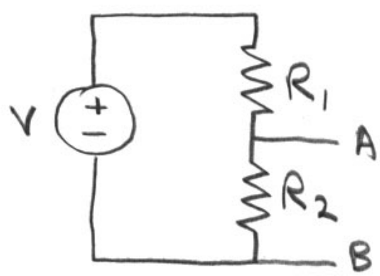
BioE 1310 - Exam 3 4/25/2011
Answer Sheet - Correct answer is A for all questions

1. The following is *not* true about voltage:

A. It describes the number of electrons passing a certain point in a circuit over a given period of time.
B. It describes the energy required to move a unit charge from one place to another.
C. It is roughly analogous to pressure for water flow.
D. It can be considered for a single point in a circuit only relative to a reference point, normally called "ground."
E. When measured across a resistor, it is linearly related to the current through that resistor by Ohm's law.

Explanation: The number of electrons passing a certain point in a circuit over a given period of time is the current, not the voltage.
[*circuits0002.mcq*]

2. What is the voltage between points A and B, if $R_1 = 40\Omega$, $R_2 = 10\Omega$, and V = 5V?



A. 1V
B. 5V
C. 4V
D. 2V
E. 0V

Explanation:

$$V\frac{R_2}{R_1 + R_2}$$

[*circuits0248.mcq*]

3. How many joules does a 1000 W hair drier expend in 4 minutes?

A. 240,000 J
B. 4,000 J
C. 7.90 J
D. 250 J
E. None of the answers is correct.

Explanation: 1 J = 1 W x 1 sec
[*circuits0249.mcq*]

4. Which of the following is *not* true about a perfect current source (or all are true)?

A. It has an effective impedance of zero, since a change in current through it results in no change in voltage.

B. All the other statements are true.

C. It delivers a fixed current irrespective of the other components in the circuit.

D. The only circuit that it cannot cope with is an open circuit.

E. It is capable of producing very large voltages.

Explanation: It has an effective impedance of *infinite*since a change in voltage across it results in no change in current (impedance is voltage over current, and thus the zero is in the denominator).
[*circuits0250.mcq*]

5. The following are useful tips about safety and electricity, *except*

A. As long as your feet are grounded you are safe.

B. Electricity usually kills by effecting the heart, so keep your heart out of the circuit.

C. Barefoot and dripping from the beach is a bad time to change the lightbulb.

D. Skin resistivity is lowered by water, especially salt water.

E. High voltage can cause tetanus, or muscle contraction, so you can't let go!

Explanation: Answer A is definitely false. If your hand touches a high voltage, having your feet grounded is very bad because your body (and heart) is now in the circuit. Electrocution kills more than 500 people every year in the USA.
[*circuits0082.mcq*]

6. A system is said to have a gain of 60dB. What is the ratio of the *amplitude* of the output signal to the *amplitude* of the input signal.

A. 1,000

B. 10^{-6}

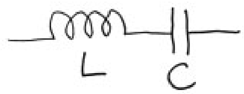
C. 1,000,000

D. 0.001

E. None of the other answers is correct.

Explanation: $dB = 10log\frac{\text{output power}}{\text{input power}}$, but $dB = 20log\frac{\text{output amplitude}}{\text{input amplitude}}$, because power is the square of amplitude (for sinusoidal signals).
[*circuits0247.mcq*]

7. Which of the following is (are) true about the circuit below,



I - The circuit is capable of displaying *resonance*.
II - At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance of the coil is exactly the negative of the impedance of the capacitor.
III - At very low or very high frequencies the impedance approaches zero.

A. I and II

B. I and III

C. II and III

D. I, II, and III

E. None of the others is correct.

Explanation: At very high frequencies the coil approaches infinite impedance and at very low frequencies the capacitor does likewise. Thus in series their resistance approaches infinite impedance at either very high or very low frequency, but equalling zero at the resonant frequency $\omega = \frac{1}{\sqrt{LC}}$.
[*circuits0246.mcq*]

8. The inductance of a coil produces a relationship between current and voltage described by $V = L\frac{dI}{dt}$. All of the following are true *except*

A. Given a certain coil wrapped around a core of material of fixed geometry, the inductance increases with decreasing permeability μ of the material.

B. Energy is stored in the magnetic field produced by the current, resulting in a tendency for the current to continue flowing unless opposed by a voltage.

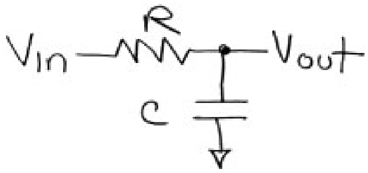
C. The same relationship can also be written $I = \frac{1}{L}\int V dt$

D. To intentionally produce a spark, as in a spark-plug in your car, one uses a coil with a large inductance L and interrupts a large current by opening a switch.

E. The impedance of an inductor increases with frequency.

Explanation: Given a certain coil around a core of material of fixed geometry, the inductance increases with *increasing* permeability μ of the material.
[*circuits0245.mcq*]

9. Which of the following is (are) true about the circuit below, given that R = 100 KΩ and C = 1 μF.



I - The circuit is a low pass filter.
II - At frequency $\omega = 100$ radians per second, the impedances of the capacitor and the resistor are equal in magnitude.
III - At very low frequencies the capacitor approaches an open circuit (infinite impedance).

A. I and III

B. II and III

C. I, and II

D. I, II and III

E. None of the other answers is correct

Explanation: Impedance for capacitor is $Z = \frac{1}{j\omega C}$. $|R| = |\frac{1}{j\omega C}|$ when $\omega = \frac{1}{RC}$; That frequency for this circuit is ω = 10 radians per second.
[*circuits0244.mcq*]

10. Evaluate the complex number expressed as a complex exponential as $2\sqrt{2}e^{j\frac{\pi}{4}}$

A. $2 + 2j$

B. $\sqrt{2}(1 + j)$

C. -2

D. 2

E. $\sqrt{2}(1 - j)$

Explanation: $e^{j\frac{\pi}{4}} = \frac{1}{\sqrt{2}}(1 + j)$
[*circuits0243.mcq*]

11. The following are true about photovoltaic (solar) cells *except*

A. They are photodiodes used in the photoconductive mode.

B. They represent a growing alternative to fossil fuels.

C. They are diodes whose surface area is intentionally large.

D. They generate a voltage such that the diode is forward biased.

E. They generate electric power from electromagnetic waves.

Explanation: Photodiodes used in the *photoconductive* mode have the diode reversed biased by an external voltage, such that the diode leaks when struck by light. Solar cells are used in the *photovoltaic* mode.
[*circuits0242.mcq*]

12. A Zener diode can best be described as

A. a diode whose reverse breakdown voltage provides a known and stable reference voltage when reverse-biased.

B. a transistor with extremely high input impedance.

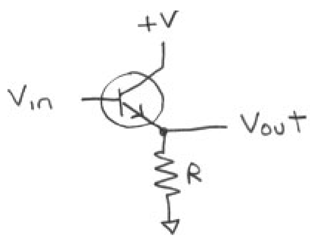
C. a diode that is actually primarily used as an capacitor.

D. a diode that exhibits identical behavior in the forward and reverse biased condition.

E. a diode that has an extremely high reverse breakdown voltage, such that the breakdown voltage is never reached in practice.

Explanation: A zener diode is one that intentionally has a known, and usually relatively low, breakdown voltage, which is used by reverse-biasing the diode.
[*circuits0165.mcq*]

13. If $R = 100\Omega$, $\beta = 100$, the current through R is 50mA, and the base-emitter voltage drop is 0.5V, what would you expect V_{in} to be? (notice we are asking for the *input* voltage!)



A. 5.5 V

B. 0.5 V

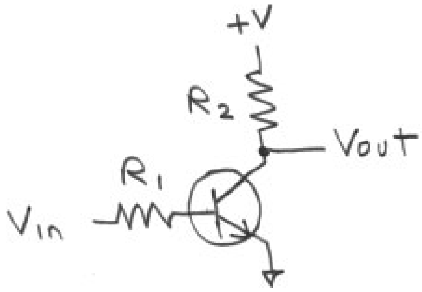
C. 1 V

D. 0 V

E. 5 V

Explanation: This is an emitter follower. $V_{out} = V_{in} - 0.5$V; β is not needed.
[*circuits0241.mcq*]

14. If $R_1 = 100\ K\Omega$, $R_2 = 2$ KΩ, $V_{in} = 2.5$ V, $+V = 11$ V, with a $\beta = 100$ for the transistor, and a base-emitter voltage drop of 0.5 V, what voltage would you expect at V_{out}?



A. 7 V

B. 5 V

C. 8 V

D. 6 V

E. 4 V

Explanation: The Voltage across R_1 is 2 V − 0.5 V, so the base current is 2V/100 $K\Omega = 20\ \mu$A. Collector current is thus 20 μA × 100 = 2 mA. Voltage across R_2 = 2 mA × 2 KΩ = 4V. V_{out} = 11 V − 4 V = 7 V
[*circuits0163.mcq*]

15. Which of the following are properties of the ideal operation amplifier?

I - Infinite input impedance.
II - Perfectly linear internal amplification.
III - Infinite gain.
IV - Zero output impedance.

A. I, III, and IV

B. I, II and III

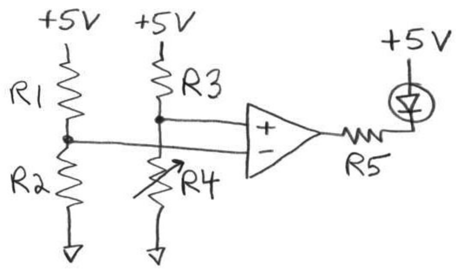
C. II, III and IV

D. I and III

E. All of them

Explanation: All but II. The gain is virtually infinite, but can be very non-linear. Linearity is supplied by the external components.
[*circuits0025.mcq*]

16. Which statement is *false* about the following circuit using a comparator (or all of the other statements are true)?



A. The output of the comparator is used to keep the (+) and (−) inputs of the comparator equal.

B. It uses a Wheatstone bridge (the four resistors to the left of the op amp).

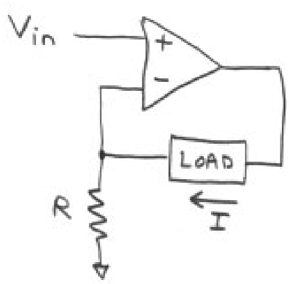
C. R_5 is present to limit the current to the LED.

D. All of the other statements are true.

E. The voltages at the (+) and (−) inputs of the comparator are equal when $\frac{R_1}{R_2} = \frac{R_3}{R_4}$.

Explanation: Answer A does not apply to this circuit but rather to the standard operational amplifier circuit. Comparators in general are not used in that manner, but rather to provide a binary output indicating which of the two inputs is higher.
[*circuits0239.mcq*]

17. Assuming that $V_{in} = 1$V and $R = 5\Omega$, what is the current I through the load?



A. 200 mA

B. 5 A

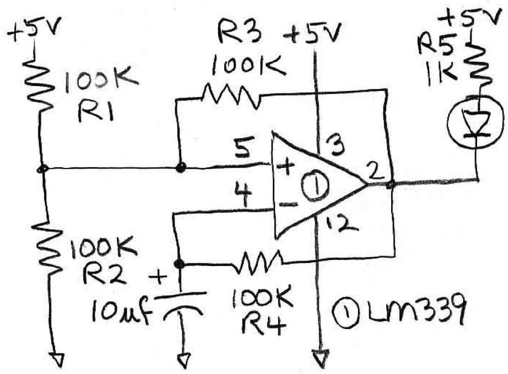
C. 5 mA

D. 200 A

E. None of the other answers is correct.

Explanation: This is a voltage to current converter, or "current source". Assuming the inputs to the op amp are the same voltage, I = V_{in} / R.
[*circuits0238.mcq*]

18. The circuit below shows an oscillator used in one of the labs. The waveforms generated at pins 5, 4, and 2 of the comparator are as follows:



A. 5-square, 4-triangle, 2-square

B. 5-square, 4-triangle, 2-triangle

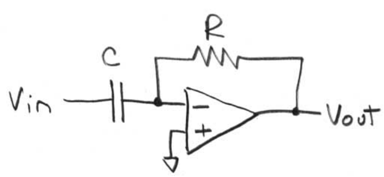
C. 5-triangle, 4-square, 2-square

D. 5-triangle, 4-triangle, 2-square

E. 5-square, 4-square, 2-triangle

Explanation: The capacitor at pin 4 charges and discharges, creating a triangle wave. The comparator goes from +5 to ground creating a square wave both at pin 2 and (a smaller one) at pin 5.
[*circuits0190.mcq*]

19. Which of the following equations describes the behavior of the following circuit?



A. $V_{out} = -RC\frac{dV_{in}}{dt}$.

B. $V_{out} = -\frac{1}{RC}\int V_{in}dt$.

C. $V_{out} = -\frac{1}{RC}\frac{dV_{in}}{dt}$.

D. $V_{out} = -RC\int V_{in}dt$

E. None of the others answers is correct.

Explanation: This is a differentiator. The input voltage causes a current through the capacitor proportional to the differential of that voltage, The same current must pass through the resistor.
[*circuits0240.mcq*]

20. Which of the following is true about the truth table below?

A B	Q
0 0	0
0 1	1
1 0	1
1 1	0

A. This represents an exclusive OR gate.

B. This represents an AND gate.

C. This represents an OR gate.

D. This represents a NOT (invertor) gate.

E. None of the others is true.

Explanation: Exclusive OR is just like OR, except that the (A=1, B=1) case is false (it is "excluded").
[*circuits0237.mcq*]

21. The binary number 00110100 is represented in hexadecimal (base 16) as

A. 34

B. 52

C. 64

D. 3A

E. A3

Explanation: Each 4 bits of the binary number represents a hexadecimal digit; thus, $0011_2 = 3_{10}$ and $0100_2 = 4_{10}$. 52 is the equivalent *decimal value.*
[*circuits0233.mcq*]

22. A portion of a digital decoder has an output that is true only when a particular number, 3, is present at its input. Representing that input as a 3-bit binary number, ABC, where A is the most significant bit and C is the least significant bit, which of the following Boolean equations is equivalent to that portion of the encoder?

A. $Q = \overline{A}BC$

B. $Q = \overline{A} + B + C$

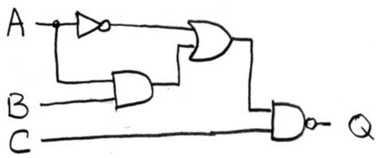
C. $Q = \overline{A} + BC$

D. $Q = \overline{(A)}(B + C)$

E. $Q = A\overline{BC}$

Explanation: The binary equivalent of 3 is 011, so B and C must be true and A must be false.
[*circuits0234.mcq*]

23. Which of the following is a correct Boolean expression for the following digital circuit?



A. $Q = \overline{C(\overline{A} + (AB))}$

B. $Q = \overline{C(\overline{A}(A + B))}$

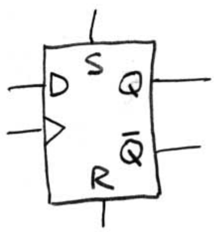
C. $Q = \overline{C}(\overline{A} + (AB))$

D. $Q = \overline{C}(\overline{A}(A + B))$

E. None of the expressions are correct.

Explanation: A is the correct expression.
[*circuits0127.mcq*]

24. Assuming inputs S (set) and R (reset) are 0, which of the following is (are) true?



I - On the rising edge of the clock input (marked by the triangle) the state of D is transfered to Q.
II - The output Q will always have the opposite state from $\overline{Q}$.
III - On the falling edge of the clock input, neither Q nor $\overline{Q}$ will change.

A. I, II, and III

B. I and III

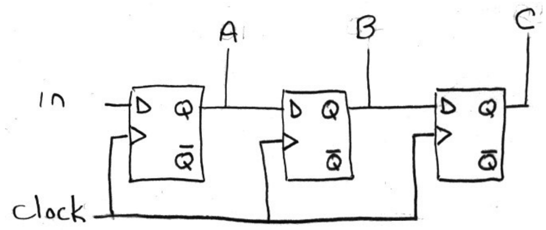
C. II and III

D. None of the other answers

E. I and II

Explanation: All are correct. The D flip-flop only changes state on the rising edge.
[*circuits0232.mcq*]

25. Assuming the Set and Reset inputs of the D flip-flops are all tied to ground, all of the following are true for the following digital circuit it except



A. The circuit is invalid because the $\overline{Q}$ outputs are not connected to anything, and every output must always be connected to something.

B. The circuit is a shift register.

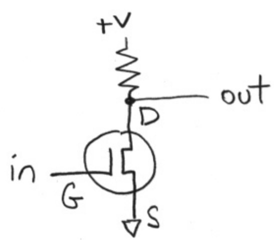
C. The circuit is a synchronously clocked state machine, meaning that a single clock controls the transitions from one state to the next in a completely pre-determined manner.

D. The pattern of bits across "in", A, B, and C, moves to the right with every positive edge on the clock input.

E. Each D flip-flop transfers the state at its input D to its Q output upon the positive edge of its particular clock input (small triangle), with the opposite state going to its $\overline{Q}$ output.

Explanation: Outputs do not need to be connected. Inputs should usually be not left floating, but outputs don't care how many inputs are connected (from 0 up to a maximum number determined by its "fan-out").
[*circuits0236.mcq*]

26. Assuming the MOSFET (metal oxide semiconductor field effect transistor) below is a N-channel enhancement mode device such as the one we used in the lab, which of the following is (are) true?



I - The current entering the gate (G) input from "in" is so small that voltages generated from static electric fields in the surrounding air can control the MOSFET.
II - Positive current I_G flows from the drain (D) to the source (S) controlled by the voltage V_{GS} between the gate and the source, such that as the voltage at "in" increases the voltage at "out" also *increases.*
III - Unlike bipolar transistors, there is an insulator between the gate and the other portions of the MOSFET. This insulator is thin enough for the electric field to be felt across.

A. I and III

B. I and II

C. II and III

D. None of the other answers

E. I, II, and III

Explanation: As V_{GS} increases, I_G also increases, *decreasing* the voltage at "out".
[*circuits0235.mcq*]

27. The following are true regarding feedback, *except*, (or all are true)

A. All are true

B. Hysteresis, as we have seen it used in our temperature regulator circuit to reduce "chatter", represents *positive* feedback.

C. Bimodal circuits, such as the flip-flop, use *positive* feedback to reinforce the present state and keep it there until actively switched to the other state.

D. Operational amplifier circuits with the (+) input tied to ground and the (−) input serving as a "virtual ground" use *negative* feedback to adjust the output so that the two inputs are almost exactly equal.

E. The classic buzzer circuit with a relay uses *negative* feedback to keep the relay continually switching between open and closed states.

Explanation: All are true.
[*circuits0229.mcq*]

28. The following are true about the chemical generation of electrical potential, *except*, (or all are true)

A. Because energy can neither be created nor destroyed, batteries operate as perfect voltage sources.

B. Neurons generate a resting potential across their membranes by maintaining a high relative concentration of potassium inside and opening a potassium-specific channel, through which entropy drives potassium ions out of the cell.

C. Batteries operate by transferring electrons from one chemical element to another, depending on a difference between the electron affinities of the two elements.

D. Fuel cells differ from batteries in that they operate using a continually renewed fuel, such as hydrogen and oxygen, which are combined in a chemical reaction in such a way that an electrical potential is generated

E. All are true

Explanation: Batteries always have a non-zero "internal resistance", which causes the measured voltage to drop as more current is drawn.
[*circuits0230.mcq*]

29. The following are true with regard to high frequency signals ($> 10^6$ Hz), *except*,

A. Currents tend to concentrate at the center of the wire rather than near the surface.

B. Coaxial and paired cables used to transmit over a distance exhibit a characteristic impedance, which is real, permitting "termination" with a simple resistor to prevent reflections.

C. Coaxial and paired cables used to transmit over a distance are modeled as an infinite number of inductances along the cable and capacitances between the two conductors in the cable.

D. Spatial considerations become much more important at higher frequencies because voltages and currents are no longer considered to be occurring everywhere simultaneously.

E. In some antennas, high frequency current can enter or leave through a single wire, in apparent contradiction of Kirchhoff's current law.

Explanation: The skin effect has currents concentrating near the surface, rather than at the center, of the wires.
[*circuits0193.mcq*]

30. The following are true with regard radio, *except*,

A. Radio waves penetrate the walls of a building because of their extremely high frequency compared to that of visible light.

B. AM radio uses the amplitude of the radio frequency (RF) signal to carry the audio information, and may be demodulated using a simple peak detector.

C. Early transmitters (using Morse code) simply created large sparks with a buzzer, which had extremely broad spectra. This was OK because there weren't a lot of them back then.

D. AM radio can be "demodulated" by multiplication with a sinusoid at the radio frequency, which shifts the spectrum down to audio (as well as up to twice the radio frequency) because of the fact that phasors spin each other when multiplied together.

E. FM radio uses the frequency of the RF signal to carry the audio information, and is commonly demodulated using a phase locked loop.

Explanation: Radio waves have a *lower* frequency (longer wavelength) than visible light.
[*circuits0231.mcq*]