Hour Examination #1

1) Write your official:
   Last Name (use capital letters): ____________________________
   First Name (use capital letters): ____________________________
   NetID: ____________________________________________
   UIN: __________________________________________________

2) Fill in the Orange bubble sheet with all the information requested:
   a. LAST NAME, FIRST INITIAL example: SCHMITZ C
   b. STUDENT NUMBER (UIN) example: 678912345
   c. SECTION (AL1 9am enter 111, AL2 10am - 222, AL3 2pm - 333, AL4 3pm - 444)
   d. NETWORK ID (NetID) example: cdshmit
   e. Also, fill out the hand-written center of the sheet with course, instructor, section and your signature.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

A. CALCULATORS ARE NOT ALLOWED ON THIS EXAM

B. Write or print clearly in this exam booklet for your own benefit. Circle the correct answer within the exam booklet and then mark it on the orange bubble sheet. You may not argue for points because you marked one answer in the exam and another on the bubble sheet, so be careful when marking your answers.

C. All problems are equally weighted.

D. Your grade will be determined based on the answers submitted on your bubble sheet.
   Submit both the bubble sheet AND the complete exam booklet.

Students caught cheating on this exam will earn a grade of F for the entire course. Other penalties may include suspension and/or dismissal from the university.

I have read and acknowledge the above statements. Furthermore, I promise not to give or receive help on this or any other exam.

________________________________________
Signature
You have TEST FORM:

A

Please enter this in the lower right corner of the orange bubble sheet in the location marked TEST FORM.
1. Consider a hybrid car that has 400 \( kJ \) of kinetic energy at a certain speed. The car’s regenerative braking is 40\% efficient (\( \eta = 0.4 \)) at converting kinetic energy \( (E = \frac{1}{2}mv^2) \) to energy stored in a battery. When the car slows down to half of its original speed, what is the energy, \( \Delta E \), added to the car’s battery?

a. \( \Delta E = 40 \) \( kJ \)
b. \( \Delta E = 80 \) \( kJ \)
c. \( \Delta E = 120 \) \( kJ \)
d. \( \Delta E = 160 \) \( kJ \)
e. \( \Delta E = 200 \) \( kJ \)

2. The energy of a certain charged capacitor is 5 J. What is the new energy stored in that capacitor, if its charge decreases to 1/3 of its original value? (Hint: The capacitance does not change. Consider what happened to the voltage across the capacitor.)

a. Stays the same: 5 J
b. Decreased to 2/3 of original: 10/3 J
c. Decreases to 4/9 of original: 20/9 J
d. Decreases to 1/3 of original: 5/3 J
e. Decreases to 1/9 of original: 5/9 J

3. What is the maximum voltage that can be applied across a 400 \( \Omega \) resistor without risking damage, if the resistor’s maximum power rating is \( \frac{1}{4}W \)?

a. 10 V
b. \( 10\sqrt{2} \) V
c. 20 V
d. \( 20\sqrt{2} \) V
e. 40 V
4. If $V_1 = 0.7\, V, V_4 = 0.3\, V, V_5 = 0.4\, V$ in the circuit below, what is $V_2$?
   a. 1.4 V
   b. 0.8 V
   c. 0.6 V
   d. 0 V
   e. −0.6 V

5. If $I_1 = −10\, mA$ (yes, $I_1$ is negative), $I_3 = 6\, mA, I_6 = 8\, mA$ in the circuit below, what is $I_4$?
   a. −0 mA
   b. −4 mA
   c. −6 mA
   d. −10 mA
   e. −20 mA

6. Which of the following KCL and KVL equations is incorrect for this circuit?
   a. $I_1 = I_4$
   b. $I_2 = I_3 + I_4$
   c. $I_2R_2 + I_3R_3 - V_2 = 0$
   d. $I_1R_1 + I_2R_2 + I_4R_4 = V_1$
   e. $V_1 - I_1R_1 - I_3R_3 - V_2 - I_4R_4 = 0$
7. What is the value of resistance between \(a\) and \(b\)?

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

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. \(R = \frac{R_1R_2R_3}{R_1+R_2+R_3}\)

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

a. \(V_1 = 10 \text{ \text{V}}\) and \(V_2 = 5 \text{ \text{V}}\)
b. \(V_1 = 9 \text{ \text{V}}\) and \(V_2 = 6 \text{ \text{V}}\)
c. \(V_1 = 7.5 \text{ \text{V}}\) and \(V_2 = 7.5 \text{ \text{V}}\)
d. \(V_1 = 6 \text{ \text{V}}\) and \(V_2 = 9 \text{ \text{V}}\)
e. \(V_1 = 5 \text{ \text{V}}\) and \(V_2 = 10 \text{ \text{V}}\)
10. 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 $V_2 = 3 \text{ V}$
e. Not enough info to tell

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

a. $I_1 = 30 \text{ mA}$ and $I_2 = 10 \text{ mA}$
b. $I_1 = 10 \text{ mA}$ and $I_2 = 30 \text{ mA}$
c. $I_1 = 45 \text{ mA}$ and $I_2 = 15 \text{ mA}$
d. $I_1 = 15 \text{ mA}$ and $I_2 = 45 \text{ mA}$
e. $I_1 = 15 \text{ mA}$ and $I_2 = 5 \text{ mA}$

12. What is the value of resistance $R$ needed to make $V_o = 4 \text{ V}$?

a. $1 \text{ k}\Omega$
b. $1.2 \text{ k}\Omega$
c. $1.5 \text{ k}\Omega$
d. $2 \text{ k}\Omega$
e. $3 \text{ k}\Omega$
13. How much power is being absorbed by the 6 Ω resistor if the 3 Ω resistor is absorbing 60 W?

a. 120 W  
b. 90 W  
c. 60 W  
d. 30 W  
e. 20 W

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 Ω 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 Ω  
   b. 450 Ω  
   c. 600 Ω  
   d. 900 Ω  
   e. 1200 Ω
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 $V_1 = 15 \, V$?

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
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 \( k\Omega \)  
b. 1.4 \( k\Omega \)  
c. 2.0 \( k\Omega \)  
d. 2.4 \( k\Omega \)  
e. 4.0 \( k\Omega \)
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 Ω  
b. 30 Ω  
c. 40 Ω  
d. 50 Ω  
e. 60 Ω

![Diagram of a circuit with a voltage source and a light-emitting diode (LED)]

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

![Diagram of a circuit with a voltage source and two diodes]
THIS IS SCRATCH PAPER – PLEASE TURN IN WITH THE EXAM