \( V_1 = 4 \, V \) and \( V_2 = 2 \, V \)
d. \( V_1 = 6 \, V \) and \( V_2 = 6 \, V \)
e. Not enough info to tell
12. What are the voltages $V_1$ and $V_2$ in the circuit below?

a. $V_1 = 2 \text{ V}$ and $V_2 = 4 \text{ V}$
b. $V_1 = 3 \text{ V}$ and $V_2 = 3 \text{ V}$
c. $V_1 = 4 \text{ V}$ and $V_2 = 2 \text{ V}$
d. $V_1 = 6 \text{ V}$ and $V_2 = 6 \text{ V}$
e. Not enough info to tell

13. What are the values of the currents $I_1$ and $I_2$ in the circuit below?

a. $I_1 = 10 \text{ mA}$ and $I_2 = 30 \text{ mA}$
b. $I_1 = 30 \text{ mA}$ and $I_2 = 10 \text{ mA}$
c. $I_1 = 40 \text{ mA}$ and $I_2 = 40 \text{ mA}$
d. $I_1 = 20 \text{ mA}$ and $I_2 = 60 \text{ mA}$
e. $I_1 = 60 \text{ mA}$ and $I_2 = 20 \text{ mA}$

More practice: Solve 13 again breaking the circuit down the middle and replacing the left and right side with Thevenin equivalents. Use this to determine the voltage $V$. See below.

13. What are the values of the currents $I_1$ and $I_2$ in the circuit below?
14. What is the value of resistance R needed to make \( V_0 = 6 \, V \)?

- a. 3 k\( \Omega \)
- b. 4.5 k\( \Omega \)
- c. 6 k\( \Omega \)
- d. 9 k\( \Omega \)
- e. 18 k\( \Omega \)

16. How can one describe the IV characteristics line of an ideal voltmeter (aka ideal voltage meter)?

- a. Horizontal line going through the origin
- b. Vertical line going through the origin
- c. Any line going through the origin
- d. Any horizontal line
- e. Any vertical line

19. Find the Thevenin equivalent circuit parameters for the circuit below:

- a. \( V_T = 3.0 \, V, \, R_T = 8 \, \Omega \)
- b. \( V_T = 2.0 \, V, \, R_T = 8 \, \Omega \)
- c. \( V_T = 3.0 \, V, \, R_T = 4 \, \Omega \)
- d. \( V_T = 2.0 \, V, \, R_T = 4 \, \Omega \)
- e. \( V_T = 3.0 \, V, \, R_T = 1 \, \Omega \)
21. What is the voltage $V_R$ across the 30 $\Omega$ resistor?

a. 0.75 V  
b. 1.5 V  
c. 2.1 V  
d. 2.4 V  
e. 3.0 V

Challenge: solve again by splitting the circuit as shown below and converting the left side to the Thevenin equivalent:

21. What is the voltage $V_R$ across the 30 $\Omega$ resistor?

22. What is the ideal source voltage, $V_s$, for which there is no current flowing through it, i.e. $I_s=0$.

a. 2 V  
b. 4 V  
c. 6 V  
d. 8 V  
e. 10 V
Solve again by using a Thevenin equivalent circuit on the left. See below.

22. What is the ideal source voltage, $V_s$, for which there is no current flowing through it, i.e. $I_s=0$.

![Thevenin equivalent circuit](image)

23. Which of the ideal sources in the circuit below are supplying power?

a. Just the 9 V source
b. Just the 50 mA source
c. 50 mA and 2 V sources
d. 50 mA and 9 V sources
e. All three sources

From Hour Exam 2, Spring 2015

1. What is the node voltage $V_A$ if $V_1=3$ V and $V_2=2$ V?

a. 1 V
b. 1.5 V
c. 2 V
d. 2.5 V
e. 3 V
2. What is the node voltage $V_A$ if $V_1 = 6 \, V$?

   a. 2.5 $V$
   b. 3 $V$
   c. 3.5 $V$
   d. 4 $V$
   e. 4.5 $V$

5. Assuming an offset ideal model, what is the current, $I$, through the voltage source if the diodes have the turn on voltage $V_{ON} = 0.7 \, V$?

   a. 110 mA
   b. 55 mA
   c. 40 mA
   d. 20 mA
   e. 10 mA

6. Assuming an ideal offset model with $V_{ON} = 0.7 \, V$ for each diode, what minimum voltage $V_2$ drives D2 to the point of turning on?

   a. 0.7 $V$
   b. 1.2 $V$
   c. 1.7 $V$
   d. 2.2 $V$
   e. 2.9 $V$
7. What are the minimum and maximum values of $V_{out}$ assuming the offset ideal model for the diodes with $V_{ON} = 0.7 \, \text{V}$ and the input signal given by $V_m = 6 \cos(120\pi t) \, \text{V}$?

- a. minimum -6 V, maximum 6 V
- b. minimum -6 V, maximum 0.7 V
- c. minimum -6 V, maximum 1.4 V
- d. minimum -0.7 V, maximum 6 V
- e. minimum -1.4 V, maximum 6 V

8. How many of the light-emitting diodes are ON (emitting light) in the diagram below, assuming an offset ideal model with $V_{ON} = 2 \, \text{V}$?

- a. 3
- b. 4
- c. 5
- d. 6
- e. 7

---

6. All lightbulbs below are identical and can be modeled as resistors. Of the labeled lightbulbs, which one is dissipating the least power?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5
8. What is the smallest non-zero resistance one can make with one 200 Ω, one 300 Ω, and one 600 Ω resistor?
   a. 50 Ω
   b. 75 Ω
   c. 100 Ω
   d. 150 Ω
   e. 200 Ω

9. What is the power supplied by the current source?
   a. 25 mW
   b. 50 mW
   c. 75 mW
   d. 100 mW
   e. 125 mW

11. What is the power dissipated (absorbed) by the 60 Ω resistor?
    a. 1/6 W
    b. 2/15 W
    c. 1/10 W
    d. 1/15 W
    e. 1/30 W

12. What is the resistance, \( R \), which makes the labeled current zero, i.e. \( I_1 = 0 \)?
    a. 100 Ω
    b. 150 Ω
    c. 600 Ω
    d. 750 Ω
    e. 2 kΩ
13. What is the correct I-V expression (where $I$ is in amps and $V$ is in volts), for the circuit below?

a. $I = -\frac{V}{240} + 1$

b. $I = -\frac{V}{240} + 2$

c. $I = -\frac{V}{120} + 1$

d. $I = -\frac{V}{120} + 2$

e. $I = -\frac{V}{60} + 1$

14. In comparison with a higher-valued resistor a lower-valued resistor's IV characteristic line would have a

a. larger magnitude voltage-axis intercept

b. smaller magnitude current-axis intercept

c. smaller magnitude voltage-axis and larger magnitude current-axis intercepts

d. larger magnitude slope

e. smaller magnitude slope

15. Consider a circuit, C, with two terminals shown connected to three loads below. If its open-circuit voltage is 12 V, short circuit current is 3 A, what is the power dissipated (absorbed) by a 2 A load connected to the circuit?

a. 36 W

b. 24 W

c. 16 W

d. 8 W

e. 6 W
16. What is the Norton equivalent of the circuit below?

![Circuit Diagram]

a. \( I_N = 1.5 \, \text{A}, \ R_N = 9 \, \Omega \)
b. \( I_N = 1.5 \, \text{A}, \ R_N = 6 \, \Omega \)
c. \( I_N = 1.5 \, \text{A}, \ R_N = 2 \, \Omega \)
d. \( I_N = 0.5 \, \text{A}, \ R_N = 6 \, \Omega \)
e. \( I_N = 0.5 \, \text{A}, \ R_N = 2 \, \Omega \)

17. Two identical linear circuits, each with a Norton equivalent given by \( I_N = 3 \, \text{A}, \ R_N = 3 \, \Omega \), are combined in parallel to form a new circuit. The new circuit’s Thevenin equivalent is given by

a. \( V_T = 18 \, \text{V}, \ R_T = 3 \, \Omega \)
b. \( V_T = 18 \, \text{V}, \ R_T = 1.5 \, \Omega \)
c. \( V_T = 9 \, \text{V}, \ R_T = 3 \, \Omega \)
d. \( V_T = 9 \, \text{V}, \ R_T = 1.5 \, \Omega \)
e. \( V_T = 4.5 \, \text{V}, \ R_T = 3 \, \Omega \)

18. What is a good estimate of a lightbulb’s resistance, if the lightbulb absorbs 50W of average power when the AC voltage across it is given by the following equation? (If you need, \(1.4^2 = 2\))

\[ v(t) = 140 \cos(120\pi t) \]

a. \( 100 \, \Omega \)
b. \( 140 \, \Omega \)
c. \( 200 \, \Omega \)
d. \( 250 \, \Omega \)
e. \( 400 \, \Omega \)
20. What is the current, \( I \), supplied by the voltage source, if \( V_{\text{ON}} = 0.7 \, \text{V} \), assuming offset ideal diode model?

a. 0 mA  
b. 8.0 mA  
c. 11.5 mA  
d. 16 mA  
e. 23 mA

22. Suppose that the input signal is given by \( V_{\text{in}} = 2 \cos(120\pi t) \, \text{V} \) and we would like to set the minimum value of \( V_{\text{out}} \) to \(-1 \, \text{V} \). Assuming the offset ideal model for the diode with \( V_{\text{ON}} = 0.7 \, \text{V} \), what should be the value chosen for \( V_s \)?

a. \( V_s = -1.7 \, \text{V} \)  
b. \( V_s = -1.3 \, \text{V} \)  
c. \( V_s = -1 \, \text{V} \)  
d. \( V_s = -0.3 \, \text{V} \)  
e. \( V_s = 0.3 \, \text{V} \)