

ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING

UNIT – I

ELECTRICAL CIRCUITS AND FIELDS

KCL, KVL, Nodal & Mesh analysis, Transient response of D.C and A.C Networks; Sinusoidal steady-state analysis; Resonance in electrical circuits; Concepts of ideal voltage and Current sources, Network theorems, Driving point admittance and transfer functions of two port network, Three Phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectric, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, Inductance calculations for simple configurations.

1. Which of the following statements are true about an electric circuit? List all that apply.
 - A) Electrons are the mobile charge carriers in an electric circuit.
 - B) The path of charge flow from the + to the – terminal of the circuit can consist of nonconductive material.
 - C) In an electric circuit of an automobile, the 12-Volt car battery is sometimes referred to as the internal circuit because it is located inside of the hood of the car.

- D) Charge is supplied with energy in the internal circuit and the energy is transformed into other forms in the external circuit.
 - E) Charge is consumed as it moves through the energy-transforming devices of the external circuit. For instance, the amount of charge entering a light bulb in a second is less than that which exits the light bulb in a second.
 - F) A battery is used to power a flashlight circuit. When the battery no longer works, it is because it has run out of charge.
 - G) The location on an electric circuit where the charge possesses the greatest amount of electric potential energy is the + terminal of the battery.
2. Which of the following statements are true about an electric potential or electric potential difference? List all that apply.
 - A) Electric potential can be expressed in units of volts.
 - B) Electric potential can also be expressed in units of Joules.
 - C) The electric potential of a charge at a given location provides a measure of the rate at which charge flows past that point.
 - D) Work must be done on a + charge to move it *against* i.e, in the opposite direction of an electric field.
 - E) As a + charge moves in the same direction as an electric field, it gains electric potential.

1. (ADG) 2. (ADGHIJ)

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- F) The electric potential difference between two points is simply the difference in potential energy possessed by charge between those two points.
- G) If a unit of charge has a high electric potential at any given location, then that charge possesses a large amount of electric potential energy at that location.
- H) The + terminal of a battery is a location with a higher electric potential than the - terminal of a battery.
- I) Charge flowing through a battery will experience a gain in electric potential.
- J) A 6-Volt battery would provide 12 Joules of energy to 2 Coulombs of charge as it is moved from the - to the + terminal.
3. Which of the following statements are true about electric current? List all that apply.
- A) Electric current is measured in units of Amperes.
- B) Electric current and drift speed are synonymous terms.
- C) Electric current is defined as the number of Coulombs of charge which move past a point on a circuit.
- D) Electric current is equal to the number of Coulombs of charge which move past a point on a circuit per unit of time.
- E) Electric current provides a measure of how fast charge moves between two points on a circuit.
- F) The electric current diminishes in value as charge progresses to locations further and further from the + terminal of the battery.
- G) The electric current in a circuit will increase as the electric potential impressed across a circuit is increased.
- H) The electric current in a circuit will triple in value as the electric potential impressed across a circuit is increased by a factor of three.
- I) Suppose a miniature light bulb is connected to a battery in a circuit. A light bulb with a greater resistance will have a greater current.
- J) Wider conducting wires are capable of carrying larger currents.
- K) If one starts getting technical about the meaning of electric current, one could argue that electric current is not *something* that flows past a point on a circuit, but rather *something* that exists to a given measure at a point on a circuit.
4. Which of the following statements are true about an electric resistance? List all that apply.
- A) The resistance of an electric circuit is a measure of the overall amount of hindrance to the flow of charge through the circuit.
- B) A large resistance value indicates that the charge is encountering a relatively large amount of difficulty in moving through the circuit.
- C) The unit of resistance is the ampere
- D) A 5-ohm resistor would allow a current of 0.5 Amperes when 2.5 Volts is impressed across it.
- E) A 10-ohm resistor would allow a current of 2 Amperes when 5 Volts is impressed across it.
- F) The resistance of a conducting wire will increase as the length of the wire is increased.
- G) The resistance of a conducting wire will increase as the cross-sectional area of the wire is increased.
- H) Increasing the resistance of an electric circuit will cause the current in the circuit to increase.
- I) A threefold increase in the resistance of an electric circuit will result in a threefold decrease in the electric current.
- J) A miniature light bulb with a specific resistance is connected to a 1.5-Volt battery to form a circuit. If it were connected to a 6-Volt battery instead, its resistance would increase by a factor of
5. Which of the following statements are true about electric power and electric potential energy? List all that apply.
- A) Power is the amount of energy used by an electrical appliance.
- B) Power is the rate at which energy is used by an electric circuit.
- C) A kilo Watt hour is a unit of electric power.
- D) A Joule/second is a unit of power.

3. (ADGJHK)

4. (ABDFI)

5. (BDGJ)

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- E) A 60-Watt light bulb would *consume* 30 Joules of electrical energy in 2 seconds.
- F) A 120-Watt light bulb would *consume* 1200 Joules of electrical energy in 6 seconds.
- G) A charge moving through an electric circuit would gain electric potential energy in the internal circuit and lose electric potential energy in the external circuit.
- H) Charge has the greatest amount of electric potential energy at the - terminal of the battery.
- I) If a 60-Watt light bulb is placed in a 120-Volt circuit, then the current in the light bulb is 2 Amps.
- J) Consider two light bulbs with different power ratings. A 60-Watt light bulb has a greater resistance than a 100-Watt light bulb.
6. Which of the following statements are true about a series circuit? List all that apply.
- A) Series circuits are characterized by the fact that there is a single pathway by which charge can travel from the + terminal to the - terminal.
- B) During any single loop of charge around a series circuit, the charge will pass through each resistor in the circuit.
- C) The overall resistance of a circuit increases as more and more resistors are placed in series in the circuit.
- D) The total current in a circuit increases as more and more resistors are placed in series in the circuit.
- E) Suppose that three identical resistors with a resistance of 3-ohms are placed in series with a 12-Volt battery. The current in the circuit is 4 Amps.
- F) Suppose that three identical resistors with a resistance of 3-ohms are placed in series with a 12-Volt battery. The electric potential difference across each resistor is 12 Volts.
- G) Suppose that two identical resistors are placed in series with a 12-Volt battery. The current in the circuit is 6 amps. The resistance of each resistor is 4 ohms.
7. Which of the following statements are true about a parallel circuit? List all that apply.
- A) Parallel circuits are characterized by the fact that there are multiple pathways by which charge can travel from the + terminal to the - terminal.
- B) During any single loop of charge around a parallel circuit, the charge will pass through each resistor in the circuit.
- C) The overall resistance of a circuit increases as more and more resistors are placed in parallel in the circuit.
- D) The total current in a circuit increases as more and more resistors are placed in parallel in the circuit.
- E) Suppose that three identical resistors with a resistance of 3-ohms are placed in parallel with a 12-Volt battery. The current in the circuit is 1 Amp.
- F) Suppose that three identical resistors with a resistance of 3-ohms are placed in parallel with a 12-Volt battery. The electric potential difference across each resistor is 12 Volts.
- G) Suppose that two identical resistors are placed in parallel with a 12-Volt battery. The overall current in the circuit is 6 amps. The resistance of each resistor is 4 ohms.
8. If an electric circuit was analogous to a water park, then the battery would be analogous to the ____.
- A) pipes which carry the water through the water circuit
- B) pump which supplies energy to move the water from the ground to a high elevation
- C) the people which flow from the top of the water ride to the bottom of the water ride

6. (ABC)

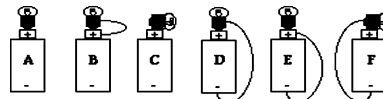
7. (ADFG)

8. (B)

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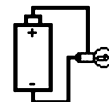
- D) the rate at which water is pumped onto the slide
 E) the change in potential energy of the riders
 F) the top of the water slide
 G) the bottom of the water slide
 H) the long lines which exist at the park
 I) the speed at which riders move as they slide from the top to the bottom of the ride
9. **If an electric circuit was analogous to a water park, then the positive terminal of the battery would be analogous to the ____.**
 A) pipes which carry the water through the water circuit
 B) pump which supplies energy to move the water from the ground to a high elevation
 C) the people which flow from the top of the water ride to the bottom of the water ride
 D) the rate at which water is pumped onto the slide
 E) the change in potential energy of the riders
 F) the top of the water slide
 G) the bottom of the water slide
 H) the long lines which exist at the park
 I) the speed at which riders move as they slide from the top to the bottom of the ride
10. **If an electric circuit was analogous to a water park, then the electric current would be analogous to the ____.**
 A) pipes which carry the water through the water circuit
 B) pump which supplies energy to move the water from the ground to a high elevation
 C) the people which flow from the top of the water ride to the bottom of the water ride
 D) the rate at which water is pumped onto the slide
 E) the change in potential energy of the riders

- F) the top of the water slide
 G) the bottom of the water slide
 H) the long lines which exist at the park
 I) the speed at which riders move as they slide from the top to the bottom of the ride
11. **The potential energy possessed per unit of charge at any given location is referred to as the electric ____.**
 A) current B) resistance
 C) potential D) power
12. **One ampere is the amount of current that exists when ____ flows by a certain point in a conductor in ____.**
 A) one watt; one second
 B) one joule; one hour
 C) one electron; one second
 D) one electron; one hour
 E) one volt; one second
 F) one volt; one hour
 G) one coulomb; one second
 H) one coulomb; one hour
13. **If 6 coulombs of charge flow past point 'A' in a circuit in 4 seconds, then ____ coulombs of charge will flow past point 'A' in 8 seconds.**
 A) 0.67 B) 1.5
 C) 2 D) 3
 E) 4 F) 6
 G) 8 H) 12
 I) 24
14. **In which of the following situations will the light bulb light? List all that apply.**



For Questions #15 to #17:

A simple circuit containing a battery and a light bulb is shown in the diagram at the right. Use this diagram to answer the next several questions.

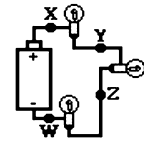


9. (F) 10. (D) 11. (C) 12. (G) 13. (H) 14. (DF)

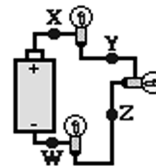
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15. The current through the battery is ____.
- greater than that through the light bulb
 - less than that through the light bulb
 - the same as that through the light bulb
 - greater than that through each wire
 - less than that through each wire
16. Charge flowing through this circuit is most energized at ____.
- Choose the one best answer.
- the + terminal of the battery
 - the - terminal of the battery
 - just prior to entering the light bulb
 - just after exiting the light bulb
 - ... nonsense! The energy of the charge is the same everywhere throughout the circuit.
17. The role or purpose of the battery in this circuit is to ____.
- Choose three.
- supply electric charge so that a current can exist
 - supply energy to the charge
 - move the charge from the - to the + terminal of the battery
 - transform energy from electrical energy into light energy
 - establish an electric potential difference between the + and - terminals
 - replenish the charge which is lost in the light bulb
 - offer resistance to the flow of charge so that the light bulb can get hot
18. A 12-Volt battery would supply ____.
- List all that apply.
- 3 Coulombs of charge with 4 Joules of energy
 - 4 Coulombs of charge with 3 Joules of energy
 - 12 Coulombs of charge with 1 Joule of energy
 - 1 Coulomb of charge with 12 Joules of energy
 - 0.5 Coulombs of charge with 24 Joules of energy
 - 24 Coulombs of charge with 2 Joules of energy

19. The charges that flow through the wires in your home ____.
- are stored in the outlets at your home
 - are created when an appliance is turned on
 - originate at the power (energy) company
 - originate in the wires between your home and the power company
 - already exist in the wires at your home
20. Approximately how long would it take an electron to travel from the battery of a car to a head light and back (complete loop)?
- seconds
 - hours
 - years
 - one-millionth of a second
 - one-tenth of a second
21. The electric circuit shown at the right consists of a battery and three identical light bulbs. Which of the following statements are true concerning this circuit? List all that apply.
- The current through point X will be greater than that through point Z.
 - The current through point Z will be greater than that through point Y.
 - The current will be the same through points X, Y and Z.
 - The current through point X will be greater than that through point Y.
 - The current through point Y will be greater than that through point X.



22. The electric circuit shown at the right consists of a battery and three identical light bulbs. Which of the following statements are true concerning this circuit? List all that apply.
- The electric potential difference between X and Y is more than that between Y and Z.
 - The electric potential difference between X and Z is more than that between Y and W.



15. (C) 16. (A) 17. (BCE) 18. (D) 19. (E) 20. (B) 21. (C) 22. (DE)

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- C) The electric potential difference between X and Y is the same as that between Y and Z.
D) The electric potential difference between X and Z is the same as that between Y and W.
E) The electric potential difference between Y and W is more than that between X and Y.
23. **The electric circuit shown at the right consists of a battery and three identical light bulbs. Which of the following statements are true concerning this circuit? List all that apply.**
A) Conventional current is directed through the external circuit from point X to Y to Z to W.
B) Conventional current is directed through the external circuit from point W to Z to Y to X.
C) Conventional current is directed through the internal circuit from point W to point X.
D) Conventional current is directed through the internal circuit from point X to point W.
E) The point where charge possesses the least amount of electric potential energy is point W.
24. **Voltage _____ an electrical circuit.**
A) goes through
B) is expressed across
C) is constant throughout
D) is the rate at which charges move through
25. **Two or more of the following words and phrases mean the same thing. Identify them by listing their letters.**
A) Voltage
B) Wattage
C) Electric Potential Difference
D) Rate at which charge flows
E) Electric Pressure
F) Energy
26. **A high voltage battery can _____.**
A) do a lot of work on each charge it encounters
B) do a lot of work over the course of its lifetime
C) push a lot of charge through a circuit
D) last a long time
27. **Which one of the following occurs when a rechargeable battery is recharged?**
A) The battery, which has run out of watts, has its wattage restored.
B) The battery, which has run out of amps, has current placed back into it.
C) The battery, which has run out of charge, has charge returned to it.
D) The battery, which has run out of chemical reactants, has its chemicals reformed.
28. **Birds can safely stand on high voltage electric power lines. This is because _____.**
A) they are at low potential with respect to the ground.
B) they offer no resistance to current.
C) they always choose power lines that are not in use.
D) the potential difference between their feet is low.
E) they are perfect insulators.
F) they are perfect conductors.
29. **When the light bulb in your lamp no longer works, it is because the bulb has _____.**
A) run out of energy and can no longer pump charge
B) run out of voltage and must be recharged
C) run out of electrons and so there is no more current
D) burned all of its watts and can no longer shine
E) tripped a circuit breaker and must be fixed at the fuse box
F) a broken filament which has resulted in an open circuit
G) ... nonsense! The bulb is fine; your family just needs to fully pay their power bill.

23. (ACE) 24. (B) 25. (ACE) 26. (A) 27. (D) 28. (D) 29. (F)