BioE 1310 - Review Op Amps (and comparators) 3/20/2010
Instructions: On the Answer Sheet, enter your 2-digit ID number (with a leading 0 if needed) in the boxes of the ID section. *Fill in the corresponding numbered circles.* Answer each of the numbered questions by filling in the corresponding circles in the numbered question section. Print your name in the space at the bottom of the answer sheet. Sign here stating that you have neither given nor received help.

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your signature

1. 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, II and III

B. I and III

C. All of them

D. I, III, and IV

E. II, III and IV

2. The following are true regarding hysteresis as applied in our lab about thermoregulation *except*, (or all are true).

A. It was brought about by tying a resistor from the output of the comparator to the center point of the resistor divider.

B. All are true.

C. It decreases the frequency at which the heater turns on and off.

D. It represents a form of positive feedback, in which, once the heater begins to turn on or off, it is encouraged to turn *all the way* on or off.

E. It provides for two different set-points for the comparator.

3. Which of the following is (are) true about comparators vs. operation amplifiers (op amps) as used in our labs.

I - Comparators generally give a true/false output whereas op amps generally give an output voltage at some intermediate value.
II - Comparators often use a single-sided power supply, whereas op amps are usually configured with plus-and-minus power supplies.
III - Op amps have infinite input impedance, whereas comparators have zero input impedance.
IV - Both have enormous internal gain.

A. I, II and III

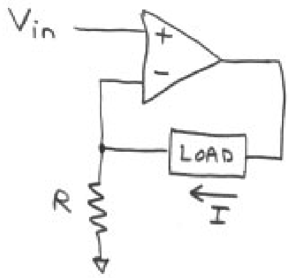
B. All of them

C. II, III and IV

D. I and II

E. I, II, and IV

4. Assuming that $V_{in} = 3$ V and $R = 600\Omega$, what is the current I through the load?



A. 200 A

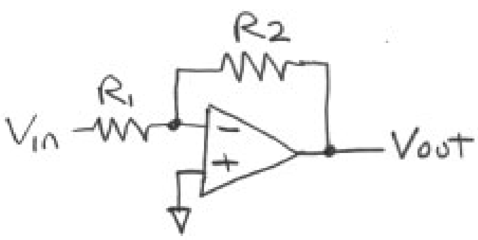
B. 200 ma

C. 5 mA

D. .05 A

E. Cannot be determined.

5. If $R_2 = 150\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 0.3\text{V}$, what voltage would you expect at V_{out}?



A. 0.2V

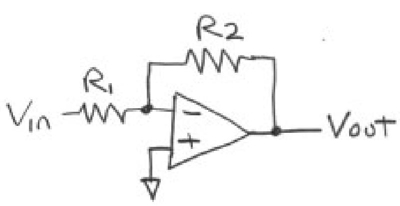
B. 4.5V

C. -185.5mV

D. -4.5V

E. 185.5mV

6. If $R_2 = 100\text{K}\Omega$, $R_1 = 5\text{K}\Omega$, $V_{in} = 0.25\text{V}$, what voltage would you expect at V_{out}?



A. 5.0V

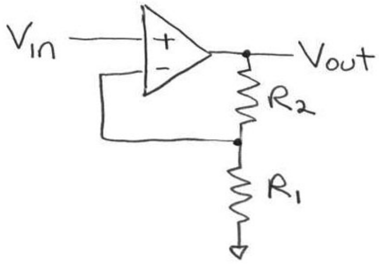
B. -0.25V

C. -238mV

D. -5.0V

E. 238mV

7. What is the voltage V_{out}, if $R_1 = 100\Omega$, $R_2 = 200\Omega$, and $V_{in} = 1.5V$?



A. 3V

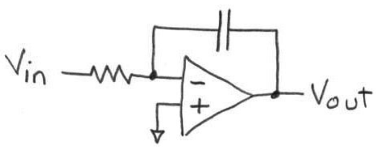
B. 0.5V

C. 4.5V

D. 0V

E. 1V

8. What is the voltage V_{out} after 1 second, if V_{out} begins at 0V, the resistor is $1M\Omega$, the capacitor is $1\mu F$, and $V_{in} = 1V$?



A. -0.25V

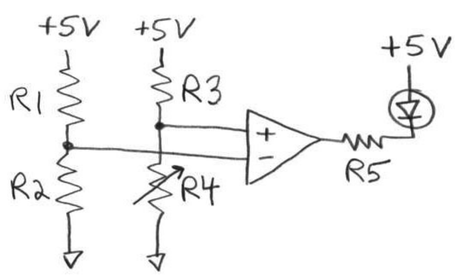
B. 4V

C. Cannot be determined.

D. 1V

E. -1V

9. What value must variable resistor R_4 be adjusted to for the comparator to be just at the point of turning on, or off, the LED in the following circuit, if $R_1 = 100\ \Omega$, $R_2 = 200\ \Omega$, $R_3 = 300\ \Omega$, and $R_5 = 250\ \Omega$?



A. 150 Ω

B. 400 Ω

C. Cannot be determined from the information given.

D. 300 Ω

E. 600 Ω

10. The following are true about feedback *except* (or all are true).

A. Negative feedback can be used with an operational amplifier (op amp) to hold a "virtual ground" at zero volts.

B. Hysteresis is a form of positive feedback.

C. Positive feedback can be used to reinforce a particular state and make it stable and distinct from another possible state for a given system.

D. All are true.

E. Negative feedback can be used to make a system unstable and thus produce oscillation.

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

I - The (+) input is always at "virtual ground".
II - Infinite input impedance.
III - Infinite gain.
IV - Zero output impedance.

A. I and III

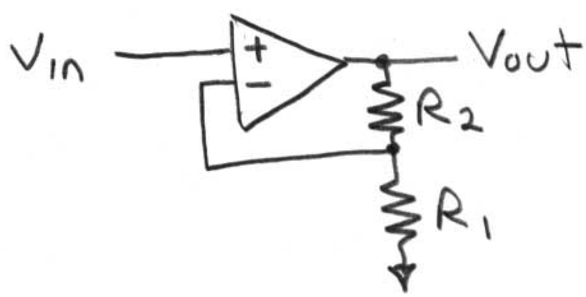
B. I, II and III

C. II, III and IV

D. I, III, and IV

E. All of them

12. Assuming that $V_{in} = 3$ V, $R_2 = 200\Omega$, $R_1 = 100\Omega$, what is V_{out}?



A. 9 V

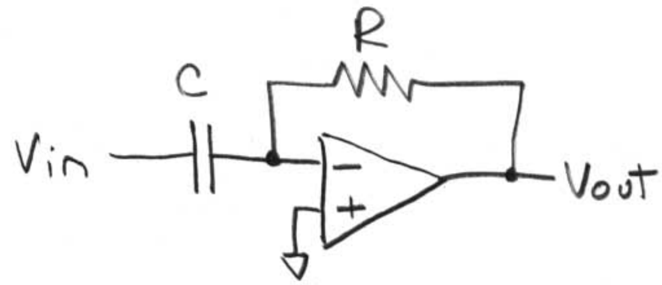
B. 4.5 V

C. 2 V

D. None of the other answers is correct.

E. 1 V

13. The following circuit



A. is a differentiator.

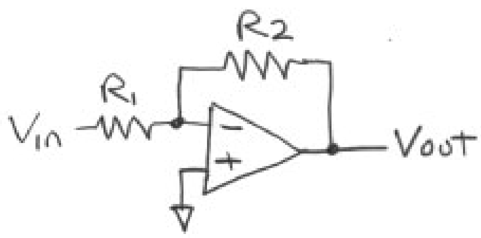
B. is an integrator.

C. is a peak detector.

D. is non-linear.

E. performs a logarithm.

14. If $R_2 = 50\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 0.3\text{V}$, which of the following is (are) true?



I - $V_{out} = -1.5V$.
II - The negative input will be a "virtual ground".
III - No current will run through R_2.

A. I and III

B. II and III

C. I and II

D. I

E. II

15. The following are true about comparators and operational amplifiers, *except*

A. Comparators tend to be used to determine which input is higher, and often have positive feedback (hysteresis) added to prevent chatter when the inputs are very close in value.

B. They both can generally be modeled to have infinite input impedance.

C. Op amps circuits tend to be designed with negative feedback, in which an implicit equation is solved by having the output do what it must to keep the inputs equal.

D. Op amps are generally modeled to have infinite gain, whereas comparators are not.

E. Op amps tend to be used with dual (+ and −) power supplies, whereas comparators are often used with a single (+) power supply.

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

I - Infinite input impedance.
II - Infinite output impedance.
III - Infinite gain.

A. II and III

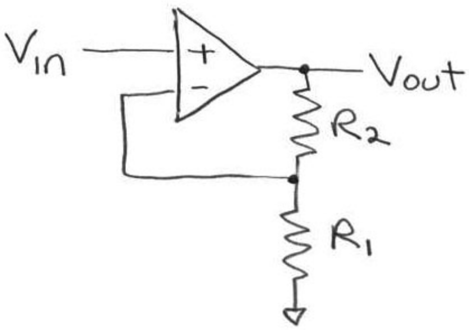
B. I and III

C. Only I

D. I and II

E. I, II, and III

17. What is the voltage V_{in} that would produce 5 V at V_{out}, if $R_1 = 200$ KΩ and $R_2 = 300$ KΩ?



A. 7.5 V

B. 2 V

C. 3.33 V

D. 3 V

E. 12.5 V

18. The following are true regarding hysteresis as applied in our lab about thermoregulation *except*, (or all are true).

A. It represents a form of positive feedback, in which, once the heater begins to turn on or off, it is encouraged to turn *all the way* on or off.

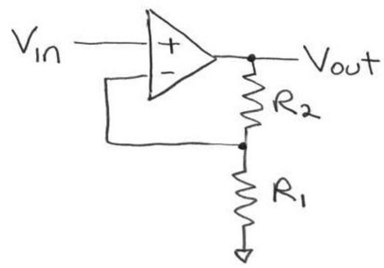
B. It is present in standard old electromechanical thermostats in the form of a little heating element that changes the effective set-point.

C. It provides for two different set-points for the comparator.

D. All are true.

E. It *increases* the frequency at which the heater turns on and off, increasing what is known as "chatter".

19. What is the voltage V_{out}, if $R_1 = 200\Omega$, $R_2 = 100\Omega$, and $V_{in} = 2\text{V}$?



A. 0V

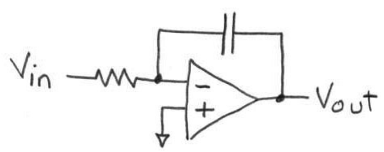
B. 4.5V

C. 1V

D. 0.5V

E. 3V

20. What is the voltage V_{out} after 1 second, if V_{out} begins at 0V, the resistor is $1M\Omega$, the capacitor is $1\mu F$, and $V_{in} = -4V$?



A. -0.25V

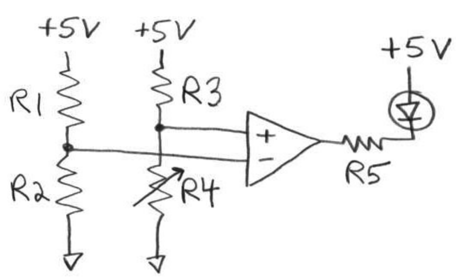
B. Cannot be determined.

C. 1V

D. 4V

E. -1V

21. Which is true about the following circuit?



A. The diode is used to prevent current from leaving the comparator.

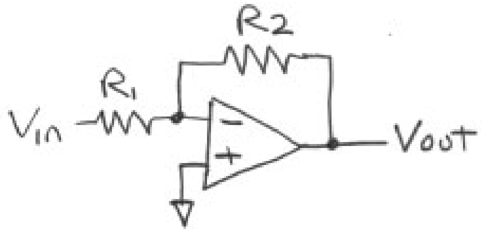
B. It is contains a Wheatstone bridge.

C. None of the other statements is true.

D. It uses hysteresis.

E. R_5 provides negative feedback.

22. If $R_2 = 20\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 1\text{V}$, which of the following is (are) true?



I - $V_{out} = -2V$.
II - The negative input of the Op Amp will be at 0 volts.
III - The current through R_1 is the same as through R_2.

A. II and III

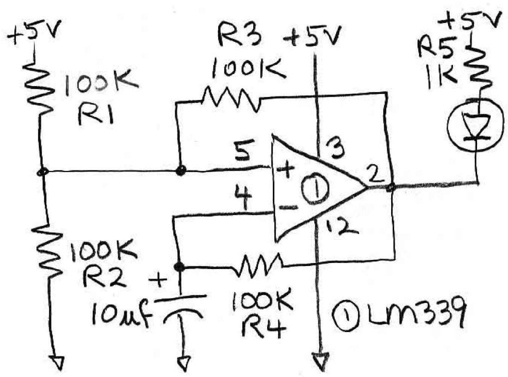
B. I

C. I, II, and III

D. I and II

E. I and III

23. 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-triangle

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

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

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

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

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BioE 1310 - Review Op Amps (and comparators) 3/20/2010
Answer Sheet - Correct answer is A for all questions

1. 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*]

2. The following are true regarding hysteresis as applied in our lab about thermoregulation *except*, (or all are true).

A. All are true.

B. It provides for two different set-points for the comparator.

C. It decreases the frequency at which the heater turns on and off.

D. It was brought about by tying a resistor from the output of the comparator to the center point of the resistor divider.

E. It represents a form of positive feedback, in which, once the heater begins to turn on or off, it is encouraged to turn *all the way* on or off.

Explanation: See lab.
[*circuits0026.mcq*]

3. Which of the following is (are) true about comparators vs. operation amplifiers (op amps) as used in our labs.

I - Comparators generally give a true/false output whereas op amps generally give an output voltage at some intermediate value.
II - Comparators often use a single-sided power supply, whereas op amps are usually configured with plus-and-minus power supplies.
III - Op amps have infinite input impedance, whereas comparators have zero input impedance.
IV - Both have enormous internal gain.

A. I, II, and IV

B. I, II and III

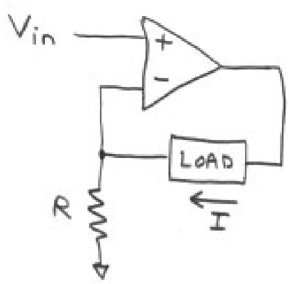
C. II, III and IV

D. I and II

E. All of them

Explanation: Comparators have infinite input impedance and very high gain, just like op amps.
[*circuits0027.mcq*]

4. Assuming that $V_{in} = 3$ V and $R = 600\Omega$, what is the current I through the load?



A. 5 mA

B. .05 A

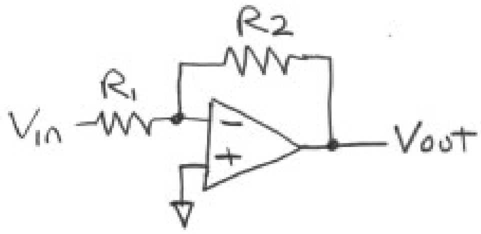
C. 200 ma

D. 200 A

E. Cannot be determined.

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.
[*circuits0029.mcq*]

5. If $R_2 = 150\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 0.3\text{V}$, what voltage would you expect at V_{out}?



A. -4.5V

B. 4.5V

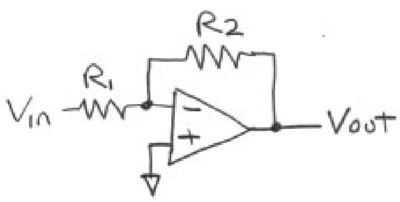
C. 0.2V

D. 185.5mV

E. -185.5mV

Explanation: $V_{out} = -V_{in}\frac{R_2}{R_1}$
[*circuits0031.mcq*]

6. If $R_2 = 100\text{K}\Omega$, $R_1 = 5\text{K}\Omega$, $V_{in} = 0.25\text{V}$, what voltage would you expect at V_{out}?



A. -5.0V

B. 5.0V

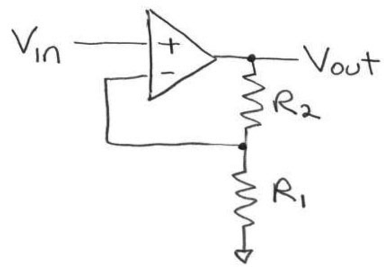
C. -0.25V

D. 238mV

E. -238mV

Explanation: $V_{out} = -V_{in}\frac{R_2}{R_1}$
[*circuits0042.mcq*]

7. What is the voltage V_{out}, if $R_1 = 100\Omega$, $R_2 = 200\Omega$, and $V_{in} = 1.5V$?



A. 4.5V

B. 0.5V

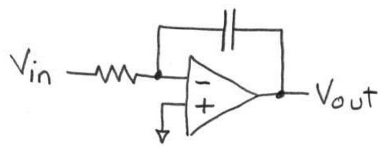
C. 1V

D. 3V

E. 0V

Explanation: $V_{out} = \frac{R_1+R_2}{R_1} V_{in}$
[*circuits0046.mcq*]

8. What is the voltage V_{out} after 1 second, if V_{out} begins at 0V, the resistor is $1M\Omega$, the capacitor is $1\mu F$, and $V_{in} = 1V$?



A. -1V

B. 4V

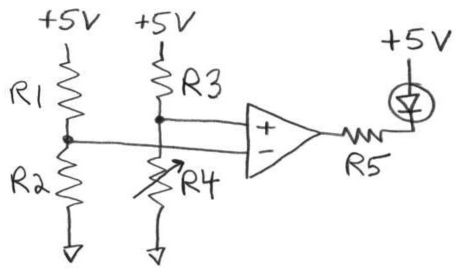
C. -0.25V

D. 1V

E. Cannot be determined.

Explanation: $V_{out} = -\frac{1}{RC} \int V_{in} dt$
[*circuits0048.mcq*]

9. What value must variable resistor R_4 be adjusted to for the comparator to be just at the point of turning on, or off, the LED in the following circuit, if $R_1 = 100\ \Omega$, $R_2 = 200\ \Omega$, $R_3 = 300\ \Omega$, and $R_5 = 250\ \Omega$?



A. 600 Ω

B. 150 Ω

C. 300 Ω

D. 400 Ω

E. Cannot be determined from the information given.

Explanation: The voltages at the (+) and (−) inputs of the comparator are equal when $\frac{R_1}{R_2} = \frac{R_3}{R_4}$
[*circuits0051.mcq*]

10. The following are true about feedback *except* (or all are true).

A. All are true.

B. Positive feedback can be used to reinforce a particular state and make it stable and distinct from another possible state for a given system.

C. Negative feedback can be used to make a system unstable and thus produce oscillation.

D. Negative feedback can be used with an operational amplifier (op amp) to hold a "virtual ground" at zero volts.

E. Hysteresis is a form of positive feedback.

Explanation: These are all true.
[*circuits0056.mcq*]

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

I - The (+) input is always at "virtual ground".
II - Infinite input impedance.
III - Infinite gain.
IV - Zero output impedance.

A. II, III and IV

B. I, II and III

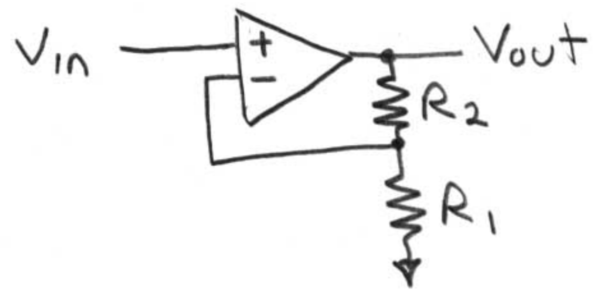
C. I, III, and IV

D. I and III

E. All of them

Explanation: All but I. The (+) input should be equal to the (-) input in a properly biased op amp circuit, but that voltage doesn't necessarily have to be ground (although it is in many circuits).
[*circuits0099.mcq*]

12. Assuming that $V_{in} = 3$ V, $R_2 = 200\Omega$, $R_1 = 100\Omega$, what is V_{out}?



A. 9 V

B. 2 V

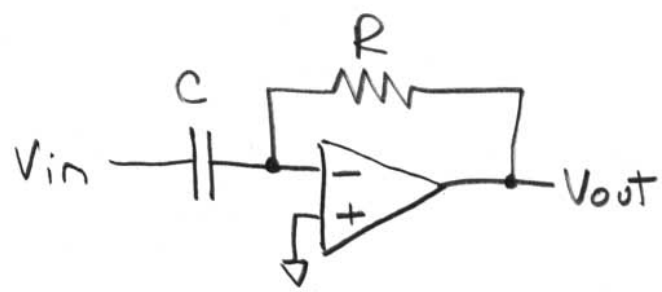
C. 1 V

D. 4.5 V

E. None of the other answers is correct.

Explanation: This is a non-inverting amplifier. Solve by setting the inputs of the op amp to the same voltage, and you basically have an implicit version of a voltage divider: $V_{out} = V_{in} \frac{R_2 + R_1}{R_1}$.
[*circuits0101.mcq*]

13. The following circuit



A. is a differentiator.

B. is an integrator.

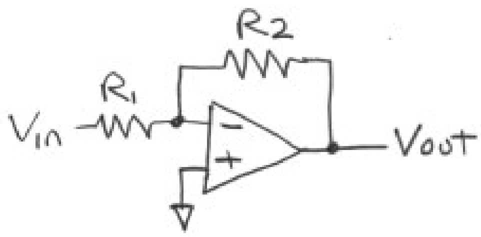
C. performs a logarithm.

D. is a peak detector.

E. is non-linear.

Explanation: This is a differentiator. The negative input is a virtual ground. The current through the capacitor is proportional to the derivative of the input voltage, and that current passes through the resistor as well (because it cannot go into the op amp) indicating that the output voltage must be proportional to that current (although negative). Differentiation, capacitors, and resistors, are all linear.
[*circuits0102.mcq*]

14. If $R_2 = 50\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 0.3\text{V}$, which of the following is (are) true?



I - $V_{out} = -1.5V$.
II - The negative input will be a "virtual ground".
III - No current will run through R_2.

A. I and II

B. II

C. I

D. II and III

E. I and III

Explanation: $V_{out} = -V_{in}\frac{R_2}{R_1}$. The same current will run through R_2 as R_1. The inputs to the op amp will be equal, i.e., at ground.
[*circuits0107.mcq*]

15. The following are true about comparators and operational amplifiers, *except*

A. Op amps are generally modeled to have infinite gain, whereas comparators are not.

B. They both can generally be modeled to have infinite input impedance.

C. Comparators tend to be used to determine which input is higher, and often have positive feedback (hysteresis) added to prevent chatter when the inputs are very close in value.

D. Op amps circuits tend to be designed with negative feedback, in which an implicit equation is solved by having the output do what it must to keep the inputs equal.

E. Op amps tend to be used with dual (+ and −) power supplies, whereas comparators are often used with a single (+) power supply.

Explanation: Both operational amplifiers and comparators are modeled to have infinite gain. The fact that an comparator can accurately compare, means that it must have very high gain so that the two compared voltages can be very close.
[*circuits0110.mcq*]

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

I - Infinite input impedance.
II - Infinite output impedance.
III - Infinite gain.

A. I and III

B. I and II

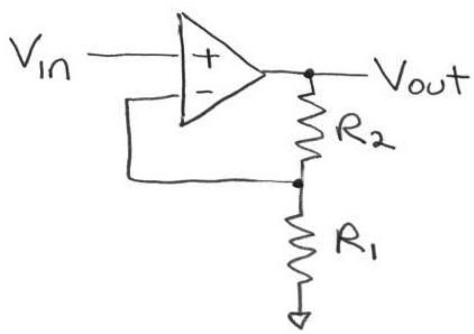
C. II and III

D. I, II, and III

E. Only I

Explanation: II is not true; the ideal op amp has *zero* output impedance.
[*circuits0116.mcq*]

17. What is the voltage V_{in} that would produce 5 V at V_{out}, if $R_1 = 200$ KΩ and $R_2 = 300$ KΩ?



A. 2 V

B. 3 V

C. 7.5 V

D. 3.33 V

E. 12.5 V

Explanation: $V_{out} = \frac{R_1+R_2}{R_1} V_{in}$, $V_{in} = \frac{R_1}{R_1+R_2} V_{out}$
[*circuits0118.mcq*]

18. The following are true regarding hysteresis as applied in our lab about thermoregulation *except*, (or all are true).

A. It *increases* the frequency at which the heater turns on and off, increasing what is known as "chatter".

B. It provides for two different set-points for the comparator.

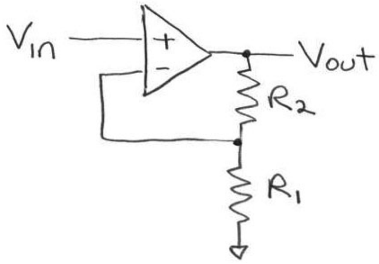
C. All are true.

D. It is present in standard old electromechanical thermostats in the form of a little heating element that changes the effective set-point.

E. It represents a form of positive feedback, in which, once the heater begins to turn on or off, it is encouraged to turn *all the way* on or off.

Explanation: See lab. It actually *decreases* chatter.
[*circuits0166.mcq*]

19. What is the voltage V_{out}, if $R_1 = 200\Omega$, $R_2 = 100\Omega$, and $V_{in} = 2$V?



A. 3V

B. 0.5V

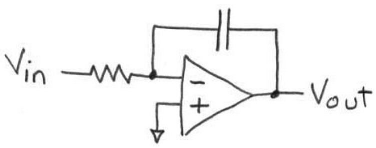
C. 1V

D. 4.5V

E. 0V

Explanation: $V_{out} = \frac{R_1+R_2}{R_1} V_{in}$
[*circuits0167.mcq*]

20. What is the voltage V_{out} after 1 second, if V_{out} begins at 0V, the resistor is $1M\Omega$, the capacitor is $1\mu F$, and $V_{in} = -4V$?



A. 4V

B. -1V

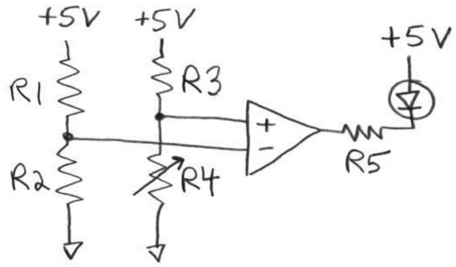
C. -0.25V

D. 1V

E. Cannot be determined.

Explanation: $V_{out} = -\frac{1}{RC} \int V_{in} dt$
[*circuits0168.mcq*]

21. Which is true about the following circuit?



A. It is contains a Wheatstone bridge.

B. It uses hysteresis.

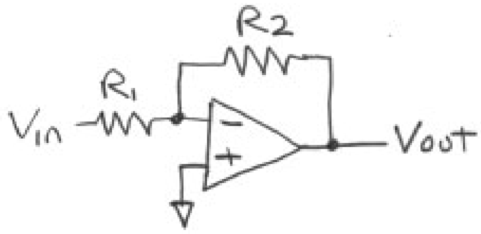
C. R_5 provides negative feedback.

D. The diode is used to prevent current from leaving the comparator.

E. None of the other statements is true.

Explanation: It uses a Wheatstone bridge (the four resistors to the left of the op amp). The voltages at the (+) and (−) inputs of the comparator are equal when $\frac{R_1}{R_2} = \frac{R_3}{R_4}$. R_5 is present simply to limit the current to the LED.
[*circuits0169.mcq*]

22. If $R_2 = 20\text{K}\Omega$, $R_1 = 10\text{K}\Omega$, $V_{in} = 1\text{V}$, which of the following is (are) true?



I - $V_{out} = -2V$.
II - The negative input of the Op Amp will be at 0 volts.
III - The current through R_1 is the same as through R_2.

A. I, II, and III

B. I and II

C. I

D. II and III

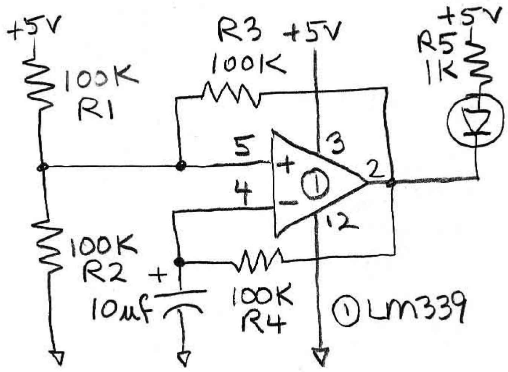
E. I and III

Explanation: $V_{out} = -V_{in}\frac{R_2}{R_1}$. The same current will run through R_2 as R_1. The inputs to the op amp will be equal, i.e., at ground.

Alternate acceptable answer: B

Errata: III should really say "magnitude of the current", since the direction might be construed as being opposite.
[*circuits0185.mcq*]

23. 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*]