Professors Schmitz, Varodayan, and Minin  ECE 110  September 23, 2013

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 (for AL1 10am enter 111, AL2 1pm = 222, AL3 3pm = 333)
   d. NETWORK ID (NetID) example: cdschmit
   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. 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.

B. All problems are equally weighted.

C. Your grade will be determined based on the answers submitted on your bubble sheet. **But you must 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.

NO CALCULATORS

YOU MAY TEAR OFF THE LAST PAGE (HELP SHEET) AND USE THE BACK FOR SCRATCH PAPER
1. Who is a co-inventor of the transistor and, soon after, became a physics professor at the University of Illinois?
   a. Ilesanmi Adesida
   b. John Bardeen
   c. Rosalyn Yalow
   d. Jack Kilby
   e. Paul Lauterbur

2. According to the ABET definition of engineering presented in class, the engineers “…utilize…forces of nature…for the benefit of __________.”
   a. themselves
   b. their employers
   c. their university
   d. their country
   e. mankind

3. Which is not a main point of the IEEE Code of Ethics?
   a. professional development
   b. avoiding conflicts of interest
   c. providing and accepting honest criticism
   d. public safety and environment
   e. building financial success

4. Oersted’s widely-publicized experiment led to the invention of
   a. the capacitor.
   b. the battery.
   c. the resistor.
   d. the conductor.
   e. the electromagnet.
5. If a 1 nF capacitor is charged to 10,000 V and a 1 µF capacitor is charged to 100 V, which one has more energy stored?
   a. the 1 nF capacitor
   b. the 1 µF capacitor
   c. the same for both
   d. charge needs to be given
   e. neither stores any energy

6. An electromagnet with 200 turns can lift a certain mass across a certain gap. If the mass doubles, while the gap and the current stay the same, the new number of turns needed is:
   a. about 100 turns
   b. about 140 turns
   c. the same, 200 turns
   d. about 280 turns
   e. about 400 turns

7. A thin wire of 100 meters in length has a certain resistance. In order to obtain the same resistance from a wire of twice the diameter, we would need the length of
   a. 25 meters.
   b. 50 meters.
   c. 100 meters.
   d. 200 meters.
   e. 400 meters.
8. Imagine we cook an egg by immersing it into water which is boiled by an electric heater. The heater utilizes a current, $I$, at a voltage, $V$, for a time, $T$. If the change in energy of a newly cooked egg over its raw energy is given by $\Delta E_{\text{egg}}$, the energy wasted in the cooking process is given by which equation below?
   
   a. $E_{\text{wasted}} = IV$
   b. $E_{\text{wasted}} = IV + \Delta E_{\text{egg}}$
   c. $E_{\text{wasted}} = IV - \Delta E_{\text{egg}}$
   d. $E_{\text{wasted}} = IVT + \Delta E_{\text{egg}}$
   e. $E_{\text{wasted}} = IVT - \Delta E_{\text{egg}}$

9. Assuming $v_2 = 9\, V$, $v_4 = 3\, V$, $v_5 = 4\, V$ in the circuit below, what is $v_3$?

![Circuit Diagram]

a. $1\, V$

b. $4\, V$

c. $5\, V$

d. $6\, V$

e. $7\, V$
10. Assuming $i_1 = -3 \, mA$, $i_3 = 5 \, mA$, $i_6 = 1 \, mA$, defined according to SRS, (currents entering each elements from the + side) in the circuit below, what is the SRS-consistent value of current $i_4$?

-3 \, mA

- 3 mA

3 mA

1 mA

-1 mA

0 mA
11. Find the value of current $I_1$.

![DIAGRAM]

a. $-1 \, A$
b. $-0.75 \, A$
c. $-0.5 \, A$
d. $0.75 \, A$
e. $1 \, A$

12. Find the value of current $I$.

![DIAGRAM]

a. $2 \, mA$
b. $4 \, mA$
c. $6 \, mA$
d. $8 \, mA$
e. $12 \, mA$
13. The current passing through the horizontal resistor when the switch is open has value $I \text{ Amps}$. What happens to the current through the horizontal resistor when the third resistor is added to the circuit by closing the switch?

![Circuit Diagram]

a. The current decreases to $I/2 \text{ Amps}$.
b. The current decreases to $2I/3 \text{ Amps}$.
c. The current stays the same.
d. The current increases to $4I/3 \text{ Amps}$.
e. The current increases to $2I \text{ Amps}$.

14. What is the value of $R$ required to make $R_{ab} = 50 \Omega$ (between $a$ and $b$)?

![Circuit Diagram]

a. $R = 25 \Omega$
b. $R = 50 \Omega$
c. $R = 75 \Omega$
d. $R = 100 \Omega$
e. $R = 150 \Omega$
15. What is the equivalent resistance between nodes B and A, $R_{BA}$?

![Electrical Circuit Diagram]

- **a.** $R_{BA} = 3 + 4||4||1 \Omega$
- **b.** $R_{BA} = 2||1 + 2||4 + 3 \Omega$
- **c.** $R_{BA} = 2 + 1||2 + 4 + 3||0 + 0 \Omega$
- **d.** $R_{BA} = (3||4 + 4)||1 \Omega$
- **e.** $R_{BA} = 3||4 + 4||1 \Omega$
16. Which equation expresses a correct application of KCL at the node labeled with voltage, \( V \)?

\[ \frac{9-V}{R_1} + \frac{V}{R_2} + \frac{3-V}{R_3} = 0 \]

\[ \frac{V-9}{R_1} + \frac{V}{R_2} + \frac{3-V}{R_3} = 0 \]

\[ \frac{9-V}{R_1} - \frac{V}{R_2} + \frac{3-V}{R_3} = 0 \]

\[ \frac{9-V}{R_1} + \frac{V}{R_2} + \frac{V-3}{R_3} = 0 \]

\[ \frac{V}{R_1} + \frac{V-9}{R_2} + \frac{3-V}{R_3} = 0 \]

17. The IV characteristic described by \( 3I + 2V = -4 \) is to be plotted on an IV graph as in lecture. What is the slope of the line described by this equation?

a. \(-2\)

b. \(-3/2\)

c. \(-2/3\)

d. \(3/4\)

e. \(3/2\)
18. Which is the IV equation corresponding to the labeled terminals?

\[ I = \frac{3}{2} V - 4 \]

b. \[ I = \frac{8}{3} V + 4 \]

c. \[ I = \frac{8}{3} V - 4 \]

d. \[ I = -\frac{8}{3} V + 4 \]

e. \[ I = -4 \]

19. It is known that the voltage source below has an SRS-consistent power, \( P = -144 \, mW \). How much power is dissipated in the 3 kΩ resistor?

\[ V \]

\[ 3 \, kΩ \]

\[ 9 \, kΩ \]

a. 0 mW

b. 36 mW

c. 72 mW

d. 108 mW

e. 144 mW
20. Which source is supplying energy?

a. the voltage source
b. the current source
c. both the voltage source and the current source
d. neither
e. There is not enough information to tell.
21. Find the value of current $I_1$.

\[ \Omega_{g18}(5 \Omega_{g|869}) \]

a. 0
b. $0.5 V_s$
c. $V_s$
d. $V_s/R_{BA}$
e. $2V_s/R_{BA}$
22. Which of the following equations is always true for this circuit?

![Circuit Diagram]

a. $I_2 = I_4$

b. $V_2 - I_3 - I_2 = 0$

c. $I_1 R_1 + I_3 R_3 = I_2 R_2$

d. $V_1 + I_4 R_4 + I_2 R_2 + I_1 R_1 = 0$

e. $V_1 - I_1 R_1 + I_3 R_3 - V_2 - I_4 R_4 = 0$
23. Which of the following is an application of KCL to the circuit at the marked node A?

- a. $I_2 + I_3 + I_4 = 0$
- b. $I_3 + I_5 = 0$
- c. $I_6 = I_7$
- d. $-I_1 + I_2 + I_3 + I_4 = 0$
- e. $I_5 = I_1 + I_2$
24. Find the Thévenin-equivalent parameters for the following circuit.

\[ R_T = 11\Omega, V_T = \frac{8}{3} \text{ Volts} \]

b. \[ R_T = 11\Omega, V_T = 4 \text{ Volts} \]

c. \[ R_T = \frac{13}{3} \Omega, V_T = \frac{8}{3} \text{ Volts} \]

d. \[ R_T = \frac{13}{3} \Omega, V_T = 4 \text{ Volts} \]

e. \[ R_T = \frac{65}{11} \Omega, V_T = 4 \text{ Volts} \]
25. Find the Norton-equivalent current, $I_N$, as seen between the open terminals of nodes D and A. **HINT:** If you choose to find short circuit current, $i_{sc}$, the resulting circuit can be significantly simplified and redrawn.

\[ a. \quad I_N = 0.2 \, I_s \]
\[ b. \quad I_N = 0.4 \, I_s \]
\[ c. \quad I_N = 0.5 \, I_s \]
\[ d. \quad I_N = 0.6 \, I_s \]
\[ e. \quad I_N = I_s \]
ECE 110 Exam 1 Data Sheet

Not all of this data will be useful in the exam.

Physical Constants

Charge of an electron = \(-1.6 \times 10^{-19}\) C

Permittivity of free space,
\[ \varepsilon_0 = 8.854 \times 10^{-12} \text{ F/m} \]

Permeability of free space,
\[ \mu_0 = 4\pi \times 10^{-7} \text{ Wb/(A.m)} \]

Capacitors

\[ C = \frac{Q}{V} = \frac{\varepsilon A}{d} \]
\[ E = \frac{1}{2} Q v \]

Force exerted across free space by an electromagnet of cross-sectional area \(A\) on a ferromagnetic mass is given by
\[ F = \frac{A}{2\mu_0} B^2 \text{ where } B = \mu_0 \frac{NI}{l_g} \]

SRS

In the Standard Reference System:

if \( P_s > 0 \) then energy is being dissipated (load)
if \( P_s < 0 \) then energy is being generated (source)

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<th>Resistivity ((\times 10^{-6} \text{ \Omega cm}))</th>
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