

1. A condenser microphone is reported to have a signal-to-noise ratio of 60dB. This means that the ratio of the largest amplitude the microphone is capable of handling to the amplitude of background noise seen on the microphone's output is

- A. 1,000
- B. 1,000,000
- C. 60
- D. 60,000
- E. 30

**Explanation:**  $60 = 20 \log_{10}(1000)$ .  
[ *circuits0021.mcq* ]

2. Evaluate the complex number expressed in polar notation by  $\frac{6 \angle 90^\circ}{3 \angle 45^\circ}$

- A.  $\sqrt{2}(1 + i)$
- B.  $\frac{\sqrt{2}}{2}(1 + i)$
- C.  $3 \angle 2^\circ$
- D.  $2 \angle 235^\circ$
- E. none of the other answers

**Explanation:**  $\frac{6 \angle 90^\circ}{3 \angle 45^\circ} = 2 \angle 45^\circ$   
[ *circuits0022.mcq* ]

3. Euler's Identity  $e^{j\theta} = \cos \theta + i \sin \theta$ , can be rewritten as  $\cos \theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$  and  $\sin \theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$ . Using these, which of the following is an equivalent expression for  $\cos^2 \theta$ ?

- A.  $1 + \frac{\cos 2\theta}{2}$
- B.  $1 + \frac{\sin 2\theta}{2}$
- C.  $1 - \frac{\cos 2\theta}{2}$
- D.  $1 - \frac{\sin 2\theta}{2}$
- E.  $\sin^2 \theta$

**Explanation:** Simply square  $\cos \theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$  and regroup terms.

**Errata:** The formulae in A, B, C, and D are all wrong. Credit was given for any answer or no answer. The right answer is  $\frac{1 + \cos 2\theta}{2}$ .  
[ *circuits0023.mcq* ]

4. The following are true regarding square and triangle waves *except*, (or all are true).

A. All are true.

B. Square waves sound “harsher” than triangle waves because higher harmonics have greater amplitudes in the square wave as compared to the triangle wave.

C. Square waves result from differentiating triangle waves, which boosts their higher harmonics.

D. Each wave can be mathematically represented by a Fourier series of harmonics.

E. Neither wave can be actually created because infinitely high harmonics would be required.

**Explanation:** The Fourier series is infinite, with the higher harmonics especially prominent in the square wave, giving it its harsh, buzzer-like quality.

[ *circuits0024.mcq* ]

5. 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* ]

6. 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* ]

7. 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* ]

8. The following are true about bipolar transistors *except*

A. They are inherently linear devices.

B. When properly biased, the collector current  $I_C$  and the base current  $I_B$  are related by an approximately constant proportion,  $\beta$ .

C. They can be modeled as two diodes back-to-back.

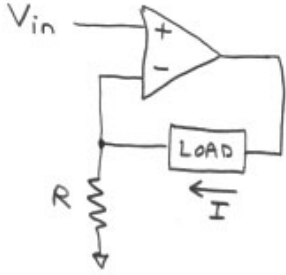
D. They come in two major types, PNP and NPN.

E. They exhibit a voltage drop between the base and emitter, similar to that of a forward-biased diode, of about 0.5-0.7 volt.

**Explanation:** They are decidedly non-linear devices, except when properly biased.

[ *circuits0028.mcq* ]

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

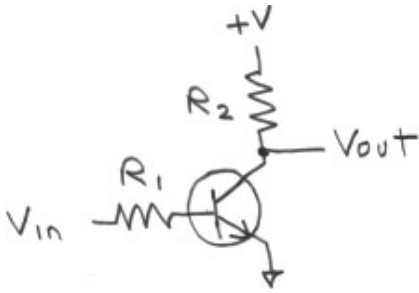


- A. 5 mA
- B. .05 A
- C. 200 ma
- D. 200 A
- E. Cannot be determined.

**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* ]

10. If  $R_1 = 200\text{K}\Omega$ ,  $R_2 = 1\text{K}\Omega$ ,  $V_{in} = 5\text{V}$ ,  $+V = 10\text{V}$ , with a  $\beta = 150$  for the transistor, and ignoring the base-emitter voltage drop, what voltage would you expect at  $V_{out}$ ?

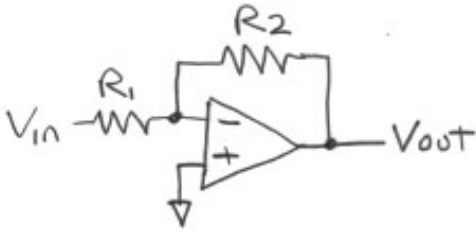


- A. 6.25V
- B. 5V
- C. 2.75V
- D. 3.75V
- E. Cannot be determined.

**Explanation:**  $V_{out} = (10 - 150 \times 1000\Omega(5\text{V}/200\text{K}\Omega))$

[ *circuits0030.mcq* ]

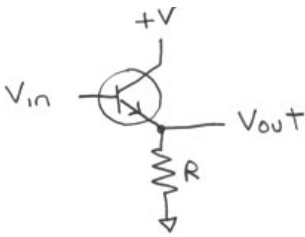
11. If  $R_2 = 150\text{K}\Omega$ ,  $R_1 = 10\text{K}\Omega$ ,  $V_{in} = 0.3\text{V}$ , what voltage would you expect at  $V_{out}$ ?



- 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 ]

12. If  $R = 1\text{K}\Omega$ ,  $V_{in} = 2.5\text{V}$ ,  $\beta = 150$ , and the base-emitter voltage drop is  $0.5\text{V}$ , what would you expect the current through  $R$  to be?



- A. 2mA
- B. 2.5mA
- C. 0.3A
- D. 375mA
- E. 0.2A

**Explanation:** Current =  $\frac{V_{in} - 0.5\text{V}}{R}$ ;  $\beta$  is not needed.  
[ circuits0032.mcq ]

13. Which of the following is (are) true about the photo-resistor used in our lab.

I - It is constructed of cadmium-sulfide.

II - Its resistance goes from very high in total darkness to much lower in bright light.

III - It is a polar device, and therefore must be inserted in the proper orientation.

A. I and II

B. I, II and III

C. II and III

D. I

E. I and III

**Explanation:** It is generally the (-) input of the op amp. III is nonsense.

[ *circuits0033.mcq* ]

14. A thermistor differs from a standard resistor in that

A. A thermistor demonstrates an intentionally poor constancy of resistance with change in temperature.

B. A thermistor, unlike a standard resistor, has a non-linear relationship between current and voltage.

C. A thermistor's behavior depends on the direction of current through it.

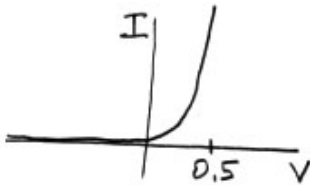
D. A thermistor has an imaginary impedance whereas the impedance of a standard resistance is real.

E. None of the other answers is true.

**Explanation:** Thermistors change resistance intentionally with temperature.

[ *circuits0034.mcq* ]

15. Which of the following is (are) true about the graph below.



I - It shows that current flows when the diode is forward-biased but not when reverse-biased.

II - It shows that the diode can be safely attached to 1V in either orientation (forward- or reverse-biased).

III - It shows that the diode is a linear device.

IV - It shows that over a wide range of currents the voltage across the forward-biased diode is approximately 0.5V

A. I and IV

B. I, II and III

C. I, II, and IV

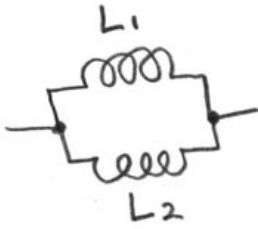
D. I and III

E. All of them.

**Explanation:** The diode is clearly not linear (like a resistor is), and the current approaches  $\infty$  mathematically as the voltage goes over 0.5V.

[ *circuits0035.mcq* ]

16. If  $L_1 = 150\text{mH}$ ,  $L_2 = 300\text{mH}$ , the circuit below is equivalent to



- A. a single 100mH inductor.
- B. a single 100mF capacitor.
- C. a single 450mH inductor.
- D. an RC filter
- E. none of the other answers.

**Explanation:** Inductors add in parallel as resistors do:  $L_{parallel} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2}}$ .

[ *circuits0036.mcq* ]

17. If  $L = 250\text{mH}$ ,  $C = 300\mu\text{F}$ , the circuit below has zero impedance at what frequency (in Hz)?

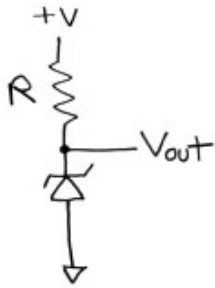


- A. 18.4 Hz
- B. 115 Hz
- C. 13.3 KHz
- D. 83.8 KHz
- E. 75 KHz

**Explanation:**  $\omega = \frac{1}{\sqrt{LC}}$ ;  $f = \omega/2\pi$ .

[ *circuits0037.mcq* ]

18. Which of the following is (are) true about the circuit below, given that  $R = 1000\Omega$ ,  $+V = 5V$ , and the zener diode has a reverse breakdown voltage of  $3V$ .



- I - The current through the resistor is  $3mA$ .
- II - The zener diode is back-biased.
- III - No current flows through the resistor.
- IV -  $V_{out} = 3V$

- A. II and IV
- B. I, II and IV
- C. II, III, and IV
- D. II and III
- E. I, II, and III

**Explanation:** The voltage across the back-biased diode is  $3V$ . The voltage across the resistor is  $5V - 3V = 2V$ ; The current through the resistor is  $2\text{ mA}$ .

[ *circuits0038.mcq* ]

19. What is the total complex impedance (in ohms) of this branch if  $C = 0.1\mu F$ ,  $R = 10K\Omega$ ,  $f = 1000Hz$ ?

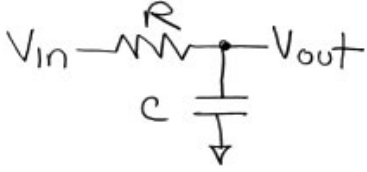


- A.  $10^4 - 1.59 \times 10^3 j$
- B.  $10^4 + 1.59 \times 10^3 j$
- C.  $10^4 - 10^4 j$
- D.  $10^4 + 10^4 j$
- E.  $10^4 - 10^7 j$

**Explanation:** The impedance of a capacitor is  $1/j\omega C$ ,  $\omega = 2\pi f$ . The unit of complex impedance is still ohms.

[ *circuits0039.mcq* ]

20. Which of the following is (are) true about the circuit below, given that  $R = 1\text{M}\Omega$  and  $C = .01\mu\text{F}$ .



I - The circuit is a high pass filter.

II -  $|V_{out}| = \frac{1}{2}|V_{in}|$  at frequency  $f = 15.9$  Hz.

III - Since it is constructed from linear components, the circuit represents a linear system.

A. II and III

B. I, II and III

C. I, and II

D. I and III

E. III

**Explanation:**  $|R| = \left| \frac{1}{j\omega C} \right|$ ;  $\omega = \frac{1}{RC}$ ;  $f = \frac{\omega}{2\pi}$   
[ circuits0040.mcq ]