Electrical Engineering

1. The unit of electrical permittivity is:

A) Henry / meter

B) Farad / meter

C) Weber / meter

D) Tesla / meter

Answer: B) Farad / meter

Explanation: Permittivity is a measure of how an electric field affects a dielectric medium. It is a fundamental parameter used in the formula for capacitance.

2. A practical ammeter has a:

A) Very high internal resistance

B) Very low internal resistance

C) Infinite internal resistance

D) Zero internal resistance

Answer: B) Very low internal resistance

Explanation: An ammeter is connected in series to measure current. To avoid affecting the circuit it is measuring, its own resistance should be as low as possible to minimize the voltage drop across it.

3. The temperature coefficient of resistance for a semiconductor is:

A) Positive

B) Negative

C) Zero

D) Infinite

Answer: B) Negative

Explanation: In semiconductors, as temperature increases, more charge carriers are freed, which increases conductivity and therefore decreases resistivity. This is the opposite behavior of most metals.

4. The energy required to move a charge of 1 Coulomb through a potential difference of 1 Volt is:

A) 1 Watt

B) 1 Ampere

C) 1 Joule

D) 1 Farad

Answer: C) 1 Joule

Explanation: This is the definition of a Volt. A Volt is one Joule of energy per Coulomb of charge ($V = W/Q$). Therefore, the work or energy (W) is $W = V * Q = 1V * 1C = 1$ Joule.

5. In a parallel circuit, the total current is equal to the:

A) Current through the largest resistor

B) Average of the branch currents

C) Sum of the individual branch currents

D) Product of the branch currents

Answer: C) Sum of the individual branch currents

Explanation: This is a direct statement of Kirchhoff's Current Law (KCL) applied to a simple parallel circuit. The total current entering the parallel combination must equal the total current leaving it.

6. A bridge circuit is said to be balanced when the current through the galvanometer is:

A) Maximum

B) Minimum

C) Zero

D) Equal to the source current

Answer: C) Zero

Explanation: In a balanced Wheatstone bridge, the voltage at the two middle nodes is equal. Since there is no potential difference across the galvanometer, no current flows through it.

7. Tellegen's theorem is valid for any network that is:

A) Linear and bilateral

B) Passive and time-invariant

C) Active and non-linear

D) Obeying Kirchhoff's Laws

Answer: D) Obeying Kirchhoff's Laws

Explanation: Tellegen's theorem is extremely general. It relies only on Kirchhoff's laws and not on the nature of the components, making it applicable to linear, non-linear, passive, active, and time-varying networks.

8. The number of independent equations required for nodal analysis is equal to the number of:

A) Branches minus 1

B) Nodes minus 1

C) Loops in the circuit

D) Sources in the circuit

Answer: B) Nodes minus 1

Explanation: In nodal analysis, one node is chosen as the reference node (ground). An independent KCL equation is then written for each of the remaining non-reference nodes.

9. The magnetic lines of force around a bar magnet:

A) Originate from the south pole and end at the north pole

B) Originate from the north pole and end at the south pole

C) Form concentric circles around the magnet

D) Do not have a specific direction

Answer: B) Originate from the north pole and end at the south pole

Explanation: By convention, magnetic field lines are drawn to show the direction of the force that would be exerted on a hypothetical north pole. Therefore, they emerge from the north pole and enter the south pole externally.

10. The angular frequency of a 60 Hz sine wave is approximately:

A) 60 rad/s

B) 120 rad/s

C) 377 rad/s

D) 188 rad/s

Answer: C) 377 rad/s

Explanation: Angular frequency (omega) is calculated as omega = 2 * pi * f. So, omega = 2 * 3.14159 * 60 Hz, which is approximately 377 radians per second.

11. A capacitor's ability to store charge for a given voltage is its:

A) Reactance

B) Inductance

C) Capacitance

D) Resistance

Answer: C) Capacitance

Explanation: Capacitance (C) is the fundamental property of a capacitor, defined as the ratio of stored charge (Q) to the applied voltage (V), so C = Q/V. It is measured in Farads.

12. Two 4 H inductors are connected in series. Their total inductance is:

A) 2 H

B) 4 H

C) 8 H

D) 16 H

Answer: C) 8 H

Explanation: Inductors in series add directly, just like resistors in series. Lt = L1 + L2 = 4 H + 4 H = 8 H.

13. An ideal transformer does not change the:

A) Voltage

B) Current

C) Impedance

D) Power

Answer: D) Power

Explanation: An ideal transformer is 100% efficient. The power in the primary winding (Vp * Ip) is equal to the power in the secondary winding (Vs * Is). It transforms voltage and current levels, but not power.

14. The natural response of a first-order RC circuit is a/an:

A) Sinusoidal wave

B) Decaying exponential

C) Growing exponential

D) Constant DC value

Answer: B) Decaying exponential

Explanation: The natural response describes how the circuit behaves due to initially stored energy. In an RC circuit, the capacitor's voltage and current will decay exponentially to zero with a time constant of tau = RC.

15. In a series RL circuit, the power factor can never be:

A) Zero

B) Unity (1)

C) Leading

D) Lagging

Answer: C) Leading

Explanation: An RL circuit is inherently inductive, meaning the current will always lag the voltage. The phase angle will be between 0 degrees (purely resistive) and 90 degrees (purely inductive). A leading power factor is only possible with a capacitor.

16. In a parallel RLC circuit, the current at resonance is:

A) Maximum

B) Minimum

C) Zero

D) Infinite

Answer: B) Minimum

Explanation: At resonance, the large but opposing currents in the inductor and capacitor branches cancel each other out. This leaves only the smaller current flowing through the resistor, so the total current drawn from the source is at its minimum.

17. An active filter differs from a passive filter because it:

A) Uses an op-amp or transistor

B) Provides gain

C) Does not require inductors

D) All of the above

Answer: D) All of the above

Explanation: Active filters use active components (like op-amps) which allows them to amplify the signal (provide gain). This also enables the design of high-quality filters without the need for bulky and non-ideal inductors.

18. The reciprocity theorem states that the ratio of excitation to response is:

A) Constant if the source and meter are interchanged

B) Always equal to 1

C) Proportional to the number of nodes

D) The same as the power factor

Answer: A) Constant if the source and meter are interchanged

Explanation: If a voltage source in branch 'A' produces a current in branch 'B', the theorem states that the same voltage source placed in branch 'B' would produce the same current in branch 'A'.

19. The complete response of a circuit is composed of the:

A) Thevenin equivalent and Norton equivalent

B) AC response and DC response

C) Transient response and steady-state response

D) Real part and imaginary part

Answer: C) Transient response and steady-state response

Explanation: The total solution for a circuit's behavior over time is the sum of two components: the transient part that decays to zero, and the steady-state part that remains after the transients have disappeared.

20. The power consumed by a balanced three-phase load can be measured using:

A) Only one wattmeter

B) Two wattmeters

C) Three wattmeters

D) Both B and C are valid methods

Answer: D) Both B and C are valid methods

Explanation: The two-wattmeter method is a standard technique that works for both star and delta, balanced or unbalanced loads (on 3-wire systems). Using three wattmeters (one per phase) is also a valid, though often less common, method for 4-wire systems.

21. Diamagnetic materials are those which have a relative permeability that is:

A) Slightly greater than 1

B) Slightly less than 1

C) Equal to 1

D) Much greater than 1

Answer: B) Slightly less than 1

Explanation: Diamagnetic materials (like copper and water) are weakly repelled by a magnetic field. Their internal induced magnetic field opposes the external field, resulting in a relative permeability slightly less than unity.

22. A short circuit has a resistance of approximately:

A) Infinity

B) Zero

C) A very high value

D) A negative value

Answer: B) Zero

Explanation: An ideal short circuit represents a perfect conducting path with zero resistance. It allows any amount of current to flow without any voltage drop across it.

23. The total charge that has passed a point in a circuit is the:

A) Derivative of the current with respect to time

B) Integral of the current with respect to time

C) Product of current and time

D) Ratio of current to time

Answer: B) Integral of the current with respect to time

Explanation: Since current is the rate of flow of charge ($I = dQ/dt$), the total charge (Q) can be found by integrating the current over a period of time.

24. Two 2 H inductors are in parallel. The total inductance is:

A) 4 H

B) 2 H

C) 1 H

D) 0.5 H

Answer: C) 1 H

Explanation: For N identical inductors in parallel, the total inductance is the value of one inductor divided by the number of inductors. Lt = L / N = 2 H / 2 = 1 H.

25. The voltage-division rule states that the voltage across a resistor in a series circuit is proportional to:

A) The total resistance

B) The total current

C) Its own resistance

D) The resistance of the other resistors

Answer: C) Its own resistance

Explanation: The formula is Vx = V_total * (Rx / R_total). This shows that the largest resistor in a series string gets the largest share of the total voltage.

26. A mesh is a loop that does not contain any other:

A) Nodes within it

B) Loops within it

C) Voltage sources within it

D) Branches within it

Answer: B) Loops within it

Explanation: This is the definition of a mesh, which distinguishes it from a more general loop. Meshes are like the "window panes" of a circuit diagram and are used as the basis for mesh analysis.

27. The area inside a B-H curve represents the:

A) Hysteresis loss per unit volume per cycle

B) Magnetic permeability

C) Retentivity

D) Coercive force

Answer: A) Hysteresis loss per unit volume per cycle

Explanation: The area of the hysteresis loop is a direct measure of the energy that is lost (converted to heat) in the magnetic material as it is cycled through magnetization and demagnetization.

28. An AC voltage is given by v(t) = 200 cos(100t + 45 degrees). The peak voltage is:

A) 200 V

B) 100 V

C) 45 V

D) 141.4 V

Answer: A) 200 V

Explanation: In the standard form v(t) = V_peak * cos(omega*t + phi), the peak amplitude is the number multiplying the cosine function, which is 200 V.

29. A capacitor opposes a sudden change in:

A) Current

B) Voltage

C) Resistance

D) Frequency

Answer: B) Voltage

Explanation: The voltage across a capacitor is proportional to the stored charge. Since it takes time for charge to accumulate, the voltage cannot change instantaneously.

30. In an AC circuit, the ratio of the true power to the apparent power is the:

A) Quality factor

B) Form factor

C) Power factor

D) Crest factor

Answer: C) Power factor

Explanation: This is the definition of power factor. PF = P / S = (True Power in Watts) / (Apparent Power in VA). It is a measure of the circuit's efficiency.

31. In a series RC circuit, the total voltage is the:

A) Algebraic sum of the resistor and capacitor voltages

B) Vector sum of the resistor and capacitor voltages

C) Voltage across the capacitor only

D) Voltage across the resistor only

Answer: B) Vector sum of the resistor and capacitor voltages

Explanation: Because the voltage across the resistor (VR) and the voltage across the capacitor (VC) are 90 degrees out of phase, they must be added as vectors using the Pythagorean theorem: V_total = sqrt(VR squared + VC squared).

32. A circuit that passes frequencies between two cutoff points is a:

A) Low-pass filter

B) High-pass filter

C) Band-pass filter

D) Band-stop filter

Answer: C) Band-pass filter

Explanation: A band-pass filter has a lower cutoff frequency and an upper cutoff frequency. It attenuates frequencies below the lower cutoff and above the upper cutoff, creating a "passband" in between.

33. An ideal op-amp is an example of a:

A) Voltage-controlled voltage source

B) Current-controlled voltage source

C) Voltage-controlled current source

D) Current-controlled current source

Answer: A) Voltage-controlled voltage source

Explanation: The output voltage of an op-amp is a function of the differential input voltage (V+ minus V-). Its output acts as a near-perfect voltage source, making it a VCVS.

34. A circuit's "time constant" determines the:

A) Final steady-state value

B) Initial value at t=0

C) Rate at which the transient response decays

D) Phase angle of the response

Answer: C) Rate at which the transient response decays

Explanation: A smaller time constant means the transient part of the response will decay to zero more quickly. A larger time constant means the circuit takes longer to reach its steady state.

35. The two-wattmeter method of power measurement gives an incorrect reading if the:

A) Load is unbalanced

B) System is a 4-wire system and the load is unbalanced

C) Power factor is not unity

D) Load is star-connected

Answer: B) The system is a 4-wire system and the load is unbalanced

Explanation: The two-wattmeter method works correctly for 3-wire systems under all conditions. However, if there is a neutral wire (a 4-wire system) and the load is unbalanced, a current can flow in the neutral wire that is not measured by the two wattmeters, leading to an incorrect reading.

36. An electric field is a region where a/an:

A) Magnetic pole experiences a force

B) Electric charge experiences a force

C) Moving charge experiences a force

D) Current-carrying wire experiences a force

Answer: B) Electric charge experiences a force

Explanation: This is the definition of an electric field. The field is defined by the force it exerts per unit of positive charge ($E = F/q$).

37. A "bilateral" circuit element is one whose property:

A) Changes with time

B) Is the same for current flowing in either direction

C) Depends on the voltage

D) Is independent of temperature

Answer: B) Is the same for current flowing in either direction

Explanation: A resistor is a classic example of a bilateral element; its resistance is the same regardless of the direction of current. A diode is unilateral because it allows current to flow easily in only one direction.

38. Ferromagnetic materials are those which have a relative permeability that is:

A) Slightly greater than 1

B) Slightly less than 1

C) Equal to 1

D) Much greater than 1

Answer: D) Much greater than 1

Explanation: Ferromagnetic materials (like iron, nickel, and cobalt) are strongly attracted to a magnetic field. Their ability to concentrate magnetic flux results in relative permeabilities that can be in the hundreds or thousands.

39. The unit of apparent power is the:

A) Watt (W)

B) Volt-Ampere (VA)

C) Volt-Ampere Reactive (VAR)

D) Joule (J)

Answer: B) Volt-Ampere (VA)

Explanation: Apparent power is the product of the RMS voltage and RMS current. Its unit, the VA, distinguishes it from true power (Watts), which accounts for the phase angle.

40. If the number of turns on an inductor's coil is doubled, its inductance will be:

A) Halved

B) Doubled

C) Quadrupled

D) Unchanged

Answer: C) Quadrupled

Explanation: The inductance of a coil is proportional to the square of the number of turns (L is proportional to N squared). Therefore, doubling the number of turns will multiply the inductance by a factor of four.

41. In an AC circuit, the quantity Z = R + jX is known as:

A) Admittance

B) Impedance

C) Susceptance

D) Conductance

Answer: B) Impedance

Explanation: Impedance (Z) is the complex representation of the total opposition to current in an AC circuit. It has a real part (resistance, R) and an imaginary part (reactance, X).

42. The "half-power frequencies" are the two frequencies at which the:

A) Current is half its maximum value

B) Power is half its maximum value

C) Impedance is half its minimum value

D) Voltage is half its maximum value

Answer: B) Power is half its maximum value

Explanation: The half-power points define the bandwidth of a resonant circuit. They are the frequencies on either side of resonance where the power dissipated has dropped to 50% of the peak power at resonance.

43. A first-order circuit's response to a step input will never:

A) Decay to zero

B) Reach a steady state

C) Oscillate

D) Be an exponential function

Answer: C) Oscillate

Explanation: The response of a first-order circuit (simple RC or RL) is always a non-oscillatory exponential rise or decay. Oscillations can only occur in circuits that are second-order or higher (containing both L and C).

44. In a balanced three-phase system, the power delivered to the load is:

A) Pulsating at twice the line frequency

B) Pulsating at three times the line frequency

C) Constant at all times

D) Zero

Answer: C) Constant at all times

Explanation: Although the power in each individual phase is pulsating, the sum of the instantaneous powers of all three phases is a constant, non-pulsating value. This is a major advantage for running large motors smoothly.

45. The ability of a circuit to store energy is a property of:

A) Resistors only

B) Inductors and capacitors

C) Ideal sources

D) Diodes and transistors

Answer: B) Inductors and capacitors

Explanation: Resistors dissipate energy as heat. Inductors store energy in a magnetic field, and capacitors store energy in an electric field. These are the two energy storage elements in electrical circuits.

46. The time constant of a series RL circuit is given by:

A) R / L

B) L / R

C) R * L

D) 1 / (R*L)

Answer: B) L / R

Explanation: The time constant (tau) for a series RL circuit is the ratio of the inductance to the resistance. It represents the time it takes for the current to reach approximately 63.2% of its final value.

47. The total opposition to current in a parallel AC circuit is found by calculating the:

A) Vector sum of the branch impedances

B) Reciprocal of the vector sum of the branch admittances

C) Algebraic sum of the branch impedances

D) Product of the branch impedances

Answer: B) Reciprocal of the vector sum of the branch admittances

Explanation: For parallel AC circuits, it is much easier to work with admittances (Y = 1/Z). The total admittance is the vector sum of the individual branch admittances (Yt = Y1 + Y2 + ...), and the total impedance is the reciprocal of this sum (Zt = 1/Yt).

48. A "planer circuit" is one that can be:

A) Drawn on a flat surface without any wires crossing

B) Solved using only Ohm's Law

C) Analyzed using nodal analysis

D) Built using only resistors

Answer: A) Drawn on a flat surface without any wires crossing

Explanation: This is the definition of a planar circuit. If a circuit diagram can be drawn such that no two branches cross each other, it is planar. This is a condition for applying mesh analysis in its simplest form.

49. An electric generator that produces a DC voltage is often called a/an:

A) Alternator

B) Dynamo

C) Inverter

D) Motor

Answer: B) Dynamo

Explanation: A dynamo is a DC generator. It works on the same principle of electromagnetic induction as an alternator but uses a commutator to mechanically rectify the AC voltage produced in the rotating armature into a DC output.

50. The unit of electrical energy is the:

A) Watt

B) Ampere

C) Volt

D) Joule or Watt-second

Answer: D) Joule or Watt-second

Explanation: Energy is power multiplied by time. The SI unit of energy is the Joule (J). Since power is in Watts (Joules/second) and time is in seconds, a Joule is equivalent to a Watt-second.

51. The resistance of a conductor is directly proportional to its:

A) Cross-sectional area

B) Diameter

C) Length

D) Mass

Answer: C) Length

Explanation: According to the formula R = (rho * L) / A, resistance increases in direct proportion to the length (L) of the conductor. A longer wire has more resistance.

52. In a purely capacitive circuit, the reactive power is:

A) Zero

B) Positive

C) Negative

D) The same as the true power

Answer: C) Negative

Explanation: By convention, an inductor is said to absorb or consume reactive power (positive VARs), while a capacitor is said to supply or generate reactive power (negative VARs).

53. If the turns ratio (Np/Ns) of a transformer is 5, and the primary current is 2 A, the secondary current is:

A) 10 A

B) 2 A

C) 0.4 A

D) 2.5 A

Answer: A) 10 A

Explanation: For an ideal transformer, the current ratio is the inverse of the turns ratio: Is / Ip = Np / Ns. Therefore, Is = Ip * (Np / Ns) = 2 A * 5 = 10 A.

54. The transient period of a circuit is considered to be over after approximately:

A) One time constant

B) Two time constants

C) Three time constants

D) Five time constants

Answer: D) Five time constants

Explanation: After 5 time constants (5*tau), the exponential decay term (e^-5) is approximately 0.0067. This means the transient response has decayed to less than 1% of its initial value and is considered to have effectively disappeared.

55. In a series RLC circuit, as the frequency is varied from zero to infinity, the current will:

A) Continuously increase

B) Continuously decrease

C) Increase to a maximum at resonance and then decrease

D) Decrease to a minimum at resonance and then increase

Answer: C) Increase to a maximum at resonance and then decrease

Explanation: At very low and very high frequencies, the impedance is large (due to C and L, respectively), so the current is low. At the resonant frequency, the impedance is at its minimum, so the current reaches its peak value.

56. The two-wattmeter method of power measurement indicates that one wattmeter is reading negative. This implies that the power factor of the load is:

A) Unity

B) Greater than 0.5 lagging

C) Less than 0.5 lagging

D) Leading

Answer: C) Less than 0.5 lagging

Explanation: When the phase angle of the load is greater than 60 degrees (which corresponds to a power factor of cos(60) = 0.5), one of the wattmeters will start to read negative.

57. An electric charge is a source of an:

A) Electric field only

B) Magnetic field only

C) Both electric and magnetic fields

D) Gravitational field

Answer: A) Electric field only

Explanation: A stationary electric charge creates an electric field in the space around it. A magnetic field is only produced when the charge is in motion (i.e., an electric current).

58. The unit of magnetic permeability is:

A) Henry / meter

B) Farad / meter

C) Weber / meter

D) Tesla / meter

Answer: A) Henry / meter

Explanation: Permeability (mu) is a measure of a material's ability to support the formation of a magnetic field within itself. It is a key parameter in the formula for inductance.

59. The total power in a circuit with several resistors is the:

A) Average of the power in each resistor

B) Sum of the power in each resistor

C) Product of the power in each resistor

D) Power dissipated by the largest resistor only

Answer: B) Sum of the power in each resistor

Explanation: Based on the conservation of energy, the total power delivered by the source must be equal to the total power consumed or dissipated by all the components in the circuit.

60. A short circuit fault in a power system typically results in a very:

A) Low current and high voltage

B) High current and low voltage

C) Low current and low voltage

D) High current and high voltage

Answer: B) High current and low voltage

Explanation: A short circuit creates a very low impedance path. According to Ohm's law, this low impedance allows a very large fault current to flow. This large current flowing through the system's inherent impedance causes the voltage at the fault location to drop to a very low value.