Electrical Engineering

1. The unit of electrical conductivity is:

A) Ohm-meter

B) Siemens / meter

C) Ohm / meter

D) Meter / Siemens

Answer: B) Siemens / meter

Explanation: Conductivity (sigma) is the reciprocal of resistivity (rho). Since resistivity is in Ohm-meters, the unit for conductivity is 1 / (Ohm-meter), which is Siemens per meter.

2. A material's resistance is independent of its:

A) Length

B) Cross-sectional area

C) Temperature

D) The current flowing through it (for an ohmic material)

Answer: D) The current flowing through it (for an ohmic material)

Explanation: For an ohmic material, the resistance is considered a constant property determined by its physical dimensions and material type, not by the voltage or current applied.

3. Ohm's law describes the relationship between voltage, current, and resistance for:

A) All electrical materials

B) Linear, bilateral elements

C) Non-linear devices

D) Unilateral elements

Answer: B) Linear, bilateral elements

Explanation: Ohm's law is only valid for materials and components (like resistors) where the resistance is constant, meaning the voltage-current graph is a straight line. It does not apply to non-linear devices like diodes.

4. One British thermal unit (BTU) of heat energy is equivalent to approximately how many joules?

A) 4.184 J

B) 1055 J

C) 3600 J

D) 100 J

Answer: B) 1055 J

Explanation: The BTU is a unit of heat. The conversion between the thermal unit (BTU) and the electrical unit of energy (Joule) is approximately 1 BTU = 1055 joules.

5. If one of the resistors in a series circuit is open-circuited, the total current will be:

A) Maximum

B) Zero

C) The normal value

D) Infinite

Answer: B) Zero

Explanation: A series circuit provides only one path for the current. An open circuit in any part of that path breaks the entire path, and no current can flow.

6. If one of the resistors in a parallel circuit is open-circuited, the total resistance will:

A) Decrease

B) Increase

C) Remain the same

D) Become zero

Answer: B) Increase

Explanation: Removing a parallel branch eliminates one path for the current. With fewer paths available, the overall opposition to the current flow increases, so the total equivalent resistance increases.

7. In a series-parallel circuit, the component that has the same voltage across it as the source is the one that is:

A) In series with the source

B) In a branch that is directly parallel to the source

C) Farthest from the source

D) Has the highest resistance

Answer: B) In a branch that is directly parallel to the source

Explanation: By definition, components in parallel share the same two nodes. If a branch containing one or more components is connected directly across the terminals of the voltage source, it will have the full source voltage across it.

8. When converting a delta network to an equivalent star network, the resistance of each arm of the star is the:

A) Sum of the two adjacent delta resistances

B) Product of the two adjacent delta resistances divided by the sum of all three delta resistances

C) Sum of all three delta resistances

D) Difference between the two adjacent delta resistances

Answer: B) Product of the two adjacent delta resistances divided by the sum of all three delta resistances

Explanation: This is the standard formula for a Delta-to-Star (or Pi-to-Tee) conversion. For a star resistor Ra, the formula is Ra = (R1 * R2) / (R1 + R2 + R3), where R1 and R2 are the adjacent resistors in the delta network.

9. The number of KVL equations needed to solve a circuit is equal to the number of:

A) Nodes

B) Branches

C) Independent loops (meshes)

D) Sources

Answer: C) Independent loops (meshes)

Explanation: Mesh analysis, which is based on KVL, requires one independent equation for each mesh in a planar circuit. The number of meshes is equal to b - (n - 1), where b is branches and n is nodes.

10. The property of a magnetic material that measures the opposition to the magnetic flux is:

A) Permeability

B) Reluctance

C) Inductance

D) Retentivity

Answer: B) Reluctance

Explanation: Reluctance is analogous to resistance in an electric circuit. A material with high reluctance (like air) offers high opposition to magnetic flux, while a material with low reluctance (like iron) offers low opposition.

11. The phase angle of an AC voltage $v(t) = V_m \cos(\omega t + \phi)$ represents the:

A) Angular frequency of the waveform

B) Peak amplitude of the waveform

C) Horizontal shift of the waveform relative to a reference

D) Rate of change of the waveform

Answer: C) Horizontal shift of the waveform relative to a reference

Explanation: The phase angle (ϕ) determines the starting point of the waveform at t=0. A positive angle indicates a lead (shift to the left), and a negative angle indicates a lag (shift to the right).

12. The relative permittivity of a material is the ratio of its permittivity to the:

A) Permittivity of free space

B) Permeability of free space

C) Its own permeability

D) A reference value of 1

Answer: A) Permittivity of free space

Explanation: Relative permittivity (or dielectric constant) is a dimensionless factor that shows how much a dielectric material can enhance the storage of electric energy compared to a vacuum (free space).

13. The induced EMF in an inductor is proportional to the:

A) Current flowing through it

B) Square of the current

C) Rate of change of current

D) Inductance value only

Answer: C) Rate of change of current

Explanation: This is a direct statement of Faraday's Law as applied to an inductor: V = L * (di/dt). The voltage is zero if the current is constant, regardless of how large the current is.

14. The open-circuit and short-circuit tests on a transformer are performed to determine its:

A) Efficiency and voltage regulation

B) Equivalent circuit parameters

C) Turns ratio and phase angle

D) Core material and winding type

Answer: B) Equivalent circuit parameters

Explanation: The open-circuit test is used to find the core loss resistance and magnetizing reactance. The short-circuit test is used to find the equivalent winding resistance and leakage reactance.

15. In a charging RC circuit, the current is maximum at:

A) t = one time constant

B) The end of the charging process (t = infinity)

C) The very beginning of the charging process (t = 0+)

D) The point where voltage is half its maximum

Answer: C) The very beginning of the charging process (t = 0+)

Explanation: At the instant the switch is closed, the uncharged capacitor acts like a short circuit, allowing the maximum possible current (limited only by the resistance, I = V/R) to flow. The current then decays exponentially.

16. In a discharging RL circuit, the voltage across the inductor will:

A) Be zero initially

B) Be maximum (and negative) initially and decay to zero

C) Increase exponentially from zero

D) Remain constant

Answer: B) Be maximum (and negative) initially and decay to zero

Explanation: When the source is removed, the collapsing magnetic field tries to keep the current flowing. This induces a reverse voltage that is at its maximum at t=0+ and then decays to zero as the stored energy is dissipated in the resistor.

17. If the resistance in a series RLC circuit is increased, the bandwidth of the resonance curve will:

A) Increase

B) Decrease

C) Remain the same

D) Become zero

Answer: A) Increase

Explanation: The bandwidth (BW) of a series RLC circuit is given by BW = R/L. Therefore, increasing the resistance directly increases the bandwidth, making the resonance curve broader and less selective.

18. An ideal band-pass filter would have a gain of:

A) Unity in the passband and zero in the stopband

B) Infinity in the passband and unity in the stopband

C) Zero in the passband and unity in the stopband

D) Unity at all frequencies

Answer: A) Unity in the passband and zero in the stopband

Explanation: An ideal "brick-wall" filter has a perfectly flat passband (with a gain of 1, or 0dB) and infinite attenuation (a gain of 0) in the stopband, with an instantaneous transition between them.

19. Millman's theorem converts a set of parallel branches, each with a voltage source and series resistor, into an equivalent:

A) Single Thevenin circuit

B) Single Norton circuit

C) Single resistor

D) Both A and B are possible

Answer: D) Both A and B are possible

Explanation: Millman's theorem directly calculates the equivalent voltage of the parallel combination. Once you have this voltage (V_eq) and the equivalent parallel resistance (R_eq), you

have created an equivalent Thevenin circuit (V_eq in series with R_eq). This can then be easily converted to a Norton equivalent.

20. In the time domain, the voltage across an inductor is related to the:

A) Integral of the current

B) Derivative of the current

C) Current itself

D) Square of the current

Answer: B) Derivative of the current

Explanation: The fundamental relationship for an inductor in the time domain is v(t) = L * [di(t)/dt], meaning the voltage is proportional to the rate of change (derivative) of the current.

21. The power supplied by a three-phase generator to a balanced load is:

A) Pulsating at the line frequency

B) Pulsating at twice the line frequency

C) Constant at all times

D) Zero

Answer: C) Constant at all times

Explanation: While 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.

22. The resistivity of a material is a measure of its:

A) Intrinsic opposition to current flow

B) Total opposition in a specific shape

C) Ability to store charge

D) Ability to create a magnetic field

Answer: A) Intrinsic opposition to current flow

Explanation: Resistivity is a bulk property of a material, independent of its size or shape. Resistance, on the other hand, depends on resistivity as well as the length and cross-sectional area of the specific component.

23. One kilowatt-hour (kWh) is a unit of:

A) Power

B) Energy

C) Charge

D) Current

Answer: B) Energy

Explanation: Power is the rate of energy use (in Watts or kilowatts). Energy is power multiplied by time. A kWh is the energy consumed by a 1 kW device running for 1 hour.

24. If two resistors in a series circuit have the same resistance, the voltage drop across each will be:

A) The same

B) Twice the source voltage

C) Zero

D) Different

Answer: A) The same

Explanation: In a series circuit, the total voltage is divided among the resistors in proportion to their resistance. If the resistances are equal, they will each get an equal share of the voltage.

25. The total resistance of a parallel circuit is always:

A) Greater than the largest resistance in the combination

B) Equal to the smallest resistance in the combination

C) Less than the smallest resistance in the combination

D) Equal to the average of the resistances

Answer: C) Less than the smallest resistance in the combination

Explanation: Adding more parallel paths for the current always makes it easier for the total current to flow. Therefore, the overall equivalent resistance is always reduced and will be smaller than the value of any single branch resistor.

26. Source transformation is a technique based on the equivalence between:

A) Ohm's Law and Kirchhoff's Law

B) Thevenin's and Norton's theorems

C) Series and parallel circuits

D) Resistors and inductors

Answer: B) Thevenin's and Norton's theorems

Explanation: Source transformation is the practical application of the duality between Thevenin's theorem (voltage source in series with R) and Norton's theorem (current source in parallel with R).

27. The coercive force of a magnetic material is a measure of its:

A) Ability to conduct magnetic flux

B) Ability to retain magnetism

C) Resistance to demagnetization

D) Maximum possible magnetic strength

Answer: C) Resistance to demagnetization

Explanation: Coercivity is the intensity of the reverse magnetic field that must be applied to a magnetized material to reduce its magnetization to zero. A "hard" magnet has high coercivity.

28. The RMS value of an AC current that produces the same heating effect as 5 A of DC current is:

A) 7.07 A

B) 5 A

C) 3.53 A

D) 10 A

Answer: B) 5 A

Explanation: This is the definition of the RMS value. The RMS (Root Mean Square) value of an AC current is the equivalent DC current that would dissipate the same amount of power (heat) in a given resistor.

29. A capacitor is fully charged and the source is removed. The voltage across the capacitor will:

A) Drop to zero immediately

B) Theoretically remain constant forever (if ideal)

C) Reverse its polarity

D) Start to oscillate

Answer: B) Theoretically remain constant forever (if ideal)

Explanation: An ideal capacitor has no leakage current. Once charged, the energy is stored in its electric field, and the voltage will remain across its terminals indefinitely until a discharge path is provided.

30. In an AC circuit, the reactive power is associated with the energy that is:

A) Dissipated as heat

B) Converted to mechanical work

C) Stored and returned by reactive components

D) Lost in transmission

Answer: C) Stored and returned by reactive components

Explanation: Reactive power represents the energy that is borrowed from the source to build up electric or magnetic fields and is then returned to the source when the fields collapse. It does no real work.

31. In a series RC circuit, the impedance will decrease 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: The impedance is Z = sqrt(R squared + XC squared). As frequency increases, the capacitive reactance (XC) decreases. Since XC is one of the terms in the sum, the overall impedance Z will also decrease.

32. The quality factor (Q) of a parallel resonant circuit is a measure of the:

A) Current magnification

B) Voltage magnification

C) Power loss

D) Bandwidth

Answer: A) Current magnification

Explanation: In a parallel resonant circuit, the circulating current between the inductor and capacitor can be many times larger than the source current. The Q factor is the ratio of this circulating current to the source current.

33. A second-order filter is one that contains:

A) Two resistors

B) Two capacitors

C) Two independent energy storage elements (L or C)

D) Two op-amps

Answer: C) Two independent energy storage elements (L or C)

Explanation: The "order" of a filter is determined by the number of reactive (energy storage) components. A second-order filter, such as an RLC filter, has two such components, and its response has a steeper roll-off (40 dB/decade) than a first-order filter.

34. The admittance triangle is a right-angled triangle whose sides represent:

A) Resistance, reactance, and impedance

B) Conductance, susceptance, and admittance

C) True power, reactive power, and apparent power

D) Voltage, current, and power

Answer: B) Conductance, susceptance, and admittance

Explanation: The admittance triangle is the reciprocal of the impedance triangle. The horizontal side is conductance (G), the vertical side is susceptance (B), and the hypotenuse is admittance (Y).

35. The transient response of a circuit is also known as its:

A) Natural response

B) Forced response

C) Steady-state response

D) Sinusoidal response

Answer: A) Natural response

Explanation: The transient response is determined by the circuit's own components (R, L, C) and describes how the circuit naturally behaves as its stored energy dissipates. It is independent of the external source's form.

36. The total power in a balanced three-phase system is given by P = sqrt(3) * V_L * I_L * cos(phi), where phi is the angle between:

A) Line voltage and line current

B) Phase voltage and phase current

C) Line voltage and phase current

D) Phase voltage and line current

Answer: B) Phase voltage and phase current

Explanation: The power factor angle (phi) is always the phase difference between the voltage and current *within a single phase* of the load. The formula uses line quantities for convenience, but the angle is the phase angle.

37. The unit of charge, the Coulomb, is equivalent to:

A) Ampere-second

B) Ampere / second

C) Volt-second

D) Watt-second

Answer: A) Ampere-second

Explanation: Since current is the rate of flow of charge (I = Q/t), charge is the product of current and time (Q = I * t). Therefore, 1 Coulomb = 1 Ampere * 1 second.

38. A "linear" circuit is one whose parameters:

A) Are constant and do not change with voltage or current

B) Change linearly with temperature

C) Are all resistors

D) Are arranged in a straight line

Answer: A) Are constant and do not change with voltage or current

Explanation: In a linear circuit, the relationship between voltage and current is a straight line (e.g., a resistor). This is the key property that allows theorems like superposition to be applied.

39. The force between two parallel conductors carrying current in the same direction will be:

A) Attractive

B) Repulsive

C) Zero

D) Dependent on the resistance

Answer: A) Attractive

Explanation: The magnetic fields produced by the two wires interact. Using the right-hand rules, it can be shown that when the currents are in the same direction, the force pulls the wires together. If the currents are in opposite directions, the force is repulsive.

40. An AC current is given by i(t) = 5 sin(377t). The RMS value of the current is approximately:

A) 5 A

B) 10 A

C) 7.07 A

D) 3.54 A

Answer: D) 3.54 A

Explanation: The peak value is 5 A. The RMS value for a sine wave is the peak value divided by the square root of 2. I_rms = 5 A / 1.414, which is approximately 3.54 A.

41. A capacitor is labeled "104". This typically represents a capacitance of:

A) 104 pF

B) 10.4 nF

C) 100 nF

D) 1.04 F

Answer: C) 100 nF

Explanation: This is a standard EIA code. The first two digits are the significant figures (10), and the third digit is the multiplier (10^4). The value is 10 * 10^4 picofarads = 100,000 pF, which is equal to 100 nanofarads (nF) or 0.1 microfarads (uF).

42. Iron losses in a transformer consist of:

A) Hysteresis and copper losses

B) Copper and eddy current losses

C) Hysteresis and eddy current losses

D) Hysteresis and stray losses

Answer: C) Hysteresis and eddy current losses

Explanation: Both hysteresis loss (from realigning magnetic domains) and eddy current loss (from induced currents in the core) occur within the iron core of the transformer.

43. An "underdamped" response in an RLC circuit means the:

A) Damping ratio is greater than 1

B) Damping ratio is equal to 1

C) Damping ratio is less than 1

D) Resistance is zero

Answer: C) Damping ratio is less than 1

Explanation: A damping ratio of less than one indicates that there is not enough resistance to prevent the circuit from oscillating as the energy is exchanged between the inductor and capacitor. The oscillations decay over time.

44. In the two-wattmeter method, if the power factor is 0.5 lagging, one of the wattmeters will read:

A) The total power

B) Half the total power

C) Zero

D) A negative value

Answer: C) Zero

Explanation: The angle for a power factor of 0.5 is 60 degrees. The formulas for the two-wattmeter method show that when the phase angle is exactly 60 degrees, one of the wattmeters will read zero, and the other will read the total power.

45. The total impedance of a series RLC circuit is given by $Z = R + j(XL - XC)$. The term $(XL - XC)$ represents the:

A) Total resistance

B) Total reactance

C) Total admittance

D) Total power factor

Answer: B) Total reactance

Explanation: The imaginary part of the impedance is the total reactance (X). It is the difference between the inductive reactance (positive imaginary) and the capacitive reactance (negative imaginary).

46. In a DC circuit, after five time constants, a charging capacitor's voltage is approximately:

A) 63.2% of the source voltage

B) 86.5% of the source voltage

C) 95% of the source voltage

D) 99.3% of the source voltage

Answer: D) 99.3% of the source voltage

Explanation: The charging voltage is V(t) = V_source * (1 - e^(-t/tau)). At t = 5*tau, the value is (1 - e^-5), which is approximately 0.993. The capacitor is considered fully charged.

47. The primary purpose of a "damper winding" in a synchronous motor is to:

A) Increase the efficiency

B) Provide starting torque and reduce oscillations

C) Step up the voltage

D) Cool the machine

Answer: B) Provide starting torque and reduce oscillations

Explanation: Damper windings are bars embedded in the pole faces of the rotor. They act like the rotor of an induction motor to produce torque to start the motor. They also provide a damping effect to suppress hunting (oscillations) during operation.

48. A "passive" component is one that:

A) Does not require a power source to operate

B) Can provide power gain

C) Is only used in DC circuits

D) Has a constant resistance

Answer: A) Does not require a power source to operate

Explanation: Passive components like resistors, capacitors, and inductors do not have the ability to amplify or control power. Active components, like transistors and op-amps, require an external power source to function.

49. An electric field line and an equipotential line are always:

A) Parallel to each other

B) Perpendicular to each other

C) At a 45-degree angle

D) In the same direction

Answer: B) Perpendicular to each other

Explanation: An equipotential line connects points of the same voltage. Since the electric field points in the direction of the steepest voltage drop, it must be perpendicular to the line of no voltage change (the equipotential line).

50. The unit of magnetic field intensity or magnetizing force (H) is:

A) Weber

B) Tesla

C) Ampere-turns / meter

D) Henry

Answer: C) Ampere-turns / meter

Explanation: Magnetic field intensity (H) is a measure of the magnetomotive force per unit length of a magnetic path. It is independent of the core material.

51. The power dissipated by a resistor is converted into:

A) Heat energy

B) Magnetic energy

C) Electric energy

D) Potential energy

Answer: A) Heat energy

Explanation: When current flows through a resistor, collisions between the moving electrons and the atoms of the material generate thermal energy. This is known as Joule heating.

52. In a series-parallel circuit, the total current from the source is equal to the:

A) Current in the main series part of the circuit

B) Current in the parallel part of the circuit

C) Sum of the series and parallel currents

D) Average of all the branch currents

Answer: A) Current in the main series part of the circuit

Explanation: Any component connected in the main series path, before the circuit splits into parallel branches, must carry the full total current that is drawn from the source.

53. Millman's theorem is a special case of:

A) Nodal analysis

B) Mesh analysis

C) Thevenin's theorem

D) Superposition theorem

Answer: A) Nodal analysis

Explanation: Millman's theorem provides a shortcut formula for finding the voltage at a common node, but it can be derived by applying the formal steps of nodal analysis to a circuit with parallel voltage source branches.

54. The phase difference between the current in the inductor and the current in the capacitor in a parallel RLC circuit is:

A) 0 degrees

B) 90 degrees

C) 180 degrees

D) 270 degrees

Answer: C) 180 degrees

Explanation: The current in the inductor lags the source voltage by 90 degrees, while the current in the capacitor leads the source voltage by 90 degrees. Therefore, the inductor current and capacitor current are 180 degrees out of phase with each other.

55. The turns ratio of a transformer can be determined from the ratio of the:

A) Primary and secondary voltages at no-load

B) Primary and secondary currents at full-load

C) Primary and secondary resistances

D) Core area and winding area

Answer: A) Primary and secondary voltages at no-load

Explanation: The voltage ratio of a practical transformer is very close to its turns ratio when there is no load connected, because the internal voltage drops are negligible. This is the basis of the open-circuit test.

56. For a second-order RLC circuit, the damping is determined by the value of the:

A) Inductor

B) Capacitor

C) Resistor

D) Source voltage

Answer: C) Resistor

Explanation: The resistor is the only element in a standard RLC circuit that dissipates energy. The amount of resistance relative to the reactive components determines how quickly the oscillations in the circuit are damped out.

57. A balanced three-phase load is one in which all three phases have:

A) Equal impedances

B) The same voltage

C) The same current

D) A power factor of unity

Answer: A) Equal impedances

Explanation: This is the definition of a balanced load. If a balanced three-phase voltage is applied to a load with three identical phase impedances, then the resulting phase currents will also be identical (and balanced).

58. The property of a circuit that opposes changes in voltage is:

A) Resistance

B) Inductance

C) Capacitance

D) Reluctance

Answer: C) Capacitance

Explanation: A capacitor stores energy in an electric field created by voltage. Because it takes time to build up or reduce this stored energy, a capacitor opposes any attempt to change the voltage across it instantaneously.

59. In the two-wattmeter method, the total power is the:

A) Product of the two readings

B) Algebraic sum of the two readings

C) Vector sum of the two readings

D) Average of the two readings

Answer: B) Algebraic sum of the two readings

Explanation: The total three-phase power is simply P_total = W1 + W2. It is an algebraic sum, meaning if one wattmeter reads negative, its value is subtracted from the other.

60. Apparent power is so named because it:

A) Is the power that appears to be consumed by the load

B) Is the true power of the circuit

C) Has no real-world effect

D) Can only be seen with special instruments

Answer: A) Is the power that appears to be consumed by the load

Explanation: Apparent power (S = V * I) is the power that the source "thinks" it is delivering, based on the total voltage and current. However, due to the phase angle, not all of this apparent power is converted to true, useful work.