BioE 1310 - Review 2 - AC 1/16/2017

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. 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. 60,000

B. 1,000,000

C. 30

D. 1,000

E. 60

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

A. $2\angle 235^\circ$

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

C. $3\angle 2^\circ$

D. none of the other answers

E. $\frac{\sqrt{2}}{2}(1+i)$

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

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

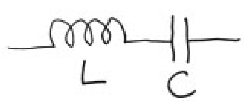
B. Neither wave can be actually created because infinitely high harmonics would be required.

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

D. All are true.

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

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



A. 18.4 Hz

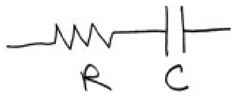
B. 83.8 KHz

C. 13.3 KHz

D. 115 Hz

E. 75 KHz

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



A. $10^4 - 1.59 \times 10^3 j$

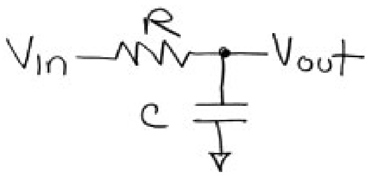
B. $10^4 + 10^4 j$

C. $10^4 + 1.59 \times 10^3 j$

D. $10^4 - 10^7 j$

E. $10^4 - 10^4 j$

6. 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 - $|V_{out}| = \frac{1}{\sqrt{2}}|V_{in}|$ 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 and III

C. I, and II

D. I, II and III

E. III

7. The following is true about the expression, $e^{j\theta} = \cos\theta + j\sin\theta$, *except* (or all are true)

A. It shows $e^{j\theta}$ to be on the unit circle in the complex plane, with θ being the angle relative to the real axis.

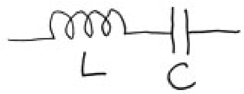
B. It is known as Euler's Identity.

C. All are true.

D. It permits algebraic solutions for expressions such as $\cos^2\theta$.

E. It leads easily to the fact that complex numbers, when multiplied by each other, scale each other's magnitudes and shift each others phases.

8. If $L = 125\text{mH}$, $C = 150\mu\text{F}$, the circuit below has zero impedance at what frequency (in Hz)?
(Recall that $Z_L = j\omega L$ and $Z_C = \frac{1}{j\omega C}$, where frequency in Hz $f = \omega/2\pi$).



A. 167.6 KHz

B. 26.6 KHz

C. 150 KHz

D. 230 Hz

E. 36.8 Hz

9. The following are true regarding a circuit containing a resistor and a capacitor with the following relationship between input and output voltages at frequency ω, *except*,

$\frac{V_{out}}{V_{in}} = \frac{1}{1+j\omega RC}$

A. At $\omega = \frac{1}{RC}$ it exhibits a phase shift.

B. It lets all frequencies through equally.

C. It acts as a low pass filter.

D. At $\omega = 0$ it acts like a piece of wire.

E. At $\omega = \infty$ it lets nothing through.

10. Two acoustic signals A and B are present in a system. The powers of the signals are
A = 10 mW and B = 10 μW.
The ratio of the two powers A/B expressed in dB is

A. 60 dB

B. 30 dB

C. 0 dB

D. -30 dB

E. -60 dB

11. Evaluate the complex number expressed in polar notation by $\frac{3\angle 120^\circ}{9\angle 150^\circ}$

A. $\frac{1}{3}\angle 30^\circ$

B. $6\angle -30^\circ$

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

D. none of the other answers

E. $\frac{1}{2\sqrt{3}} - \frac{1}{6}j$

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

13. The following is *false* regarding square and triangle waves.

A. Square waves sound "harsher" than triangle waves because higher harmonics have greater relative amplitudes in the square wave as compared to the triangle wave.

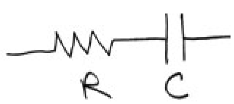
B. Triangle waves result from integrating square waves, which boosts their lower harmonics.

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

D. Triangle waves at 400 Hz into a speaker are audible, whereas square waves at 400 Hz are not.

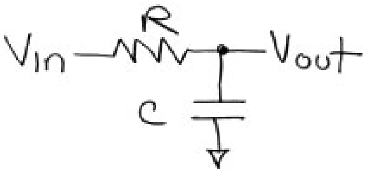
E. Neither wave can be actually created because infinitely high harmonics would be required.

14. The total complex impedance of this branch is



A. $1 + j\omega RC$
B. $\frac{1+RC}{j\omega C}$
C. $\frac{1+j\omega RC}{j\omega C}$
D. $\frac{1}{R} + \frac{1}{j\omega C}$
E. $R + j\omega C$

15. Which of the following is (are) true about the circuit below, given that $R = 1\text{M}\Omega$ and $C = .001\mu\text{F}$ and that V_{in} is sinusoidal at a particular frequency.



I - The circuit is a low pass filter.
II - $|V_{out}| = \frac{1}{\sqrt{2}}|V_{in}|$ at frequency f = 159.1 Hz.
III - The impedance of the capacitor increases as frequency increases.
IV - V_{out} is also sinusoidal at the same frequency as V_{in}

A. I, II and IV

B. All are true.

C. I, III, and IV

D. II, III, and IV

E. I, II and III

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

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

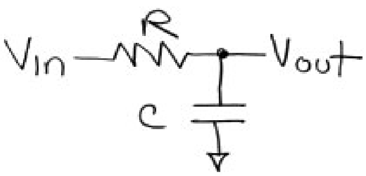
B. none of the other answers

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

D. -2

E. $2j$

17. Which of the following is (are) true about the circuit below, given that R = 10 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 II

B. I and III

C. None of the other answers is correct

D. II and III

E. I, II and III

18. The following are true about safety and electricity, *except*

A. Electricity usually kills by effecting the heart, so electricians are taught to use one hand near a high voltage.

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

C. Alternating current (AC) is inherently safer than direct current (DC), which is why we use it to transmit power.

D. High voltage can cause muscle contraction preventing the victim from releasing the wire.

E. Hospital equipment often prevents direction connection between the patient-contacting equipment and 110 V by use of optical isolators and transformers.

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

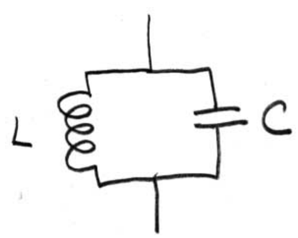
B. To intentionally produce a spark, as in a spark-plug in your car, one uses a coil with a large inductance L and interrupts a large current by opening a switch.

C. The equivalent equation for capacitance is $I = C\frac{dV}{dt}$, and energy in the capacitor is stored in the charge.

D. The impedance of an inductor is lower at higher frequencies.

E. 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.

20. Given that L = 10 μH and C = 100 pF, which of the following is (are) true about the following branch?



I - The impedance at both 0 Hz and ∞ Hz is 0.
II - The impedance at resonance is infinite.
III - Resonance happens at $\omega = \frac{1}{\sqrt{LC}}$.

A. II and III

B. I and III

C. None of the other answers is correct.

D. I and II

E. I, II, and III

21. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*

A. The discharge is governed by a first order differential equation similar to that governing radioactive decay of a certain initial amount of Carbon-14.

B. The energy initially stored in the capacitor is released as heat by the resistor.

C. Current will gradually decrease as the capacitor discharges.

D. The time required to discharge to a certain percentage of the initial charge is proportional to RC.

E. The total charge in the capacitor (the sum on both plates) gradually decreases to zero.

22. The cause of magnetism may best be described as

A. the interaction between moving charges and the nuclei of neighboring iron atoms.

B. the curvature of coils of wires creating a centrifugal force on the moving charges.

C. an independent fundamental force unrelated to the electrostatic force.

D. the Lorenz contraction of moving charges making them appear to other moving charges to be more densely packed than neighboring stationary charges.

E. a quantum effect on moving charges due to the effect of gravity.

23. The capacitance of a capacitor produces a relationship between current and voltage described by $I = C\frac{dV}{dt}$. All of the following are true *except*

A. The larger the capacitance C, the more rapid the change in voltage for a given current.

B. The equivalent equation for inductance is $V = L\frac{dI}{dt}$.

C. Energy is stored in the charge difference between the plates, making it take a current to change the voltage over time.

D. Special capacitors with very large capacitance may store appreciable energy comparable to a battery.

E. The same relationship can also be written $V = \frac{1}{C}\int Idt$

24. Which of the following is *false* about permittivity (or all are true)?

A. It permits a constant current to leak between the plates of the capacitor.

B. Even free space has a non-zero permittivity.

C. All are true.

D. In a given capacitor, it determines the capacitance for a given area of plates and distance between them.

E. It can be increased by the alignment of charges in the material between the plates of a capacitor.

25. Evaluate the complex number expressed in polar notation by $\frac{8\angle 0°}{\sqrt{8}\angle 45°}$

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

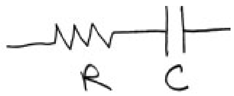
B. none of the other answers

C. $(2 - 2j)$

D. $(8 - \sqrt{8})\angle 0°$

E. $\sqrt{8}\angle 45°$

26. At what frequency (expressed in radians per second) will the capacitor in this branch have the same magnitude of impedance as the resistor, if $C = 1\mu\text{F}$, $R = 1\text{K}\Omega$?



A. 10^6

B. 10^{12}

C. none of the other answers is correct

D. 10^9

E. 10^3

27. Two sinusoidal signals A and B are present in a system. The powers of the signals are A = 0.1W and B = 100W. The ratio of the two powers A/B expressed in dB is

A. -60 dB

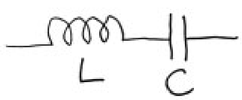
B. -30 dB

C. 30 dB

D. 0 dB

E. 60 dB

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



I - The circuit is a low pass filter.
II - At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.
III - At very low or very high frequencies the impedance approaches infinite impedance.

A. None of the others is correct.

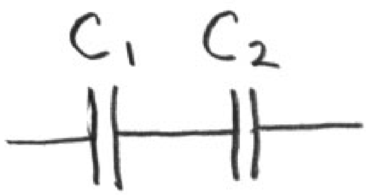
B. I, II, and III

C. I and III

D. II and III

E. I and II

29. What is the total capacitance of this branch if $C_1 = 0.1\ \mu$F, $C_2 = 0.1\ \mu$F?



A. 0.2 μF

B. None of the other answers is correct.

C. 0.1 μF

D. 0.5 μF

E. 0.05 μF

30. The property of *inductance* in a coil may best be described as follows:

A. The mass of the electrons provides inertia, which makes them want to keep moving in a given direction.

B. The buildup of charge on one section of the coil is offset by the depletion of charge on a neighboring section of the coil.

C. The magnetic field within the coil is non-linear with respect to the magnetic field of the earth.

D. The current in a coil is proportional to the voltage across the coil over the resistance of the coil.

E. The magnetic field surrounding a current contains energy, and it requires a voltage applied over time to change that energy.

31. A system is said to have a gain of 60dB. What is the ratio of the *output power* to the *input power* of the system.

A. 0.001

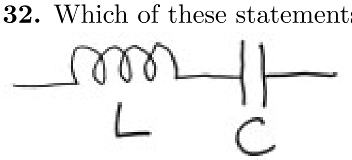
B. None of the other answers is correct.

C. 10^{-6}

D. 1,000,000

E. 1,000

32. Which of these statements is *false* about the following branch? (or all are true)



A. The impedance is infinite and imaginary at frequency $\omega = \infty$.

B. All are true.

C. The impedance is infinite and negative imaginary at frequency $\omega = 0$.

D. The impedance is zero at $\omega = \frac{1}{\sqrt{LC}}$.

E. At the resonant frequency, the branch alternately stores energy as an electric and a magnetic field.

33. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*, (or all are true)

A. Electrons leaving the negatively charged plate of the capacitor are replaced by electrons entering the postively charged plate.

B. The time required for the capacitor to discharge to exactly 50% of the initial voltage is RC.

C. All are true.

D. The energy initially stored in the capacitor ($\frac{1}{2}CV^2$, where V is the initial voltage on the capacitor) is released primarily as heat by the resistor.

E. The discharge is governed by a first order differential equation, with current gradually decreasing as the capacitor discharges.

34. Evaluate the complex exponential $\sqrt{2}e^{-j\frac{\pi}{4}}$

A. $-\sqrt{2}(j)$

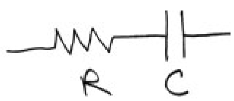
B. $(j-1)$

C. $(1-j)$

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

E. none of the other answers is correct.

35. The total complex impedance of this branch is



A. $\frac{1+j\omega RC}{j\omega C}$

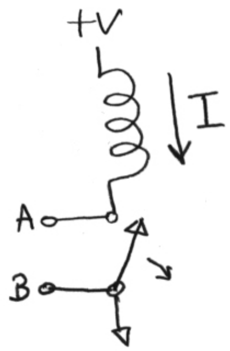
B. None of the other answers are correct.

C. $R + j\omega C$

D. $1 + j\omega RC$

E. $\frac{1+RC}{j\omega C}$

36. Given a non-zero current I through this inductor with the switch closed, what voltage would theoretically be generated between A and B if the switch were opened instantly (in zero time)?



A. 0

B. I

C. ∞

D. None of the other answers is correct.

E. $+V$

37. The following is *not* true about current:

A. In general, it can be said to obey Kirchhoff's Current Law, which states that no charge accumulates at any given node in a circuit.

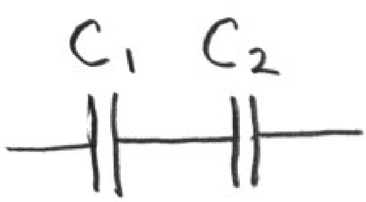
B. Its relationship to voltage across either a capacitor or inductor (coil) takes the form of a first order differential equation with respect to time.

C. The unit of current is the Ampere, which equals 6.241×10^{18} electrons per second.

D. The sum of the currents around any loop must equal zero.

E. When measured across a resistor, the voltage is linearly related to the current through that resistor.

38. What is the total capacitance of this branch if $C_1 = 2$ μF, $C_2 = 2$ μF?



A. 2 μF

B. 0.5 μF

C. 4 μF

D. None of the other answers is correct.

E. 1 μF

39. The energy stored in a 3 Henry inductor (coil) with 4 A through it

A. is 12 J.

B. is 24 J.

C. depends on how long it took to achieve the current.

D. cannot be determined without more information.

E. equals the heat dissipated by the coil.

40. A circuit takes sinusoidal input signal with amplitude $V_{in} = 10\mu$V and produces an output sinusoidal signal of the same frequency with amplitude $V_{out} = 1$mV. The gain of the system is

A. 40 dB

B. -20 dB

C. -40 dB

D. 20 dB

E. 0 dB

41. Evaluate the complex number expressed in polar notation by $\frac{1}{2\angle 45°}$

A. $\frac{2}{\sqrt{2}} - \frac{2}{\sqrt{2}}j$

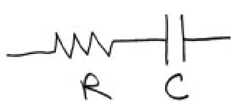
B. $\frac{1}{2\sqrt{2}} - \frac{1}{2\sqrt{2}}j$

C. $\frac{1}{2\sqrt{2}} + \frac{1}{2\sqrt{2}}j$

D. None of the other answers is correct.

E. $\frac{2}{\sqrt{2}} + \frac{2}{\sqrt{2}}j$

42. What is the total complex impedance (in ohms) of this branch if $C = 0.1\mu$F, $R = 20$KΩ, f = 100KHz?



A. $2 \times 10^4 + 10^5 j$

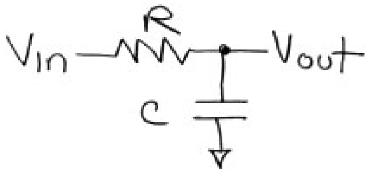
B. $2 \times 10^4 - 1.59 \times 10^4 j$

C. $2 \times 10^4 + 1.59 \times 10 j$

D. $2 \times 10^4 - 10^2 j$

E. $2 \times 10^4 - 1.59 \times 10 j$

43. Which of the following is true about the circuit below?



A. The circuit is not a linear system.

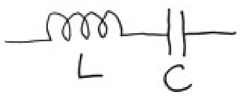
B. If V_{in} is a sinusoid at a particular frequency $\omega = \frac{1}{RC}$, the magnitude of the impedances of the resistor and the capacitors are equal

C. The circuit is a high pass filter.

D. DC passes through the capacitor as if it were a piece of wire.

E. At different frequencies of V_{in} the phase of V_{out} does not change, only its magnitude.

44. The following are true about the circuit below *except*



A. This is a high-pass filter.

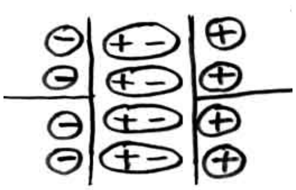
B. The circuit resonates at a particular frequency.

C. At very high frequencies it approaches infinite impedance.

D. At very low frequencies it approaches infinite impedance.

E. At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.

45. Which of the following is *false* about the following diagram of a capacitor (or all are true).



A. The material between the plates represents the dielectric, which increases capacitance by the alignment of dipoles in the electrostatic field.

B. The capacitor is shown in a charged state.

C. The permeability of the material between the plates effects the capacitance.

D. All are true.

E. The capacitance is proportional to the area of the plates and inversely proportional to the distance between them.

46. What is the total capacitance of this branch if $C_1 = C_2 = 0.001\mu$F?

A. .005 μF

B. ∞ μF

C. 200 pF

D. 500 pF

E. .002 μF

47. Given an ideal capacitor, the charge entering one wire

A. experiences a buildup over time of a voltage pushing back against it *proportional* to the capacitance.

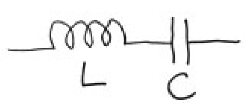
B. can accumulate on one of the plates by pushing charge off of the other plate and out the other wire, thus avoiding a net buildup of charge within the capacitor.

C. can continue forever while only experiencing a finite buildup of a voltage.

D. cannot enter the capacitor at all, because of Kirchoff's current law.

E. is of much larger magnitude than the charge leaving the other wire., resulting in the buildup of voltage across the capacitor.

48. The following are true about the circuit below *except* (or all are true)



A. At very high frequencies it approaches infinite impedance.

B. The circuit resonates at a particular frequency.

C. All are true.

D. At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.

E. At very low frequencies it approaches zero impedance.

49. A circuit takes sinusoidal input signal with amplitude $V_{in} = 1$mV and produces an output sinusoidal signal of the same frequency with amplitude $V_{out} = 10\mu$V. The gain of the system is

A. 40 dB

B. -40 dB

C. 20 dB

D. -20 dB

E. 0 dB

50. Evaluate the complex exponential $e^{j\frac{3\pi}{4}}$

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

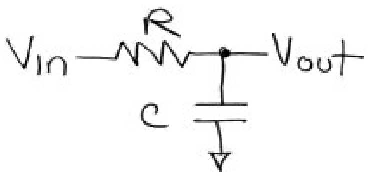
B. none of the other answers is correct.

C. $\frac{(-1+j)}{\sqrt{2}}$

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

E. $(1-j)$

51. Which of the following is (are) true about the circuit below?



I - The circuit is a low pass filter.
II - The magnitude of the two impedances is equal at frequency $\omega = \frac{1}{RC}$.
III - The impedance of each of the two components varies with frequency.

A. I and III

B. I, II, and III

C. II and III

D. II

E. I and II

52. The following are true about complex conjugates (Z and Z^*) *except* (or all are true)

A. Expressed as phasors, Z and Z^* have opposite angles with respect to the real axis.

B. ZZ^* is always a real number.

C. Multiplying by Z is the same as dividing by Z^*.

D. All are true.

E. $Z + Z^*$ is always a real number.

53. The following are true about sinusoids *except* (or all are true)

A. Adding two sinusoids with the same frequency always produces a sinusoid at that same frequency.

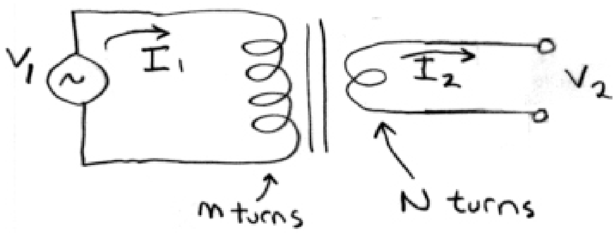
B. All are true.

C. The second derivative of a sinusoid is some negative constant times the original sinusoid.

D. They may be represented as the sum of a complex exponential and its complex conjugate.

E. Taking the derivative of a sinusoid shifts its phase 90° to the left.

54. In the following circuit, with a sinusoidal input with RMS amplitude, V_1 (and V_2, I_1, and I_2 also expressed in RMS),



which of the following is true?

I - The amplitude of V_2 is $\frac{N}{M}V_1$.
II - Since transformers are very nearly 100% efficient, it is generally assumed that $V_1I_1 = V_2I_2$.
III - The frequency of V_2 is the same as V_1 .

A. I and III

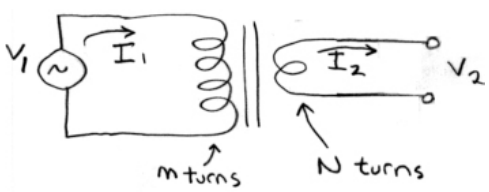
B. I, II and III

C. I and II

D. I

E. II and III

55. Assuming the transformer shown below is 100% efficient, the primary RMS voltage V_1=4V and RMS current I_1=4A, M=200, N=20, what is the power in the secondary?



A. 0.16W

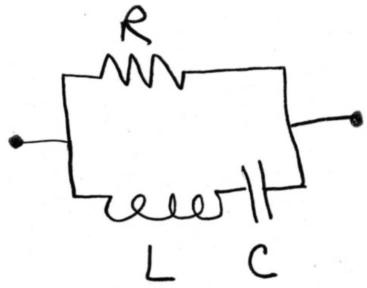
B. 16W

C. cannot be determined from the given information.

D. 1.6W

E. 160W

56. What is the impedance of the following branch at $\omega = 0$?



A. $0\ \Omega$

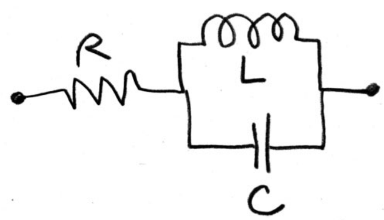
B. $j\omega L$

C. $\frac{1}{j\omega C}$

D. None of the others is correct.

E. R

57. What is the impedance of the following branch at $\omega = \infty$?



A. $\frac{1}{j\omega C}$

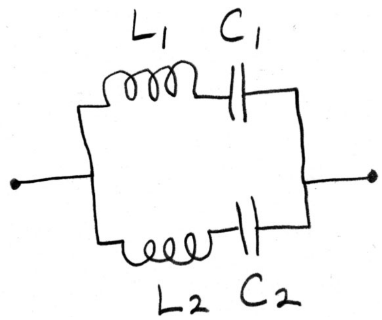
B. Infinte

C. None of the others is correct.

D. $R + j\omega L$

E. R

58. Assuming $L_1 = L_2 = 1\text{H}$ and $C_1 = C_2 = 1\text{F}$, what is the the impedance of the following branch at $f = \frac{1}{2\pi}\text{Hz}$? (hint: think about resonance of each of the LC branches)



A. $2j\omega L_1$

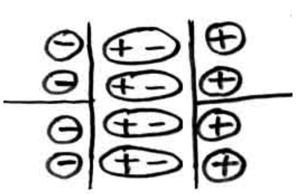
B. None of the others is correct.

C. Infinte

D. 0

E. $\frac{1}{2j\omega C_1}$

59. Which of the following is *false* about the following diagram of a capacitor (or all are true).



A. The capacitor is shown in a charged state.

B. The material between the plates represents the dielectric, which increases capacitance by the alignment of dipoles in the electrostatic field.

C. Direct Current (DC) may pass through the capacitor forever, provided there is no significant inductance to build up a magnetic field.

D. All are true.

E. The capacitance is proportional to the area of the plates and inversely proportional to the distance between them.

60. The following are all true about the property of reactance *except*

A. All are true.

B. Capacitance is a form of reactance.

C. Reactance is the imaginary component of impedance.

D. Inductance is a form of reactance.

E. Resistance is a form of reactance.

61. Which of these statements is *false* about phase? (or all are true)

A. Phase is the θ in $e^{j\theta}$.

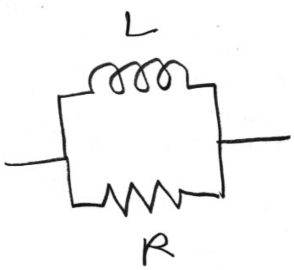
B. Phase can be expressed as an angle in degrees.

C. All are true.

D. Phase can be expressed in radians.

E. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

62. Which of the following is *false* about the impedance of the following branch?



A. It completely describes the relationship between the voltage across the branch and the current through it.

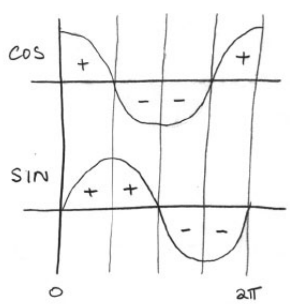
B. It represents a solution that can also be found using linear differential equations.

C. It can be found by taking the reciprocal of the sum of the reciprocals of R and $j\omega L$

D. At $\omega = \infty$ it is R.

E. At $\omega = 0$ it is ∞.

63. Which of the following is *false* about this diagram, as it was used in lecture in the section about AC power?



A. Since the capacitor integrates current to produce voltage, the current and voltage are 90° out of phase.

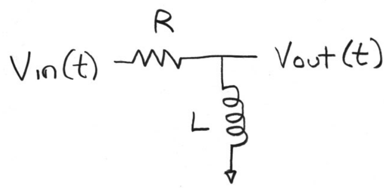
B. The energy stored in an ideal capacitor, $\frac{1}{2}CV^2$, is returned to the circuit with 100 percent efficiency.

C. The average power resulting from two non-zero voltages and currents can never be zero.

D. The power dissipated by a capacitor differs from that dissipated by a resistor, because the impedance of a capacitor is imaginary.

E. The average product of the sin and cos over one cycle is zero.

64. Which of the following statements is *false* about the following system?



A. The system response $H(\omega) = \frac{j\omega L}{R+j\omega L}$

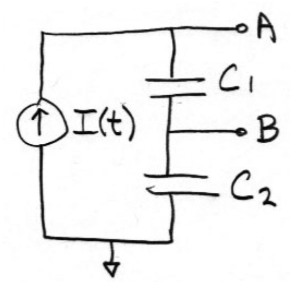
B. This is a high pass filter.

C. If $V_{in}(t)$ is a sinusoid of frequency ω, $V_{out}(t)$ is also sinusoid of frequency ω.

D. At $\omega = \infty$, the system introduces a 90° phase shift.

E. This system is called "linear" because it can be modeled by a linear differential equation.

65. Which of the following statements is *false* about the following circuit, assuming $C_1 = 1\mu$F, $C_2 = 2\mu$F, both capacitors are discharged at $t = 0$, $I(t) = 0$A for $t < 0$, and $I(t) = 1\mu$A for $t > 0$?



A. The voltage across C_2 will always be twice that across C_1.

B. The total capacitance of C_1 and C_2 in series is $\frac{2}{3}\mu$F

C. The voltage between point B and ground after 2 seconds is 4V.

D. Given enough time, any real system with this schematic will fail.

E. Because the current is itegrated on each of the capacitors, Kirchhoff's current law does not apply.

66. Which of these statements is *false* about the Bode plot?

A. It is commonly used the describe the frequency response of a filter.

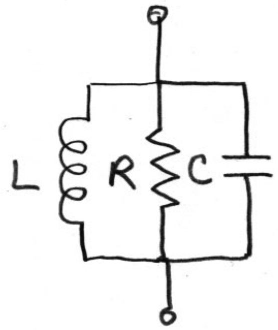
B. At $\omega = 0$, the gain is always 0dB and the phase shift is always 0°.

C. It represents a complex number in polar coordinates as a function frequency.

D. It fully describes the behavior of the transfer function $H(\omega)$.

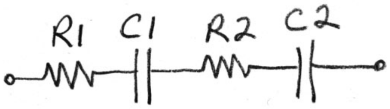
E. It consists of two plots describing a system: the gain (change in amplitude) in dB and the phase shift, both as functions of frequency (also displayed logarithmically).

67. What is the impedance across the branch shown below, at frequency $\omega = \frac{1}{\sqrt{LC}}$?



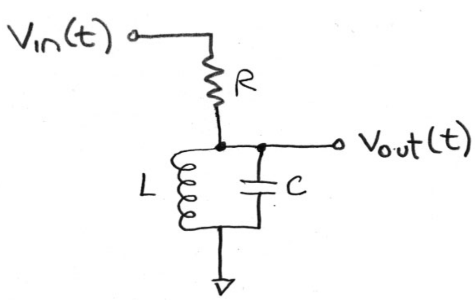
A. $j\omega L$
B. $0\ \Omega$
C. $\infty\ \Omega$
D. R
E. $\frac{1}{j\omega C}$

68. What is the total impedance of the following branch?



A. None of the others is correct.
B. R_1+R_2 + $\frac{1}{j\omega(C_1+C_2)}$
C. R_1+R_2 + $\frac{1}{j\omega(\frac{C_1C_2}{C_1+C_2})}$
D. R_1+R_2 + $j\omega(C_1 + C_2)$
E. $0\ \Omega$ at all frequencies ω.

69. All of the following are true about the following system *except* (or all are true)?



A. Given a particular signal $V_{in}(t) = Asin(\omega t)$, the output signal $V_{out}(t)$ will always be a sinusoid of frequency ω.
B. Given an input signal $V_{in}(t) = e^{j\omega t}$ the output signal $V_{out}(t)$ will never have a magnitude greater than 1.
C. The system has a transfer function $H(\omega)$, which is a complex number at any given frequency ω.
D. This is a linear system and thus can change magnitude and phase, but never frequency.
E. All of the answers are true.

70. A 1 μF capacitor that is initially completely discharged is then charged for 6 seconds with 1 μA. How many joules does it store?

A. 3 μJ

B. 18 μJ

C. 6 μJ

D. 36 μJ

E. Cannot be determined.

71. The following is *not* true about voltage, or all are true:

A. It can be considered for a single point in a circuit only relative to a reference point, normally called "ground."

B. It is the energy required to move a unit charge from one location to another.

C. When measured across a capacitor, it is linearly related to the integral of the current through that capacitor.

D. All are true.

E. Given a negative charge and a positive charge, voltage is a vector pointing from the positive charge towards the negative charge, describing the force on a unit test charge placed between them.

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

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

B. none of the other answers

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

D. $2\angle 235^\circ$

E. $2\angle 45^\circ$

73. *Admittance* is the reciprocal of

A. Resistance.

B. Capacitance.

C. None of the other answers is true.

D. Impedance.

E. Inductance.

74. Which of these statements is *false* about phase? (or all are true)

A. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

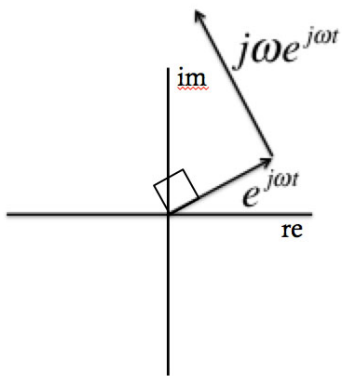
B. Phase is the imaginary component in a complex number.

C. All are true.

D. Phase is whatever is in the parenthesis in the following equation showing Euler's identity, $e^{j()} = cos() + jsin()$.

E. Phase can be expressed in units of degrees, radians, or cycles.

75. Which of the following is *false* about the following diagram (or all are true)?



A. In the diagram, as shown, $\omega > 1$.

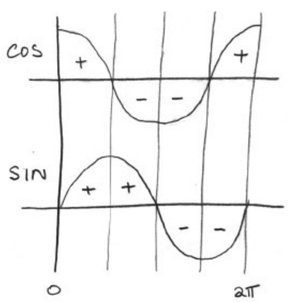
B. Given that multiplying a phasor by j rotates it 90 degrees counterclockwise, the diagram shows how the phasor $e^{j\omega t}$ will follow a circular path over time.

C. It shows a phasor of magnitude 1 and its derivative with respect to time.

D. It demonstrates Euler's identity, since $cos(\omega t)$ and $jsin(\omega t)$ define a unit circle in the complex plane.

E. All are true.

76. Which of the following is *false*, as regards this diagram in lecture in the section about AC power (or all are true)?



A. The average product of the sin and cos over one cycle is zero.

B. The energy stored in an ideal capacitor, $\frac{1}{2}CV^2$, is returned to the circuit with 100 percent efficiency.

C. Since the capacitor integrates current to produce voltage, the current and voltage are 90° out of phase.

D. All are true

E. The average power resulting from non-zero voltages and currents in a given component can be zero.

77. Which of the following is *false* about permeability in electromagnetism (or all are true)?

A. All are true.

B. The inductance of a coil can be increased by including certain materials within the coil that support the formation of a magnetic field.

C. The permiability of free space is zero.

D. Greater permeability permits an inductor to store proportionally greater energy for a given current.

E. Permeability is to inductance as permittivity is to capacitance.

78. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*, (or all are true)

A. The discharge is governed by a first order differential equation, with current gradually decreasing as the capacitor discharges.

B. The time required for the capacitor to discharge to exactly $1/e$ (about 37%) of the initial voltage is RC.

C. All are true.

D. The energy initially stored in the capacitor ($\frac{1}{2}CV^2$, where V is the initial voltage on the capacitor) is released primarily as heat by the resistor.

E. Since the voltage across the capacitor does not decrease at a constant rate, this is not a linear system.

79. A system is said to have a gain of 60dB. What is the ratio of the *output voltage* to the *input voltage* of the system.

A. 0.001

B. 1,000,000

C. 1,000

D. 10^{-6}

E. None of the other answers is correct.

80. Which of these statements is *false* about the Bode plot, or all are true?

A. It is commonly used the describe the frequency response of a filter.

B. It fully describes the behavior of the transfer function $H(\omega)$.

C. It represents a complex number in polar coordinates as a function frequency.

D. It consists of two plots describing a system: the gain (change in amplitude) in dB and the phase shift, both as functions of frequency (also displayed logarithmically).

E. All are true.

81. The following is *not* true about a linear system whose transfer function is $H(\omega) = \frac{1}{j\omega}$:

A. It performs integration.

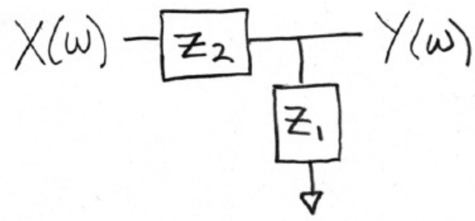
B. It goes to infinity at DC.

C. Its output signal is purely imaginary at all points in time.

D. It is a lowpass filter

E. Putting $e^{j\omega t}$ at the input yields $\frac{1}{j\omega}e^{j\omega t}$ at the output.

82. All of the following are true about the following system *except* (or all are true)?



A. All of the answers are true.

B. The system has a transfer function $H(\omega) = \frac{Y(\omega)}{X(\omega)}$.

C. The transfer function $H(\omega) = \frac{Z_1}{Z_1+Z_2}$.

D. The system is a voltage divider.

E. If Z_1 and Z_2 are real, this is simply a voltage divider consisting of two resistors.

83. A transformer with 1000 turns of wire in the primary and 50 turns of wire in the secondary is assumed to be 100% efficient. Given a sinusoidal voltage at the primary with peak voltage = 100 V, what is the RMS voltage at the secondary:

A. $\frac{50}{\sqrt{2}}$ V_{RMS}.

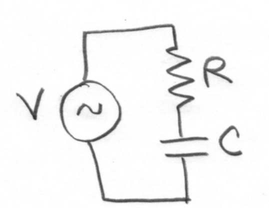
B. 5 V_{RMS}.

C. $5\sqrt{2}$ V_{RMS}.

D. 50 V_{RMS}.

E. $\frac{5}{\sqrt{2}}$ V_{RMS}.

84. The circuit below shows an AC voltage source in which $V = Acos(\omega t)$, where $\omega = \frac{1}{RC}$. What is the power *dissipated* (as heat) by the capacitor?



A. 0 W

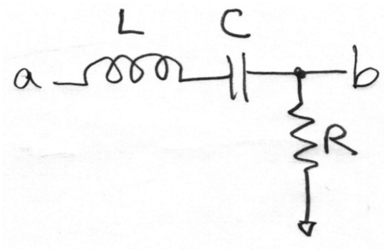
B. $\frac{A^2}{\sqrt{2}R}$ W

C. $\frac{A^2}{R}$ W

D. $\frac{1}{2\sqrt{2}}CA^2$ W

E. $\frac{1}{2}CA^2$ W

85. What is the transfer function $H(\omega)$ of the circuit at $\omega = \frac{1}{\sqrt{RC}}$, given point a is the input and point b is the output?



A. $H(\omega) = \infty$

B. $H(\omega) = \frac{R}{L+C+R}$

C. $H(\omega) = 0$

D. $H(\omega) = 1$

E. None of the other answers is correct.

86. A system is said to have a gain of -60dB. What is the ratio of the *output power* to the *input power* of this system.

A. None of the other answers is correct.

B. 1,000,000

C. 10^{-6}

D. 0.001

E. 1,000

87. What is the phasor representation of $(1-j)^3$? (Hint: convert $(1-j)$ to a phasor first and then cube it.)

A. $e^{-j\frac{3\pi}{4}}$

B. -j

C. $8e^{-j\frac{3\pi}{4}}$

D. 1

E. $2\sqrt{2}e^{-j\frac{3\pi}{4}}$

88. What is the cartesian representation of $3e^{j\frac{11\pi}{4}}$?

A. $-\frac{3}{\sqrt{2}} + j\frac{3}{\sqrt{2}}$

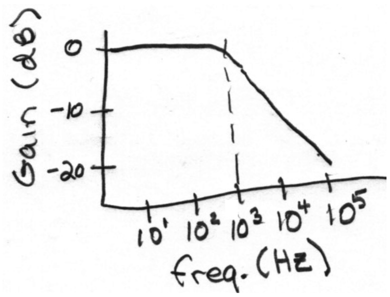
B. $-3+3j$

C. -3

D. $3-3j$

E. $-\sqrt{3} - j\sqrt{3}$

89. The following are true about the graph below *except* (or all are true).



A. It is consistant with a passive RC filter where 10^3 Hz $= \frac{1}{2\pi RC}$.

B. In the case of a passive RC filter, it would normally be accompanied by the phase portion of the Bode plot, showing a phase shift approaching $0°$ for frequencies $<< 10^3$ Hz.

C. Gain, meaning the ratio of output to input *power*, is represented in decibels (dB), such that 0 dB represents a gain of 1 and -10 dB represents a gain of $\frac{1}{10}$.

D. It represents the magnitude portion of the Bode plot of a low pass filter.

E. All are true.

90. Which of the following is *false* about permittivity (or all are true)?

A. It can be increased by the alignment of charges in the material between the plates of a capacitor.

B. Permittivity is to capacitance as permeability is to inductance.

C. All are true.

D. In a given capacitor, it determines the capacitance for a given area of plates and distance between them.

E. The permittivity and permeability of free space determine the speed of light in a vacuum.

91. Which of these statements is *false* about phase? (or all are true)

A. Phase is whatever is in the parenthesis in the following equation showing Euler's identity, $e^{j()} = cos() + jsin()$.

B. Phase and magnitude are all that can be changed by a linear system at a given frequency.

C. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

D. All are true.

E. Phase can be expressed in units of degrees, radians, or cycles.

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BioE 1310 - Review 2 - AC 1/16/2017
Answer Sheet - Correct answer is A for all questions

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

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

A. $\sqrt{2}(1+i)$

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

C. $3\angle 2°$

D. $2\angle 235°$

E. none of the other answers

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

3. 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.

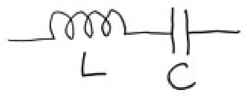
C. Square waves result from differentiating triangle waves, which boosts their higher harmonics.

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*]

4. 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

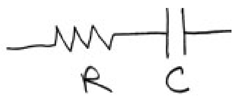
C. 13.3 KHz

D. 83.8 KHz

E. 75 KHz

Explanation: $\omega = \frac{1}{\sqrt{LC}}$; $f = \omega/2\pi$.
[*circuits0037.mcq*]

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



A. $10^4 - 1.59 \times 10^3 j$

B. $10^4 + 1.59 \times 10^3 j$

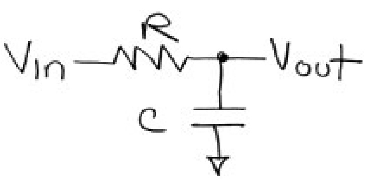
C. $10^4 - 10^4 j$

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*]

6. 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 - $|V_{out}| = \frac{1}{\sqrt{2}}|V_{in}|$ 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: Solve the divider equation for $\omega = \frac{1}{RC}$; $f = \frac{\omega}{2\pi}$
[*circuits0040.mcq*]

7. The following is true about the expression, $e^{j\theta} = \cos\theta + j\sin\theta$, *except* (or all are true)

A. All are true.

B. It permits algebraic solutions for expressions such as $\cos^2\theta$.

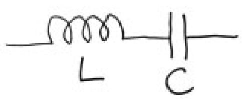
C. It is known as Euler's Identity.

D. It shows $e^{j\theta}$ to be on the unit circle in the complex plane, with θ being the angle relative to the real axis.

E. It leads easily to the fact that complex numbers, when multiplied by each other, scale each other's magnitudes and shift each others phases.

Explanation:
[*circuits0041.mcq*]

8. If $L = 125\text{mH}$, $C = 150\mu\text{F}$, the circuit below has zero impedance at what frequency (in Hz)?
(Recall that $Z_L = j\omega L$ and $Z_C = \frac{1}{j\omega C}$, where frequency in Hz $f = \omega/2\pi$).



A. 36.8 Hz

B. 230 Hz

C. 26.6 KHz

D. 167.6 KHz

E. 150 KHz

Explanation: $\omega = \frac{1}{\sqrt{LC}}$; $f = \omega/2\pi$.
[*circuits0054.mcq*]

9. The following are true regarding a circuit containing a resistor and a capacitor with the following relationship between input and output voltages at frequency ω, *except*,

$\frac{V_{out}}{V_{in}} = \frac{1}{1+j\omega RC}$

A. It lets all frequencies through equally.

B. It acts as a low pass filter.

C. At $\omega = 0$ it acts like a piece of wire.

D. At $\omega = \infty$ it lets nothing through.

E. At $\omega = \frac{1}{RC}$ it exhibits a phase shift.

Explanation: The circuit acts as a low pass filter, letting DC through completely, not letting infinitely high frequencies through at all, and shifting the phase of frequencies in between, such as $\omega = \frac{1}{RC}$, where it shifts by 45°.
[*circuits0093.mcq*]

10. Two acoustic signals A and B are present in a system. The powers of the signals are A = 10 mW and B = 10 μW.
The ratio of the two powers A/B expressed in dB is

A. 30 dB

B. -30 dB

C. 60 dB

D. -60 dB

E. 0 dB

Explanation: Since we are talking power, not amplitude, $10log_{10}(\frac{10^{-2}}{10^{-5}}) = 30$.
[*circuits0095.mcq*]

11. Evaluate the complex number expressed in polar notation by $\frac{3\angle 120°}{9\angle 150°}$

A. $\frac{1}{2\sqrt{3}} - \frac{1}{6}j$

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

C. $\frac{1}{3}\angle 30°$

D. $6\angle -30°$

E. none of the other answers

Explanation: $\frac{3\angle 120°}{9\angle 150°} = \frac{1}{3}\angle -30°$
[*circuits0096.mcq*]

12. 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. $\frac{1+\cos 2\theta}{2}$

B. $\frac{1+\sin 2\theta}{2}$

C. $\frac{1-\cos 2\theta}{2}$

D. $\frac{1-\sin 2\theta}{2}$

E. $1+\sin^2\theta$

Explanation: Simply square $\cos\theta = \frac{e^{j\theta}+e^{-j\theta}}{2}$ and regroup terms.
[*circuits0097.mcq*]

13. The following is *false* regarding square and triangle waves.

A. Triangle waves at 400 Hz into a speaker are audible, whereas square waves at 400 Hz are not.

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

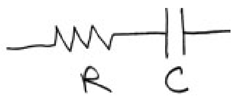
C. Square waves result from differentiating triangle waves, which boosts their higher harmonics.

D. Triangle waves result from integrating square waves, which boosts their lower harmonics.

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

Explanation: The higher harmonics especially prominent in the square wave, giving it its harsh, buzzer-like quality. The actual Fourier transform for either is infinite and thus neither can actually be created in the physical world.
[*circuits0098.mcq*]

14. The total complex impedance of this branch is



A. $\frac{1+j\omega RC}{j\omega C}$

B. $\frac{1+RC}{j\omega C}$

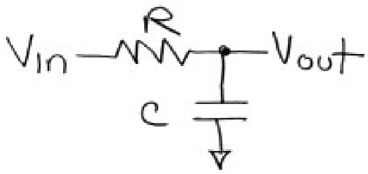
C. $1 + j\omega RC$

D. $R + j\omega C$

E. $\frac{1}{R} + \frac{1}{j\omega C}$

Explanation: The total impedance is that of the capacitor, $\frac{1}{j\omega C}$, plus that of the resistor, R. Combining terms yields a reassuring RC term in the numerator.
[*circuits0103.mcq*]

15. Which of the following is (are) true about the circuit below, given that $R = 1\text{M}\Omega$ and $C = .001\mu\text{F}$ and that V_{in} is sinusoidal at a particular frequency.



I - The circuit is a low pass filter.
II - $|V_{out}| = \frac{1}{\sqrt{2}}|V_{in}|$ at frequency f = 159.1 Hz.
III - The impedance of the capacitor increases as frequency increases.
IV - V_{out} is also sinusoidal at the same frequency as V_{in}

A. I, II and IV

B. I, II and III

C. I, III, and IV

D. II, III, and IV

E. All are true.

Explanation: $|R| = |\frac{1}{j\omega C}|$; $\omega = \frac{1}{RC}$; $f = \frac{\omega}{2\pi}$. The circuit is a low pass filter and a linear system, so a sinusoid only changes phase and amplitude, not frequency. The impedance of a capacitor, $\frac{1}{j\omega C}$, *decreases* with frequency.
[*circuits0105.mcq*]

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

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

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

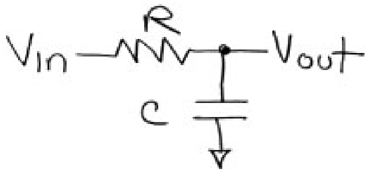
C. -2

D. $2j$

E. none of the other answers

Explanation: $-2e^{-j\frac{\pi}{4}} = -2(\frac{1}{\sqrt{2}} + \frac{-j}{\sqrt{2}}) = \sqrt{2}(j-1)$.
[*circuits0115.mcq*]

17. Which of the following is (are) true about the circuit below, given that R = 10 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, II and III

B. II and III

C. I, and II

D. I 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 $\omega = \frac{1}{RC}$;
[*circuits0122.mcq*]

18. The following are true about safety and electricity, *except*

A. Alternating current (AC) is inherently safer than direct current (DC), which is why we use it to transmit power.

B. Electricity usually kills by effecting the heart, so electricians are taught to use one hand near a high voltage.

C. Hospital equipment often prevents direction connection between the patient-contacting equipment and 110 V by use of optical isolators and transformers.

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

E. High voltage can cause muscle contraction preventing the victim from releasing the wire.

Explanation: AC is actually more dangerous than DC, because the skin impedance is lower at 60 Hz than at 0 Hz. We use AC because it permits the use of transformers to step-up and step-down the voltage for long range transmission.
[*circuits0123.mcq*]

19. 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. The impedance of an inductor is lower at higher frequencies.

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.

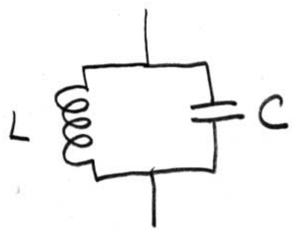
C. The same relationship can also be written $I = \frac{1}{L}\int V dt$

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 equivalent equation for capacitance is $I = C\frac{dV}{dt}$, and energy in the capacitor is stored in the charge.

Explanation: The impedance of an inductor is $Z = j\omega L$, and thus increases with frequency.
[*circuits0125.mcq*]

20. Given that L = 10 μH and C = 100 pF, which of the following is (are) true about the following branch?



I - The impedance at both 0 Hz and ∞ Hz is 0.
II - The impedance at resonance is infinite.
III - Resonance happens at $\omega = \frac{1}{\sqrt{LC}}$.

A. I, II, and III

B. None of the other answers is correct.

C. I and II

D. II and III

E. I and III

Explanation: The impedance of the branch is $\omega = \frac{1}{j\omega C + \frac{1}{j\omega L}} = \frac{j\omega L}{1-\omega^2 LC}$.
[*circuits0129.mcq*]

21. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*

A. The total charge in the capacitor (the sum on both plates) gradually decreases to zero.

B. The time required to discharge to a certain percentage of the initial charge is proportional to RC.

C. The discharge is governed by a first order differential equation similar to that governing radioactive decay of a certain initial amount of Carbon-14.

D. Current will gradually decrease as the capacitor discharges.

E. The energy initially stored in the capacitor is released as heat by the resistor.

Explanation: The total charge on both plates stays constant, increasing on one plate as it decreases on the other.
[*circuits0147.mcq*]

22. The cause of magnetism may best be described as

A. the Lorenz contraction of moving charges making them appear to other moving charges to be more densely packed than neighboring stationary charges.

B. the curvature of coils of wires creating a centrifugal force on the moving charges.

C. an independent fundamental force unrelated to the electrostatic force.

D. a quantum effect on moving charges due to the effect of gravity.

E. the interaction between moving charges and the nuclei of neighboring iron atoms.

Explanation: the Lorenz contraction was, in fact, deduced as the only reasonable explanation for magnetism.
[*circuits0148.mcq*]

23. The capacitance of a capacitor produces a relationship between current and voltage described by $I = C\frac{dV}{dt}$. All of the following are true *except*

A. The larger the capacitance C, the more rapid the change in voltage for a given current.

B. Energy is stored in the charge difference between the plates, making it take a current to change the voltage over time.

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

D. Special capacitors with very large capacitance may store appreciable energy comparable to a battery.

E. The equivalent equation for inductance is $V = L\frac{dI}{dt}$.

Explanation: A larger capacitance yields a *less* rapid change in voltage for a given current.
[*circuits0149.mcq*]

24. Which of the following is *false* about permittivity (or all are true)?

A. It permits a constant current to leak between the plates of the capacitor.

B. Even free space has a non-zero permittivity.

C. It can be increased by the alignment of charges in the material between the plates of a capacitor.

D. All are true.

E. In a given capacitor, it determines the capacitance for a given area of plates and distance between them.

Explanation: A capacitor may leak, but not because of permittivity. Permittivity relates to the storage capacity for charge between the plates due to the material between them.
[*circuits0152.mcq*]

25. Evaluate the complex number expressed in polar notation by $\frac{8\angle 0^\circ}{\sqrt{8}\angle 45^\circ}$

A. $(2 - 2j)$

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

C. $(8 - \sqrt{8})\angle 0^\circ$

D. $\sqrt{8}\angle 45^\circ$

E. none of the other answers

Explanation: $\frac{8\angle 0^\circ}{\sqrt{8}\angle 45^\circ} = \sqrt{8}\angle - 45^\circ$
[*circuits0157.mcq*]

26. At what frequency (expressed in radians per second) will the capacitor in this branch have the same magnitude of impedance as the resistor, if $C = 1\mu\text{F}$, $R = 1\text{K}\Omega$?

A. 10^3

B. 10^{12}

C. 10^9

D. 10^6

E. none of the other answers is correct

Explanation: The impedance of a capacitor is $1/j\omega C$ and the magnitude of that impedance is $1/\omega C$. Set this equal to R and solve for ω.
[*circuits0158.mcq*]

27. Two sinusoidal signals A and B are present in a system. The powers of the signals are A = 0.1W and B = 100W. The ratio of the two powers A/B expressed in dB is

A. -30 dB

B. 30 dB

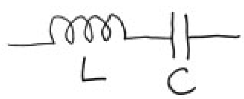
C. 60 dB

D. -60 dB

E. 0 dB

Explanation: Since we are talking power, not amplitude, $10log_{10}(\frac{A}{B})$.
[*circuits0159.mcq*]

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



I - The circuit is a low pass filter.
II - At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.
III - At very low or very high frequencies the impedance approaches infinite impedance.

A. II and III

B. I and II

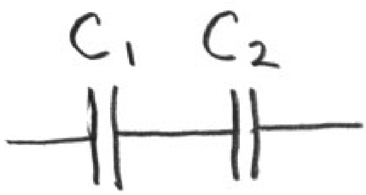
C. I and III

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. This is a bandpass filter (letting a certain frequency through at $\omega = \frac{1}{\sqrt{LC}}$, not a low-pass filter.
[*circuits0160.mcq*]

29. What is the total capacitance of this branch if $C_1 = 0.1\ \mu$F, $C_2 = 0.1\ \mu$F?



A. 0.05 μF

B. 0.2 μF

C. 0.1 μF

D. 0.5 μF

E. None of the other answers is correct.

Explanation: Capacitances in series add like resistors in parallel. In other words, $C_S = \frac{C_1 \times C_2}{C_1 + C_2}$.
[*circuits0177.mcq*]

30. The property of *inductance* in a coil may best be described as follows:

A. The magnetic field surrounding a current contains energy, and it requires a voltage applied over time to change that energy.

B. The mass of the electrons provides inertia, which makes them want to keep moving in a given direction.

C. The current in a coil is proportional to the voltage across the coil over the resistance of the coil.

D. The buildup of charge on one section of the coil is offset by the depletion of charge on a neighboring section of the coil.

E. The magnetic field within the coil is non-linear with respect to the magnetic field of the earth.

Explanation: Answer B is the actual inertia of the electrons, an insignificant factor. Answer C is simply Ohm's law, accounting for the coil's *resistance*, not its inductance. Answers D describes capacitance. Answer E is not related to inductance.
[*circuits0178.mcq*]

31. A system is said to have a gain of 60dB. What is the ratio of the *output power* to the *input power* of the system.

A. 1,000,000

B. 10^{-6}

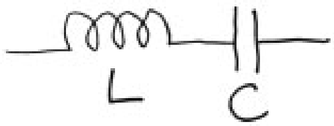
C. 1,000

D. 0.001

E. None of the other answers is correct.

Explanation: For power, $60 = 10log_{10}(1,000,000)$.
[*circuits0179.mcq*]

32. Which of these statements is *false* about the following branch? (or all are true)



A. All are true.

B. The impedance is infinite and imaginary at frequency $\omega = \infty$.

C. The impedance is infinite and negative imaginary at frequency $\omega = 0$.

D. At the resonant frequency, the branch alternately stores energy as an electric and a magnetic field.

E. The impedance is zero at $\omega = \frac{1}{\sqrt{LC}}$.

Explanation: This is the classic resonant system, whose impedance is $\frac{1}{j\omega C} + j\omega L = \frac{1-\omega^2 LC}{j\omega C}$. It acts something like a pendulum, with the energy being handed back and forth between the capacitor and the coil.
[*circuits0180.mcq*]

33. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*, (or all are true)

A. The time required for the capacitor to discharge to exactly 50% of the initial voltage is RC.

B. Electrons leaving the negatively charged plate of the capacitor are replaced by electrons entering the postively charged plate.

C. The discharge is governed by a first order differential equation, with current gradually decreasing as the capacitor discharges.

D. All are true.

E. The energy initially stored in the capacitor ($\frac{1}{2}CV^2$, where V is the initial voltage on the capacitor) is released primarily as heat by the resistor.

Explanation: RC is the time to reach $1/e$ (about 37%) times the initial voltage on the capacitor, not 50%.
[*circuits0181.mcq*]

34. Evaluate the complex exponential $\sqrt{2}e^{-j\frac{\pi}{4}}$

A. $(1 - j)$

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

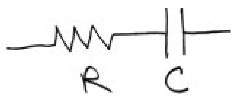
C. $(j - 1)$

D. $-\sqrt{2}(j)$

E. none of the other answers is correct.

Explanation: $\sqrt{2}e^{-j\frac{\pi}{4}} = \sqrt{2}(\frac{1}{\sqrt{2}} + \frac{-j}{\sqrt{2}}) = (1 - j)$.
[*circuits0182.mcq*]

35. The total complex impedance of this branch is



A. $\frac{1+j\omega RC}{j\omega C}$

B. $\frac{1+RC}{j\omega C}$

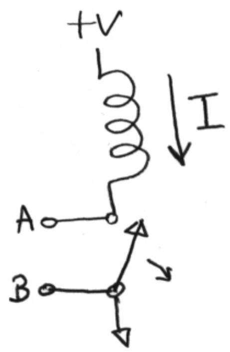
C. $1 + j\omega RC$

D. $R + j\omega C$

E. None of the other answers are correct.

Explanation: The total impedance is that of the capacitor, $\frac{1}{j\omega C}$, plus that of the resistor, R. Combining terms yields a reassuring RC term in the numerator.
[*circuits0183.mcq*]

36. Given a non-zero current I through this inductor with the switch closed, what voltage would theoretically be generated between A and B if the switch were opened instantly (in zero time)?



A. ∞

B. 0

C. I

D. $+V$

E. None of the other answers is correct.

Explanation: ∞ because the voltage across the coil is $L\frac{dI}{dt}$. The current goes from I to 0 instantly, so point A goes to infinity above +V, and therefore point A is also infinity above ground (point B).
[*circuits0201.mcq*]

37. The following is *not* true about current:

A. The sum of the currents around any loop must equal zero.

B. When measured across a resistor, the voltage is linearly related to the current through that resistor.

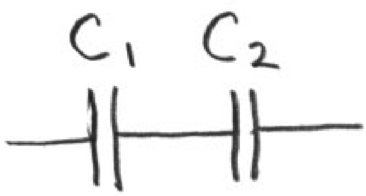
C. The unit of current is the Ampere, which equals 6.241×10^{18} electrons per second.

D. In general, it can be said to obey Kirchhoff's Current Law, which states that no charge accumulates at any given node in a circuit.

E. Its relationship to voltage across either a capacitor or inductor (coil) takes the form of a first order differential equation with respect to time.

Explanation: The sum a the *voltages* (not the currents) around any loop must equal zero. This is Kirchhoff's voltage law.
[*circuits0203.mcq*]

38. What is the total capacitance of this branch if $C_1 = 2\ \mu\text{F}$, $C_2 = 2\ \mu\text{F}$?



A. 1 μF

B. 2 μF

C. 4 μF

D. 0.5 μF

E. None of the other answers is correct.

Explanation: Capacitances in series add like resistors in parallel. In other words, $C_S = \frac{C_1 \times C_2}{C_1 + C_2}$.
[*circuits0208.mcq*]

39. The energy stored in a 3 Henry inductor (coil) with 4 A through it

A. is 24 J.

B. equals the heat dissipated by the coil.

C. is 12 J.

D. cannot be determined without more information.

E. depends on how long it took to achieve the current.

Explanation: The energy is due to the magnetic field and is independent of how long it took to achieve the current. The energy is proportional to the square of the current for a given inductance, $E = \frac{1}{2}LI^2$. The heat given off is due to the resistance of the coil, not the inductance.
[*circuits0209.mcq*]

40. A circuit takes sinusoidal input signal with amplitude $V_{in} = 10\mu$V and produces an output sinusoidal signal of the same frequency with amplitude $V_{out} = 1$mV. The gain of the system is

A. 40 dB

B. -20 dB

C. 20 dB

D. -40 dB

E. 0 dB

Explanation: Since we are talking amplitude, $20log_{10}(\frac{10^{-3}}{10^{-5}}) = 40$.
[*circuits0210.mcq*]

41. Evaluate the complex number expressed in polar notation by $\frac{1}{2\angle 45°}$

A. $\frac{1}{2\sqrt{2}} - \frac{1}{2\sqrt{2}}j$

B. $\frac{1}{2\sqrt{2}} + \frac{1}{2\sqrt{2}}j$

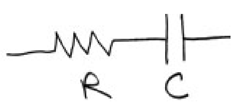
C. $\frac{2}{\sqrt{2}} + \frac{2}{\sqrt{2}}j$

D. $\frac{2}{\sqrt{2}} - \frac{2}{\sqrt{2}}j$

E. None of the other answers is correct.

Explanation: The angle in the denominator becomes negative.
[*circuits0211.mcq*]

42. What is the total complex impedance (in ohms) of this branch if $C = 0.1\mu$F, $R = 20$KΩ, f = 100KHz?



A. $2 \times 10^4 - 1.59 \times 10j$

B. $2 \times 10^4 + 1.59 \times 10j$

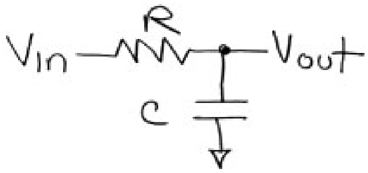
C. $2 \times 10^4 - 10^2j$

D. $2 \times 10^4 + 10^5j$

E. $2 \times 10^4 - 1.59 \times 10^4j$

Explanation: The impedance of a capacitor is $1/j\omega C$, $\omega = 2\pi f$. The unit of complex impedance is still ohms.
[*circuits0212.mcq*]

43. Which of the following is true about the circuit below?



A. If V_{in} is a sinusoid at a particular frequency $\omega = \frac{1}{RC}$, the magnitude of the impedances of the resistor and the capacitors are equal

B. The circuit is a high pass filter.

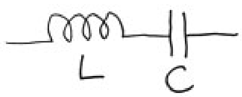
C. The circuit is not a linear system.

D. DC passes through the capacitor as if it were a piece of wire.

E. At different frequencies of V_{in} the phase of V_{out} does not change, only its magnitude.

Explanation: It is a low pass filter, and is a linear system since resistors and capacitors are linear. The capacitor does not pass DC (the voltage would climb forever). Both phase and the voltage of V_{out} changes with frequency. Substituting $\omega = \frac{1}{RC}$ into the impedance of a capacitor, $\frac{1}{j\omega C}$, yields $|R| = |\frac{1}{j\omega C}|$, so the correct answer, A.
[*circuits0213.mcq*]

44. The following are true about the circuit below *except*



A. This is a high-pass filter.

B. The circuit resonates at a particular frequency.

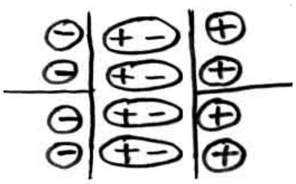
C. At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.

D. At very low frequencies it approaches infinite impedance.

E. At very high frequencies it approaches infinite impedance.

Explanation: At very high frequencies the coil approaches infinite impedance and at very low frequencies the capacitor does likewise. This is a bandpass filter (letting a certain frequency through at $\omega = \frac{1}{\sqrt{LC}}$, not a high-pass filter.
[*circuits0214.mcq*]

45. Which of the following is *false* about the following diagram of a capacitor (or all are true).



A. The permeability of the material between the plates effects the capacitance.

B. The material between the plates represents the dialectric, which increases capacitance by the alignment of dipoles in the electrostatic field.

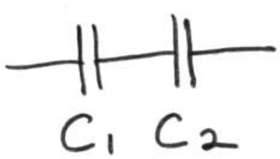
C. The capacitor is shown in a charged state.

D. The capacitance is proportional to the area of the plates and inversely proportional to the distance between them.

E. All are true.

Explanation: The *permitivity* (not permeability) of the material between the plates effects the capacitance.
[*circuits0252.mcq*]

46. What is the total capacitance of this branch if $C_1 = C_2 = 0.001\mu\text{F}$?



A. 500 pF

B. .002 μF

C. ∞ μF

D. 200 pF

E. .005 μF

Explanation: Total capacitance in series is $\frac{1}{\frac{1}{C_1}+\frac{1}{C_2}}$
[*circuits0256.mcq*]

47. Given an ideal capacitor, the charge entering one wire

A. can accumulate on one of the plates by pushing charge off of the other plate and out the other wire, thus avoiding a net buildup of charge within the capacitor.

B. is of much larger magnitude than the charge leaving the other wire., resulting in the buildup of voltage across the capacitor.

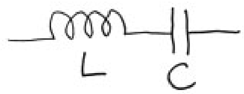
C. can continue forever while only experiencing a finite buildup of a voltage.

D. experiences a buildup over time of a voltage pushing back against it *proportional* to the capacitance.

E. cannot enter the capacitor at all, because of Kirchoff's current law.

Explanation: The current entering one of the wires causes a charge to accumulate on one of the plates, pushing an equal charge off the other plate and out the other wire. A voltage will accumulate over time pushing back against the current, *inversely* proportional to the capacitance. A bigger capacitor can handle more current to produce the same voltage.
[*circuits0257.mcq*]

48. The following are true about the circuit below *except* (or all are true)



A. At very low frequencies it approaches zero impedance.

B. The circuit resonates at a particular frequency.

C. At frequency $\omega = \frac{1}{\sqrt{LC}}$ the impedance is 0.

D. All are true.

E. At very high frequencies it approaches infinite impedance.

Explanation: At very high frequencies the coil approaches infinite impedance and at very low frequencies the capacitor does likewise. This is a bandpass filter (letting a certain frequency through at $\omega = \frac{1}{\sqrt{LC}}$, not a high-pass filter.
[*circuits0263.mcq*]

49. A circuit takes sinusoidal input signal with amplitude $V_{in} = 1\text{mV}$ and produces an output sinusoidal signal of the same frequency with amplitude $V_{out} = 10\mu\text{V}$. The gain of the system is

A. -40 dB

B. -20 dB

C. 20 dB

D. 40 dB

E. 0 dB

Explanation: Since we are talking amplitude, $20log_{10}(\frac{10^{-5}}{10^{-3}}) = -40$.
[*circuits0264.mcq*]

50. Evaluate the complex exponential $e^{j\frac{3\pi}{4}}$

A. $\frac{(-1+j)}{\sqrt{2}}$

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

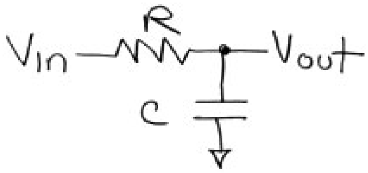
C. $(1-j)$

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

E. none of the other answers is correct.

Explanation: The magnitude is 1 and the angle is 135°.
[*circuits0265.mcq*]

51. Which of the following is (are) true about the circuit below?



I - The circuit is a low pass filter.
II - The magnitude of the two impedances is equal at frequency $\omega = \frac{1}{RC}$.
III - The impedance of each of the two components varies with frequency.

A. I and II

B. I, II, and III

C. II and III

D. I and III

E. II

Explanation: At $\omega = \frac{1}{RC}$ the magnitudes of the two impedances are equal. The circuit is a *low* pass filter. The resistor's impedance does not vary with frequency.
[*circuits0266.mcq*]

52. The following are true about complex conjugates (Z and Z^*) *except* (or all are true)

A. Multiplying by Z is the same as dividing by Z^*.

B. ZZ^* is always a real number.

C. Expressed as phasors, Z and Z^* have opposite angles with respect to the real axis.

D. All are true.

E. $Z + Z^*$ is always a real number.

Explanation: Multiplying by Z is the same as dividing by Z^* in terms of phase shift, but not in terms of gain.
[*circuits0267.mcq*]

53. The following are true about sinusoids *except* (or all are true)

A. All are true.

B. Adding two sinusoids with the same frequency always produces a sinusoid at that same frequency.

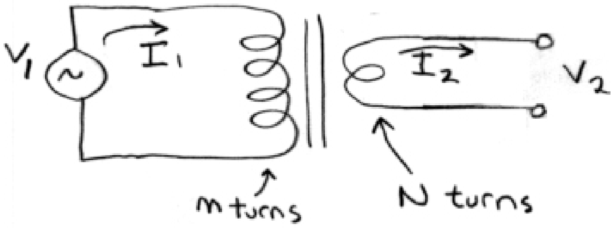
C. Taking the derivative of a sinusoid shifts its phase 90° to the left.

D. They may be represented as the sum of a complex exponential and its complex conjugate.

E. The second derivative of a sinusoid is some negative constant times the original sinusoid.

Explanation:
[*circuits0268.mcq*]

54. In the following circuit, with a sinusoidal input with RMS amplitude, V_1 (and V_2, I_1, and I_2 also expressed in RMS),



which of the following is true?

I - The amplitude of V_2 is $\frac{N}{M}V_1$.
II - Since transformers are very nearly 100% efficient, it is generally assumed that $V_1 I_1 = V_2 I_2$.
III - The frequency of V_2 is the same as V_1 .

A. I, II and III

B. I and II

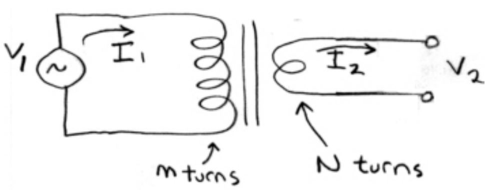
C. II and III

D. I and III

E. I

Explanation: Power is very efficiently conserved in a transformer. Transformers do not change frequency.
[*circuits0272.mcq*]

55. Assuming the transformer shown below is 100% efficient, the primary RMS voltage V_1=4V and RMS current I_1=4A, M=200, N=20, what is the power in the secondary?



A. 16W

B. 1.6W

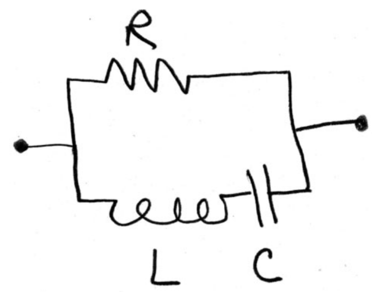
C. 0.16W

D. 160W

E. cannot be determined from the given information.

Explanation: Power is conserved in a transformer according to its efficiency. Voltage changes with N/M but current changes inversely, keeping power the same.
[*circuits0288.mcq*]

56. What is the impedance of the following branch at $\omega = 0$?



A. R

B. $0\ \Omega$

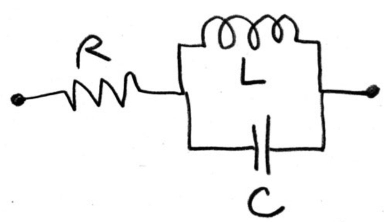
C. $j\omega L$

D. $\frac{1}{j\omega C}$

E. None of the others is correct.

Explanation: At $\omega = 0$ the capacitor has infinite impedance, so the only component that counts is the resistor.
[*circuits0314.mcq*]

57. What is the impedance of the following branch at $\omega = \infty$?



A. R

B. Infinte

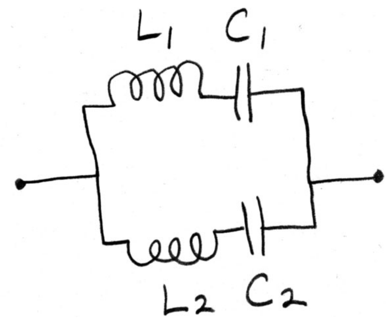
C. $R + j\omega L$

D. $\frac{1}{j\omega C}$

E. None of the others is correct.

Explanation: At $\omega = \infty$ the capacitor has zero impedance, so the only component that counts is the resistor.
[*circuits0315.mcq*]

58. Assuming $L_1 = L_2 = 1\text{H}$ and $C_1 = C_2 = 1\text{F}$, what is the the impedance of the following branch at $f = \frac{1}{2\pi}\text{Hz}$? (hint: think about resonance of each of the LC branches)



A. 0

B. Infinte

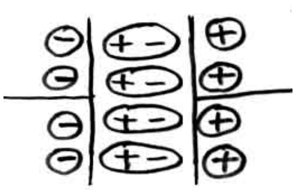
C. $2j\omega L_1$

D. $\frac{1}{2j\omega C_1}$

E. None of the others is correct.

Explanation: At $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{2\pi}\text{Hz}$, both LC circuits are at resonance, hence 0 Ω.
[*circuits0316.mcq*]

59. Which of the following is *false* about the following diagram of a capacitor (or all are true).



A. Direct Current (DC) may pass through the capacitor forever, provided there is no significant inductance to build up a magnetic field.

B. The material between the plates represents the dielectric, which increases capacitance by the alignment of dipoles in the electrostatic field.

C. The capacitor is shown in a charged state.

D. The capacitance is proportional to the area of the plates and inversely proportional to the distance between them.

E. All are true.

Explanation: Answer A is nonsense.
[*circuits0323.mcq*]

60. The following are all true about the property of reactance *except*

A. Resistance is a form of reactance.

B. Reactance is the imaginary component of impedance.

C. Capacitance is a form of reactance.

D. Inductance is a form of reactance.

E. All are true.

Explanation: Resistance is the *real* component of impedance, whereas reactance is the imaginary component.
[*circuits0324.mcq*]

61. Which of these statements is *false* about phase? (or all are true)

A. All are true.

B. Phase can be expressed as an angle in degrees.

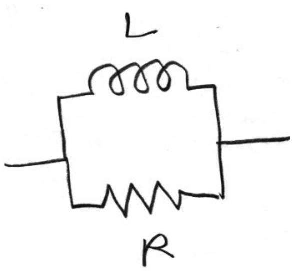
C. Phase can be expressed in radians.

D. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

E. Phase is the θ in $e^{j\theta}$.

Explanation: Phase is the imaginary exponent in the phasor.
[*circuits0325.mcq*]

62. Which of the following is *false* about the impedance of the following branch?



A. At $\omega = 0$ it is ∞.

B. At $\omega = \infty$ it is R.

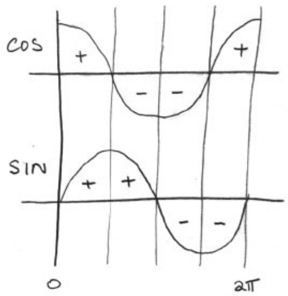
C. It can be found by taking the reciprocal of the sum of the reciprocals of R and $j\omega L$

D. It completely describes the relationship between the voltage across the branch and the current through it.

E. It represents a solution that can also be found using linear differential equations.

Explanation: At $\omega = 0$, the impedance of the inductor, $j\omega L$, goes to zero, and thus so does the impedance of the branch.
[*circuits0353.mcq*]

63. Which of the following is *false* about this diagram, as it was used in lecture in the section about AC power?



A. The average power resulting from two non-zero voltages and currents can never be zero.

B. Since the capacitor integrates current to produce voltage, the current and voltage are 90° out of phase.

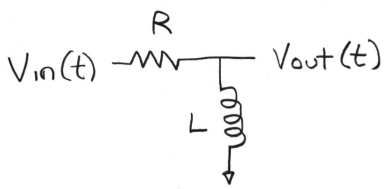
C. The average product of the sin and cos over one cycle is zero.

D. The energy stored in an ideal capacitor, $\frac{1}{2}CV^2$, is returned to the circuit with 100 percent efficiency.

E. The power dissipated by a capacitor differs from that dissipated by a resistor, because the impedance of a capacitor is imaginary.

Explanation: The average power resulting when the AC voltage and current are 90° out of phase, is indeed zero.
[*circuits0354.mcq*]

64. Which of the following statements is *false* about the following system?



A. At $\omega = \infty$, the system introduces a 90° phase shift.

B. The system response $H(\omega) = \frac{j\omega L}{R+j\omega L}$

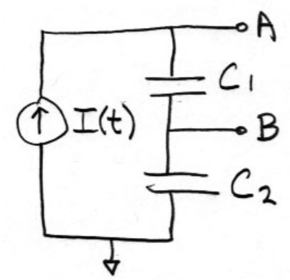
C. This is a high pass filter.

D. This system is called "linear" because it can be modeled by a linear differential equation.

E. If $V_{in}(t)$ is a sinusoid of frequency ω, $V_{out}(t)$ is also sinusoid of frequency ω.

Explanation: At $\omega = \infty$, the system introduces a 0° phase shift, since $H(\omega) = \frac{j\omega L}{R+j\omega L} = 1$
[*circuits0355.mcq*]

65. Which of the following statements is *false* about the following circuit, assuming $C_1 = 1\mu\text{F}$, $C_2 = 2\mu\text{F}$, both capacitors are discharged at $t = 0$, $I(t) = 0\text{A}$ for $t < 0$, and $I(t) = 1\mu\text{A}$ for $t > 0$?



A. Because the current is itegrated on each of the capacitors, Kirchhoff's current law does not apply.

B. The voltage across C_2 will always be twice that across C_1.

C. The total capacitance of C_1 and C_2 in series is $\frac{2}{3}\mu\text{F}$

D. The voltage between point B and ground after 2 seconds is 4V.

E. Given enough time, any real system with this schematic will fail.

Explanation: Current entering one plate of a capacitor must leave the other plate. Kirchhoff's current law *does* apply. As time approaches ∞, so does the voltage on each of the capacitors, so it will fail.

Alternate acceptable answer: BD

Errata: Answer B should read, "The voltage across C_1 will always be twice that across C_2." Answer D should read, "The voltage between point B and ground after 2 seconds is 1V."
[*circuits0356.mcq*]

66. Which of these statements is *false* about the Bode plot?

A. At $\omega = 0$, the gain is always 0dB and the phase shift is always $0°$.

B. It consists of two plots describing a system: the gain (change in amplitude) in dB and the phase shift, both as functions of frequency (also displayed logarithmically).

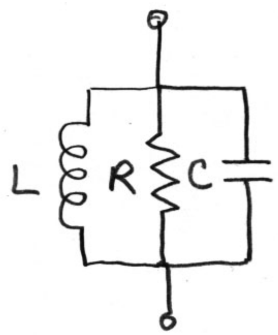
C. It fully describes the behavior of the transfer function $H(\omega)$.

D. It represents a complex number in polar coordinates as a function frequency.

E. It is commonly used the describe the frequency response of a filter.

Explanation: Answer A is not always true, for example, in a high-pass filter.
[*circuits0357.mcq*]

67. What is the impedance across the branch shown below, at frequency $\omega = \frac{1}{\sqrt{LC}}$?



A. R

B. 0 Ω

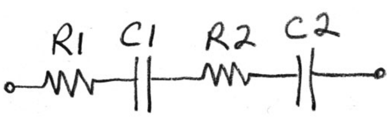
C. ∞ Ω

D. $\frac{1}{j\omega C}$

E. $j\omega L$

Explanation: L and C in parallel have infinite impedance at $\omega = \frac{1}{\sqrt{LC}}$, and so are inconsequential, leaving R as the only impedance.
[*circuits0370.mcq*]

68. What is the total impedance of the following branch?



A. $R_1 + R_2 + \frac{1}{j\omega(\frac{C_1 C_2}{C_1 + C_2})}$

B. 0 Ω at all frequencies ω.

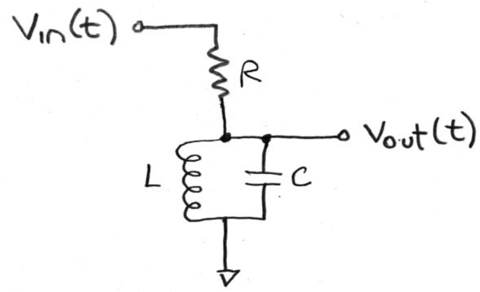
C. $R_1 + R_2 + \frac{1}{j\omega(C_1 + C_2)}$

D. $R_1 + R_2 + j\omega(C_1 + C_2)$

E. None of the others is correct.

Explanation: Impedance of components in series is their sum, which is order independent. The two resistors add and the two capacitors add following their individual rules.
[*circuits0371.mcq*]

69. All of the following are true about the following system *except* (or all are true)?



A. All of the answers are true.

B. The system has a transfer function $H(\omega)$, which is a complex number at any given frequency ω.

C. Given a particular signal $V_{in}(t) = Asin(\omega t)$, the output signal $V_{out}(t)$ will always be a sinusoid of frequency ω.

D. Given an input signal $V_{in}(t) = e^{j\omega t}$ the output signal $V_{out}(t)$ will never have a magnitude greater than 1.

E. This is a linear system and thus can change magnitude and phase, but never frequency.

Explanation: This is a passive linear system, and thus the magnitude of the output phasor will always be equal to or less than the input phasor. The transfer function $H(\omega)$ has a magnitude and a phase at any given frequency ω, which determines the change in magnitude and phase between the input signal and the output signal.
[*circuits0372.mcq*]

70. A 1 μF capacitor that is initially completely discharged is then charged for 6 seconds with 1 μA. How many joules does it store?

A. 18 μJ

B. 6 μJ

C. 36 μJ

D. 3 μJ

E. Cannot be determined.

Explanation: The capacitor will charge to 6V in 6 seconds. The energy is then $\frac{1}{2}CV^2$.
[*circuits0376.mcq*]

71. The following is *not* true about voltage, or all are true:

A. Given a negative charge and a positive charge, voltage is a vector pointing from the positive charge towards the negative charge, describing the force on a unit test charge placed between them.

B. It is the energy required to move a unit charge from one location to another.

C. All are true.

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 capacitor, it is linearly related to the integral of the current through that capacitor.

Explanation: The electric field is such a vector as described in A. Voltage is not a vector, but rather a scalar, as described in B.
[*circuits0378.mcq*]

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

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

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

C. $2\angle 45^\circ$

D. $2\angle 235^\circ$

E. none of the other answers

Explanation: $\frac{6\angle 45^\circ}{3\angle 90^\circ} = 2\angle -45^\circ$
[*circuits0379.mcq*]

73. *Admittance* is the reciprocal of

A. Impedance.

B. Capacitance.

C. Resistance.

D. Inductance.

E. None of the other answers is true.

Explanation: Whereas conductance (the reciprocal of resistance) can be viewed as a type of admittance, it is not always equal to the total admittance of a circuit that also may contain capacitance and inductance. So A is the right answer.
[*circuits0380.mcq*]

74. Which of these statements is *false* about phase? (or all are true)

A. Phase is the imaginary component in a complex number.

B. Phase can be expressed in units of degrees, radians, or cycles.

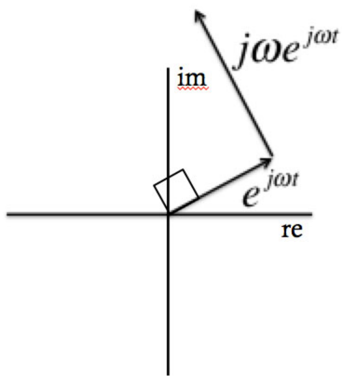
C. All are true.

D. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

E. Phase is whatever is in the parenthesis in the following equation showing Euler's identity, $e^{j()} = cos() + jsin()$.

Explanation: Phase is the *imaginary exponent in the phasor representation of a complex number.*
[*circuits0381.mcq*]

75. Which of the following is *false* about the following diagram (or all are true)?



A. All are true.

B. In the diagram, as shown, $\omega > 1$.

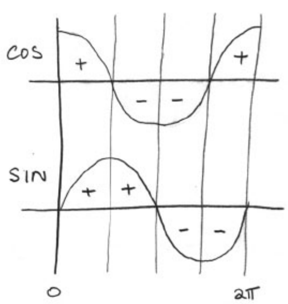
C. It demonstrates Euler's identity, since $cos(\omega t)$ and $jsin(\omega t)$ define a unit circle in the complex plane.

D. Given that multiplying a phasor by j rotates it 90 degrees counterclockwise, the diagram shows how the phasor $e^{j\omega t}$ will follow a circular path over time.

E. It shows a phasor of magnitude 1 and its derivative with respect to time.

Explanation: All are true.
[*circuits0382.mcq*]

76. Which of the following is *false*, as regards this diagram in lecture in the section about AC power (or all are true)?



A. All are true

B. Since the capacitor integrates current to produce voltage, the current and voltage are 90° out of phase.

C. The average product of the sin and cos over one cycle is zero.

D. The energy stored in an ideal capacitor, $\frac{1}{2}CV^2$, is returned to the circuit with 100 percent efficiency.

E. The average power resulting from non-zero voltages and currents in a given component can be zero.

Explanation: The average power resulting when the AC voltage and current are 90° out of phase, as in a capacitor or inductor, is zero.
[*circuits0383.mcq*]

77. Which of the following is *false* about permeability in electromagnetism (or all are true)?

A. The permiability of free space is zero.

B. Permeability is to inductance as permittivity is to capacitance.

C. The inductance of a coil can be increased by including certain materials within the coil that support the formation of a magnetic field.

D. All are true.

E. Greater permeability permits an inductor to store proportionally greater energy for a given current.

Explanation: The permeability of free space μ_0 is not zero. It, and the permittivity of free space ε_0 determine the speed of light in a vacuum.
[*circuits0384.mcq*]

78. The following are true about the discharge of a capacitor with capacitance C through a resistor with resistance R, *except*, (or all are true)

A. Since the voltage across the capacitor does not decrease at a constant rate, this is not a linear system.

B. The time required for the capacitor to discharge to exactly $1/e$ (about 37%) of the initial voltage is RC.

C. The discharge is governed by a first order differential equation, with current gradually decreasing as the capacitor discharges.

D. All are true.

E. The energy initially stored in the capacitor ($\frac{1}{2}CV^2$, where V is the initial voltage on the capacitor) is released primarily as heat by the resistor.

Explanation: This *is* a linear system, because it is governed by linear differential equations.
[*circuits0385.mcq*]

79. A system is said to have a gain of 60dB. What is the ratio of the *output voltage* to the *input voltage* of the system.

A. 1,000

B. 10^{-6}

C. 1,000,000

D. 0.001

E. None of the other answers is correct.

Explanation: For voltage, $60 = 20log_{10}(1,000)$.
[*circuits0386.mcq*]

80. Which of these statements is *false* about the Bode plot, or all are true?

A. All are true.

B. It consists of two plots describing a system: the gain (change in amplitude) in dB and the phase shift, both as functions of frequency (also displayed logarithmically).

C. It fully describes the behavior of the transfer function $H(\omega)$.

D. It represents a complex number in polar coordinates as a function frequency.

E. It is commonly used the describe the frequency response of a filter.

Explanation: All are true.
[*circuits0387.mcq*]

81. The following is *not* true about a linear system whose transfer function is $H(\omega) = \frac{1}{j\omega}$:

A. Its output signal is purely imaginary at all points in time.

B. Putting $e^{j\omega t}$ at the input yields $\frac{1}{j\omega}e^{j\omega t}$ at the output.

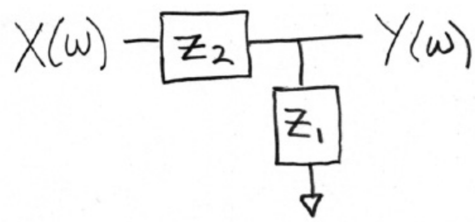
C. It is a lowpass filter

D. It performs integration.

E. It goes to infinity at DC.

Explanation: Although $H(\omega)$ is itself imaginary, its output signal can be real, imaginary, or complex at particular points in time, depending on the input signal.
[*circuits0435.mcq*]

82. All of the following are true about the following system *except* (or all are true)?



A. All of the answers are true.

B. The system has a transfer function $H(\omega) = \frac{Y(\omega)}{X(\omega)}$.

C. The system is a voltage divider.

D. If Z_1 and Z_2 are real, this is simply a voltage divider consisting of two resistors.

E. The transfer function $H(\omega) = \frac{Z_1}{Z_1+Z_2}$.

Explanation: All are true.
[*circuits0436.mcq*]

83. A transformer with 1000 turns of wire in the primary and 50 turns of wire in the secondary is assumed to be 100% efficient. Given a sinusoidal voltage at the primary with peak voltage = 100 V, what is the RMS voltage at the secondary:

A. $\frac{5}{\sqrt{2}}$ $\mathrm{V_{RMS}}$.

B. $\frac{50}{\sqrt{2}}$ $\mathrm{V_{RMS}}$.

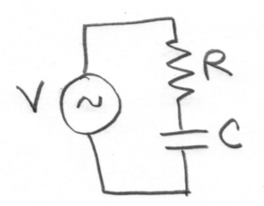
C. $5\sqrt{2}$ $\mathrm{V_{RMS}}$.

D. 5 $\mathrm{V_{RMS}}$.

E. 50 $\mathrm{V_{RMS}}$.

Explanation: $\mathrm{V_{RMS}} = \frac{\mathrm{V_{RMS}}}{\sqrt{2}}$. Voltage is proportional to number of turns of wire in a transformer.
[*circuits0439.mcq*]

84. The circuit below shows an AC voltage source in which $V = Acos(\omega t)$, where $\omega = \frac{1}{RC}$. What is the power *dissipated* (as heat) by the capacitor?



A. 0 W

B. $\frac{1}{2}CA^2$ W

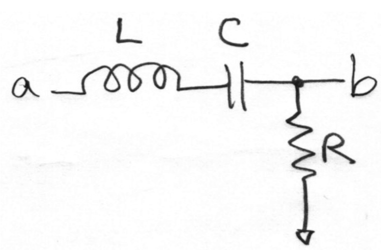
C. $\frac{1}{2\sqrt{2}}CA^2$ W

D. $\frac{A^2}{R}$ W

E. $\frac{A^2}{\sqrt{2}R}$ W

Explanation: Capacitors do not dissipate energy as heat. They can store energy as $\frac{1}{2}CV^2$, but they always return all of that energy to the circuit. The voltage $V = Acos(\omega)$ will result in a current $I = Asin(\omega)$, 90 degrees out of phase and therefore resulting in zero power dissipated.
[*circuits0458.mcq*]

85. What is the transfer function $H(\omega)$ of the circuit at $\omega = \frac{1}{\sqrt{RC}}$, given point a is the input and point b is the output?



A. $H(\omega) = 1$

B. $H(\omega) = 0$

C. $H(\omega) = \infty$

D. $H(\omega) = \frac{R}{L+C+R}$

E. None of the other answers is correct.

Explanation: The impedance between points a and b at $\omega = \frac{1}{\sqrt{RC}}$ is zero, so given the general rule for a voltage divider, $H(\omega) = \frac{R}{0+R} = 1$.

Alternate acceptable answer: BCDE

Errata: The question should say $\omega = \frac{1}{\sqrt{LC}}$ instead $\omega = \frac{1}{\sqrt{RC}}$
[*circuits0459.mcq*]

86. A system is said to have a gain of -60dB. What is the ratio of the *output power* to the *input power* of this system.

A. 10^{-6}

B. 1,000,000

C. 1,000

D. 0.001

E. None of the other answers is correct.

Explanation: For power, $-60 = 10log_{10}(\frac{1}{1{,}000{,}000})$.
[*circuits0460.mcq*]

87. What is the phasor representation of $(1-j)^3$? (Hint: convert $(1-j)$ to a phasor first and then cube it.)

A. $2\sqrt{2}e^{-j\frac{3\pi}{4}}$

B. $8e^{-j\frac{3\pi}{4}}$

C. 1

D. $e^{-j\frac{3\pi}{4}}$

E. -j

Explanation: $(\sqrt{2}e^{-j\frac{\pi}{4}})^3$
[*circuits0461.mcq*]

88. What is the cartesian representation of $3e^{j\frac{11\pi}{4}}$?

A. $-\frac{3}{\sqrt{2}} + j\frac{3}{\sqrt{2}}$

B. -3

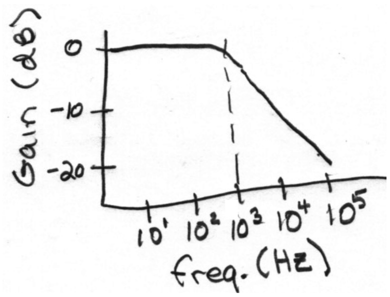
C. $3-3j$

D. $-\sqrt{3} - j\sqrt{3}$

E. $-3+3j$

Explanation: Subtracting off multiples of 2π, $3e^{j\frac{11\pi}{4}} = 3e^{j\frac{3\pi}{4}}$
[*circuits0462.mcq*]

89. The following are true about the graph below *except* (or all are true).



A. All are true.

B. It represents the magnitude portion of the Bode plot of a low pass filter.

C. It is consistant with a passive RC filter where 10^3 Hz $= \frac{1}{2\pi RC}$.

D. In the case of a passive RC filter, it would normally be accompanied by the phase portion of the Bode plot, showing a phase shift approaching $0°$ for frequencies $<< 10^3$ Hz.

E. Gain, meaning the ratio of output to input *power*, is represented in decibels (dB), such that 0 dB represents a gain of 1 and -10 dB represents a gain of $\frac{1}{10}$.

Explanation: All are true
[*circuits0463.mcq*]

90. Which of the following is *false* about permittivity (or all are true)?

A. All are true.

B. The permittivity and permeability of free space determine the speed of light in a vacuum.

C. It can be increased by the alignment of charges in the material between the plates of a capacitor.

D. Permittivity is to capacitance as permeability is to inductance.

E. In a given capacitor, it determines the capacitance for a given area of plates and distance between them.

Explanation: All are true.

Alternate acceptable answer: C

Errata: It can be increased by the *ability for the charges to align* in the material...
[*circuits0464.mcq*]

91. Which of these statements is *false* about phase? (or all are true)

A. All are true.

B. Phase can be expressed in units of degrees, radians, or cycles.

C. Phase and magnitude are all that can be changed by a linear system at a given frequency.

D. Frequency, which is the derivative of phase with regard to time, if often expressed as either radians per second or cycles per second.

E. Phase is whatever is in the parenthesis in the following equation showing Euler's identity, $e^{j()} = cos() + jsin()$.

Explanation: All are true.
[*circuits0465.mcq*]