Electrical Engineering

1. The property of a material to allow the passage of magnetic lines of flux is known as:

A) Reluctance

B) Hysteresis

C) Permeance

D) Resistivity

Answer: C) Permeance

Explanation: Permeance is the reciprocal of reluctance and is analogous to conductance in an electric circuit. It is a measure of the quantity of magnetic flux for a given number of current-turns.

2. A dependent source is one whose value depends on a:

A) Fixed constant

B) Voltage or current elsewhere in the circuit

C) Time-varying function

D) Source located in another circuit

Answer: B) Voltage or current elsewhere in the circuit

Explanation: Dependent (or controlled) sources are essential for modeling active devices like transistors and op-amps. Their output is a function of another voltage or current in the circuit.

3. If the length of a wire is doubled and its cross-sectional area is also doubled, its resistance will:

A) Halve

B) Double

C) Quadruple

D) Remain the same

Answer: D) Remain the same

Explanation: Resistance is given by R = (rho * L) / A. If L becomes 2L and A becomes 2A, the new resistance R' = (rho * 2L) / (2A) = (rho * L) / A = R. The two changes cancel each other out.

4. The algebraic sum of all the voltage drops and EMFs in a closed loop is zero. This is a statement of:

A) Ohm's Law

B) Kirchhoff's Current Law

C) Kirchhoff's Voltage Law

D) Thevenin's Theorem

Answer: C) Kirchhoff's Voltage Law

Explanation: KVL is a direct consequence of the law of conservation of energy, stating that the net change in potential energy for a charge moving around a closed path must be zero.

5. In a parallel circuit, the component with the smallest resistance will have the:

A) Smallest current

B) Largest current

C) Smallest voltage

D) Largest voltage

Answer: B) Largest current

Explanation: In a parallel circuit, the voltage across all branches is the same. According to Ohm's Law (I = V/R), current is inversely proportional to resistance. Therefore, the path of least resistance will have the most current.

6. A circuit breaker is a device that functions as a/an:

A) Automatic switch to protect against overloads

B) Voltage regulator

C) Current amplifier

D) Frequency converter

Answer: A) Automatic switch to protect against overloads

Explanation: A circuit breaker automatically interrupts the flow of current when it detects an overcurrent or short circuit condition, thereby protecting the circuit and equipment from damage.

7. A source transformation allows you to convert a:

A) Resistor into a capacitor

B) Thevenin equivalent into a Norton equivalent

C) Series circuit into a parallel circuit

D) DC source into an AC source

Answer: B) Thevenin equivalent into a Norton equivalent

Explanation: Source transformation is a technique where a voltage source in series with a resistor (Thevenin) can be replaced by an equivalent current source in parallel with the same resistor (Norton), or vice-versa.

8. Nodal analysis of a circuit is primarily based on the application of:

A) Kirchhoff's Voltage Law

B) Kirchhoff's Current Law

C) Ohm's Law

D) The superposition theorem

Answer: B) Kirchhoff's Current Law

Explanation: Nodal analysis is a systematic method to determine the voltage at each node in a circuit. It works by applying KCL at each non-reference node to form a system of simultaneous equations.

9. The lagging effect between the magnetic flux density and the magnetizing force in a magnetic material is called:

A) Permeability

B) Reluctance

C) Hysteresis

D) Coercivity

Answer: C) Hysteresis

Explanation: Hysteresis describes the tendency of a magnetic material to remain magnetized to some extent after the external magnetizing field is removed. This phenomenon leads to energy loss (hysteresis loss) in AC applications.

10. The instantaneous value of a sine wave is the:

A) Value at any given point in time

B) Same as the RMS value

C) Same as the peak value

D) Average value over one cycle

Answer: A) Value at any given point in time

Explanation: The instantaneous value describes the position of the waveform at a specific instant. It is calculated as v(t) = V_peak * sin(omega*t + phi).

11. The unit of permittivity is:

A) Farads per meter

B) Henrys per meter

C) Webers per meter

D) Coulombs per meter

Answer: A) Farads per meter

Explanation: Permittivity (epsilon) is a measure of how an electric field affects, and is affected by, a dielectric medium. It relates the electric displacement field to the electric field and is a key parameter in calculating capacitance.

12. If the current through an inductor is constant (DC), the voltage across it is:

A) Infinite

B) Zero

C) Equal to the current

D) Proportional to the inductance

Answer: B) Zero

Explanation: The voltage across an inductor is given by V = L * (di/dt). For a constant DC current, the rate of change (di/dt) is zero, so the voltage across an ideal inductor is zero. It behaves like a short circuit.

13. The core of a transformer is laminated to reduce:

A) Hysteresis loss

B) Eddy current loss

C) Copper loss

D) Mechanical vibrations

Answer: B) Eddy current loss

Explanation: The changing magnetic flux induces circulating currents (eddy currents) within the iron core. By using a laminated core (thin sheets of iron insulated from each other), the paths for these currents are broken up, significantly reducing their magnitude and the associated power loss.

14. The term "transient" refers to a:

A) Temporary state in a circuit that disappears over time

B) Permanent steady-state condition

C) Condition of maximum power transfer

D) Sinusoidal AC waveform

Answer: A) Temporary state in a circuit that disappears over time

Explanation: Transients occur in reactive circuits (with L or C) immediately after a sudden change, like a switch being thrown. This is the period where the circuit is adjusting from one steady state to another.

15. In a series RL circuit, the angle by which the current lags the voltage will increase if the:

A) Resistance is increased

B) Frequency is increased

C) Source voltage is increased

D) Frequency is decreased

Answer: B) Frequency is increased

Explanation: As frequency increases, the inductive reactance (XL = 2*pi*f*L) increases. This makes the circuit more inductive and less resistive, causing the phase angle to become larger (closer to 90 degrees).

16. In a series RLC circuit, if the frequency is above the resonant frequency, the circuit will be primarily:

A) Resistive

B) Inductive

C) Capacitive

D) Oscillatory

Answer: B) Inductive

Explanation: Above the resonant frequency, the inductive reactance (XL) becomes larger than the capacitive reactance (XC). Therefore, the net reactance is inductive, and the current lags the voltage.

17. The cutoff frequency of a filter is the frequency at which the output power is:

A) 70.7% of the input power

B) Equal to the input power

C) 50% of the maximum output power (the half-power point)

D) Zero

Answer: C) 50% of the maximum output power (the half-power point)

Explanation: The cutoff frequency, also known as the -3dB point, is the boundary of the filter's passband. At this frequency, the voltage is 70.7% of its maximum, which corresponds to the power being 50% of its maximum.

18. Thevenin's theorem is applicable to:

A) Linear and non-linear circuits

B) AC and DC circuits

C) Only circuits with resistors

D) Only DC circuits

Answer: B) AC and DC circuits

Explanation: Thevenin's theorem is a general theorem that applies to any linear bilateral network. For AC circuits, the theorem is applied using impedances (Z_th) and phasor voltages (V_th).

19. The response of a circuit that remains long after the transient response has decayed is called the:

A) Forced response or steady-state response

B) Natural response

C) Impulse response

D) Step response

Answer: A) Forced response or steady-state response

Explanation: The steady-state response is the part of the total response that is determined by the nature of the source (e.g., a sine wave for a sinusoidal source) after all transient effects have disappeared.

20. In a balanced delta-connected three-phase system, the relationship between line voltage and phase voltage is:

A) Line voltage = sqrt(3) * Phase voltage

B) Line voltage = Phase voltage / sqrt(3)

C) Line voltage = Phase voltage

D) Line voltage = 3 * Phase voltage

Answer: C) Line voltage = Phase voltage

Explanation: In a delta connection, the terminals of the load are connected directly across the lines. Therefore, the voltage across each phase of the load is equal to the line-to-line voltage.

21. The unit of magnetic flux density is the:

A) Weber

B) Henry

C) Tesla

D) Ampere-turn/meter

Answer: C) Tesla

Explanation: Magnetic flux density (B) is the amount of magnetic flux per unit area perpendicular to the direction of the flux (B = Flux / Area). One Tesla is equal to one Weber per square meter.

22. A practical voltage source is represented by an ideal voltage source in:

A) Parallel with a resistance

B) Series with a resistance

C) Parallel with a capacitance

D) Series with an inductance

Answer: B) Series with a resistance

Explanation: A practical (or real) voltage source has some internal resistance that causes its terminal voltage to drop as the load current increases. This is modeled by placing an internal resistance in series with the ideal source.

23. The total energy delivered by a source is equal to the sum of energies stored and dissipated in the circuit. This is a statement of:

A) Tellegen's Theorem

B) Millman's Theorem

C) Norton's Theorem

D) Ohm's Law

Answer: A) Tellegen's Theorem

Explanation: Tellegen's theorem is a very general theorem in network theory that relates to the conservation of power or energy in a network, regardless of the nature of the components.

24. If two 5 H inductors are connected in parallel, their total inductance is:

A) 10 H

B) 5 H

C) 2.5 H

D) 25 H

Answer: C) 2.5 H

Explanation: Inductors in parallel combine like resistors in parallel. The total inductance is Lt = (L1 * L2) / (L1 + L2) = (5 * 5) / (5 + 5) = 25 / 10 = 2.5 H.

25. The voltage-divider rule is used to find the voltage across one of several resistors connected in:

A) Series

B) Parallel

C) A bridge configuration

D) A star configuration

Answer: A) Series

Explanation: The voltage-divider rule provides a shortcut to find the voltage drop across a specific resistor in a series circuit without first having to calculate the total current.

26. A "loop" in a circuit is defined as any:

A) Open path

B) Closed path

C) Path with only one component

D) Junction of two or more components

Answer: B) Closed path

Explanation: A loop is any path in a circuit that starts at a node and ends at the same node without passing through any intermediate node more than once. This is the basis for applying KVL.

27. The coercive force of a magnetic material is the:

A) Maximum magnetic field it can produce

B) Magnetic field required to magnetize it to saturation

C) Residual magnetism after the field is removed

D) Reverse magnetic field required to demagnetize it completely

Answer: D) Reverse magnetic field required to demagnetize it completely

Explanation: Coercivity is a measure of a material's resistance to being demagnetized. A "hard" magnetic material (used for permanent magnets) has a high coercive force.

28. An AC current is given by i(t) = 10 sin(100*pi*t). The frequency of the current is:

A) 100 Hz

B) 50 Hz

C) 10 Hz

D) 10*pi Hz

Answer: B) 50 Hz

Explanation: The general form is i(t) = I_peak * sin(omega*t). Here, the angular frequency omega is 100*pi. Since omega = 2*pi*f, the frequency f = omega / (2*pi) = (100*pi) / (2*pi) = 50 Hz.

29. If the area of the plates of a parallel plate capacitor is doubled, its capacitance will:

A) Double

B) Halve

C) Remain the same

D) Quadruple

Answer: A) Double

Explanation: The capacitance of a parallel plate capacitor is directly proportional to the area of the plates (C = epsilon * A / d). Doubling the area will double the capacitance.

30. The primary and secondary windings of an ideal isolation transformer always have:

A) Different numbers of turns

B) The same number of turns

C) A common electrical connection

D) A laminated aluminum core

Answer: B) The same number of turns

Explanation: An isolation transformer has a 1:1 turns ratio. It does not step voltage up or down. Its purpose is to electrically isolate the secondary circuit from the primary circuit for safety.

31. In a series RC circuit, the total opposition to current is called:

A) Resistance

B) Reactance

C) Admittance

D) Impedance

Answer: D) Impedance

Explanation: Impedance (Z) is the general term for total opposition to current in an AC circuit. It is a complex quantity that includes both resistance (the real part) and reactance (the imaginary part).

32. A circuit with a very high Q factor will have a:

A) Wide bandwidth

B) Narrow bandwidth

C) Flat frequency response

D) Very low resonant frequency

Answer: B) Narrow bandwidth

Explanation: The Q factor is inversely proportional to the bandwidth ($Q = f_r / BW$). A high Q factor means the circuit is highly selective, responding strongly to a very narrow range of frequencies around resonance.

33. An active filter is a filter that:

A) Uses only passive components like R, L, and C

B) Uses an amplifying element like an op-amp

C) Can only be a high-pass filter

D) Does not require a power source

Answer: B) Uses an amplifying element like an op-amp

Explanation: Active filters use active components (e.g., op-amps, transistors) to provide gain and to shape the filter response. This allows for the design of filters without using bulky and expensive inductors.

34. The admittance of a circuit is a complex number whose real part is:

A) Resistance

B) Reactance

C) Conductance

D) Susceptance

Answer: C) Conductance

Explanation: Admittance (Y) is the reciprocal of impedance (Z). Y = G + jB, where G is the conductance (the real part) and B is the susceptance (the imaginary part).

35. The natural response of a circuit is its behavior:

A) When driven by an external source

B) In the absence of any external source (due to initial stored energy)

C) Only at the resonant frequency

D) Only in the steady state

Answer: B) In the absence of any external source (due to initial stored energy)

Explanation: The natural response describes how a circuit with stored energy in capacitors or inductors will behave if all the independent sources are turned off. This response is determined by the circuit's own components (R, L, C).

36. The total apparent power in a three-phase system is the:

A) Algebraic sum of the individual phase powers

B) Vector sum of the individual phase powers

C) Product of the total voltage and total current

D) Same as the total true power

Answer: B) Vector sum of the individual phase powers

Explanation: Because the powers in each phase are also sinusoidal and phase-shifted, the total power is found by vector addition. For a balanced system, the total apparent power is S = sqrt(3) * V_line * I_line.

37. A substance with a resistivity of approximately 10^12 ohm-meters would be classified as a/an:

A) Conductor

B) Insulator

C) Semiconductor

D) Superconductor

Answer: B) Insulator

Explanation: Insulators have very high resistivity, meaning they strongly oppose the flow of electric current. Conductors have very low resistivity, and semiconductors are in between.

38. When analyzing a series-parallel circuit, the first step is usually to:

A) Calculate the total power

B) Find the total current from the source

C) Identify the simple series and parallel combinations

D) Apply KVL to every loop

Answer: C) Identify the simple series and parallel combinations

Explanation: The strategy is to simplify the circuit by repeatedly finding the equivalent resistance of the innermost series or parallel sections and working outwards towards the source.

39. The right-hand grip rule is used to determine the:

A) Direction of force on a conductor

B) Direction of induced EMF

C) Direction of the magnetic field around a current-carrying conductor

D) Polarity of a voltage source

Answer: C) Direction of the magnetic field around a current-carrying conductor

Explanation: If you imagine gripping the wire with your right hand so your thumb points in the direction of the conventional current, your fingers will curl in the direction of the magnetic field lines.

40. The period of a sine wave is the:

A) Time it takes to complete one full cycle

B) Number of cycles completed in one second

C) Maximum value of the wave

D) RMS value of the wave

Answer: A) The time it takes to complete one full cycle

Explanation: The period (T) is the duration of one cycle and is measured in seconds. It is the reciprocal of the frequency (T = 1/f).

41. Two 10 microfarad capacitors are connected in parallel. The total capacitance is:

A) 5 microfarads

B) 10 microfarads

C) 20 microfarads

D) 100 microfarads

Answer: C) 20 microfarads

Explanation: Capacitors in parallel add together directly. Ct = C1 + C2 = 10 + 10 = 20 microfarads.

42. If two coils with mutual inductance are connected in series-aiding, the total inductance will be:

A) L1 + L2

B) L1 + L2 - 2M

C) L1 + L2 + 2M

D) The square root of (L1 * L2)

Answer: C) L1 + L2 + 2M

Explanation: In a series-aiding connection, the magnetic fields of the two coils assist each other. The total inductance is the sum of the self-inductances plus twice the mutual inductance (M).

43. A transformer core is made of a material with:

A) Low permeability and high reluctance

B) High permeability and low reluctance

C) Low permeability and low reluctance

D) High permeability and high reluctance

Answer: B) High permeability and low reluctance

Explanation: To be effective, the core must easily allow magnetic flux lines to be established. This requires a high permeability, which corresponds to a low reluctance (the opposition to magnetic flux).

44. The impedance of a pure inductor increases with:

A) Increasing frequency

B) Decreasing frequency

C) Increasing resistance

D) Decreasing current

Answer: A) Increasing frequency

Explanation: The inductive reactance is given by XL = 2*pi*f*L. This shows a direct, linear relationship between reactance and frequency.

45. A first-order circuit is a circuit that contains:

A) Only resistors

B) Only one reactive component (either L or C) and resistors

C) Both an inductor and a capacitor

D) At least one dependent source

Answer: B) Only one reactive component (either L or C) and resistors

Explanation: It is called a "first-order" circuit because its behavior is described by a first-order linear differential equation. Examples are simple RC and RL circuits.

46. The power factor angle is the angle between the:

A) True power and reactive power vectors

B) Voltage and current phasors

C) Apparent power and true power vectors

D) Both B and C are correct

Answer: D) Both B and C are correct

Explanation: The power factor angle (phi) is defined as the phase difference between the voltage and current waveforms. In the power triangle, this is also the angle between the apparent power (S) and the true power (P).

47. The primary reason for using a three-phase system for power distribution is:

A) It is less dangerous than single-phase

B) It is more economical and efficient

C) It is easier to generate

D) It can only be used for motors

Answer: B) It is more economical and efficient

Explanation: Three-phase systems can transmit more power for a given amount of conductor material compared to single-phase systems. Also, the constant power delivery makes large motors run more smoothly and efficiently.

48. A branch in a circuit is a part of the network that has:

A) At least one resistor

B) Two terminals and contains one or more elements

C) No sources

D) A connection to ground

Answer: B) Two terminals and contains one or more elements

Explanation: A branch represents a single path between two nodes. It can contain any number of series elements but is considered a single branch.

49. An electric generator works on the principle of:

A) Electromagnetic induction

B) The motor effect

C) Ohm's Law

D) Chemical reactions

Answer: A) Electromagnetic induction

Explanation: Generators work by moving a conductor through a magnetic field (or moving a field past a conductor). This relative motion causes a change in magnetic flux, which, according to Faraday's Law, induces an EMF (voltage) in the conductor.

50. Reactive power is the power that:

A) Is converted into useful work

B) Is dissipated as heat in resistors

C) Is stored and returned by inductors and capacitors

D) Is the vector sum of true and apparent power

Answer: C) Is stored and returned by inductors and capacitors

Explanation: Reactive power represents the energy that is exchanged back and forth between the source and the reactive components (L and C) each cycle. It does no real work and is measured in volt-amperes reactive (VAR).

51. Ohm's Law is not applicable to:

A) Resistors

B) Inductors

C) Capacitors

D) Diodes and transistors

Answer: D) Diodes and transistors

Explanation: Ohm's law (V=IR) applies to linear, bilateral components where the resistance is constant. Diodes and transistors are non-linear devices; their current-voltage relationship is not a straight line, so their "resistance" is not constant.

52. The total current entering a parallel circuit is 10 A. The circuit has two branches with resistances of 2 ohms and 8 ohms. The current in the 2-ohm branch is:

A) 2 A

B) 4 A

C) 8 A

D) 10 A

Answer: C) 8 A

Explanation: Using the current divider rule: I_2ohm = I_total * (R_other / (R_2ohm + R_other)) = 10 A * (8 / (2 + 8)) = 10 A * (8 / 10) = 8 A. Most of the current takes the path of least resistance.

53. The superposition theorem is based on the concept of:

A) Linearity

B) Duality

C) Reciprocity

D) Non-linearity

Answer: A) Linearity

Explanation: The core principle that allows superposition to work is linearity. In a linear system, the output caused by a sum of inputs is equal to the sum of the outputs caused by each input individually.

54. The unit of magnetic reluctance is:

A) Weber/meter

B) Ampere-turns/Weber

C) Tesla/meter

D) Henry

Answer: B) Ampere-turns/Weber

Explanation: Reluctance is defined as the ratio of magnetomotive force (MMF, in ampere-turns) to magnetic flux (in Webers). It quantifies the opposition to the magnetic flux.

55. An AC voltage has a peak value of 170 V. Its RMS value is approximately:

A) 170 V

B) 120 V

C) 240 V

D) 108 V

Answer: B) 120 V

Explanation: For a sine wave, V_rms = V_peak / sqrt(2). So, V_rms = 170 V / 1.414 is approximately 120 V. This is the standard relationship for household voltage in North America.

56. The turns ratio of a transformer is 2:1. This means it is a:

A) Step-up transformer

B) Step-down transformer

C) Isolation transformer

D) Autotransformer

Answer: B) Step-down transformer

Explanation: A turns ratio is often given as Np:Ns (primary to secondary). A 2:1 ratio means the primary has twice as many turns as the secondary, so the voltage will be stepped down by a factor of 2.

57. An "overdamped" response in an RLC circuit is one that:

A) Oscillates before settling

B) Is very fast with no overshoot

C) Approaches the final value slowly and without oscillation

D) Is unstable and grows indefinitely

Answer: C) Approaches the final value slowly and without oscillation

Explanation: An overdamped system has a high level of damping (large R). When subjected to a step input, it moves slowly towards its final steady-state value without ever crossing it.

58. In a series resonant circuit, the current is:

A) At a minimum

B) At a maximum

C) Zero

D) Lagging the voltage by 90 degrees

Answer: B) At a maximum

Explanation: At resonance, the impedance of a series RLC circuit is at its minimum value (equal to R). Since the voltage is constant, a minimum impedance results in a maximum current flow according to Ohm's Law (I = V/Z).

59. A full-wave rectifier is more efficient than a half-wave rectifier because it:

A) Uses fewer diodes

B) Has a lower peak inverse voltage

C) Utilizes both half-cycles of the AC input

D) Produces a lower ripple frequency

Answer: C) Utilizes both half-cycles of the AC input

Explanation: A half-wave rectifier discards one half of the AC waveform, while a full-wave rectifier inverts it, using the entire input waveform to produce the DC output. This results in a higher average voltage and less ripple.

60. The power triangle relates:

A) Voltage, current, and resistance

B) True power, reactive power, and apparent power

C) Resistance, reactance, and impedance

D) Both B and C are correct

Answer: D) Both B and C are correct

Explanation: The power triangle and the impedance triangle are geometrically similar. The sides of the impedance triangle (R, X, Z) are related to the sides of the power triangle (P, Q, S) by a factor of I-squared. Both are right-angled triangles that visually represent these AC circuit relationships.