1.
Under which one of the following conditions does a transformer operate at maximum efficiency?

(1) Copper loss = iron loss
(2) Copper loss equals 1/4th of iron loss
(3) Copper loss equals half of iron loss
(4) Copper loss equals zero

Ans:1

2. Regulation of a transformer means –

(1) Change in primary voltage between no load and full load conditions
(2) Change in secondary voltage between no load and full load conditions
(3) Differential setting of the secondary voltage of the transformer
(4) De-rating of the transformer on account of increase in ambient temperature

Ans: 2

3. The rated full load current of an 11 kV/415 V, 250 kVA transformer is-

(1) 278 Amps
(2) 435 Amps
(3) 348 Amps
(4) 602 Amps

Ans: 3

4. The induced voltage on the secondary winding of a transformer depends upon

(1) No. of turns of secondary winding
(2) Flux in the core
(3) Frequency
(4) All of the above

Ans: 4

5. Which of the following is not an essential condition for satisfactory parallel operation of two transformers?

(1) Equal voltage ratios
(2) Same percentage impedance
(3) Same phase rotation
(4) Same KVA capacity

Ans: 4

6. No load losses of a transformer include-

(1) Hysteresis, eddy current, friction and windage losses
(2) Hysteresis, eddy current and windage losses
(3) Hysteresis and windage losses
(4) Hysteresis and eddy current losses

Ans: 4

7. Three transformers to 1:5 ratio is connected in Delta-Star formation. With an input voltage of 400 volt, the output voltage between two phases will be-

(1) 3464 volts (2) 138.6 volts
(3) 2000 volts (4) 1154.7 volts

Ans: 1

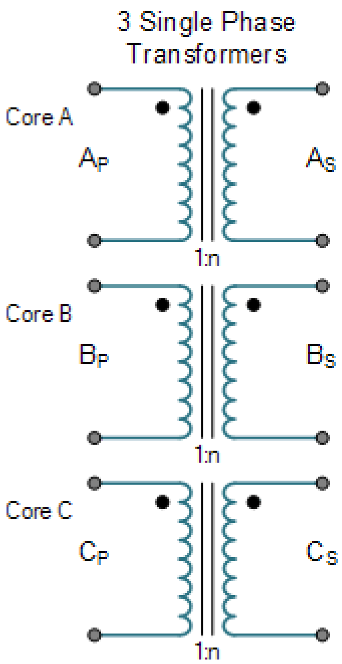
Three-phase or 3φ supplies are used for electrical power generation, transmission, and distribution, as well as for all industrial uses. Three-phase supplies have many electrical advantages over single-phase power and when considering three-phase transformers we have to deal with three alternating voltages and currents differing in phase-time by 120 degrees as shown below.

Three Phase Transformer Configuration.

A ***three phase transformer*** or 3φ transformer can be constructed either by connecting together three single-phase transformers, thereby forming a so-called three phase transformer bank, or by using one pre-assembled and balanced three phase transformer which consists of three pairs of single phase windings mounted on to one single laminated core.

The advantages of building a single three phase transformer is that for the same kVA rating it will be smaller, cheaper and lighter than three individual single phase transformers connected together because the copper and iron core are used more effectively. The methods of connecting the primary and secondary windings are the same, whether using just one **Three Phase Transformer** or three separate ***Single Phase Transformers***.

THREE PHASE TRANSFORMER CONNECTIONS



Primary Configuration	Secondary Configuration
Delta (Mesh) △	Delta (Mesh) △
Delta (Mesh) △	Star (Wye) Y
Star (Wye) Y	Delta (Mesh) △
Star (Wye) Y	Star (Wye) Y
Interconnected Star	Delta (Mesh) △
Interconnected Star	Star (Wye) Y

The primary and secondary windings of a transformer can be connected in different configuration as shown to meet practically any requirement. In the case of ***three phase transformer*** windings, three forms of connection are possible: "star" (wye), "delta" (mesh) and "interconnected-star" (zig-zag).

THREE PHASE TRANSFORMER STAR AND DELTA CONFIGURATIONS

A three phase transformer has three sets of primary and secondary windings. Depending upon how these sets of windings are interconnected, determines whether the connection is a star or delta configuration.

https://www.electronics-tutorials.ws/transformer/three-phase-transformer.html

8. For a transformation ratio k, the transformer secondary impedance has to be multiplied by the following factor to get its equivalent primary impedance-

(1) k^2 (2) $1/k$
(3) k (4) $1/k^2$

Ans: 4

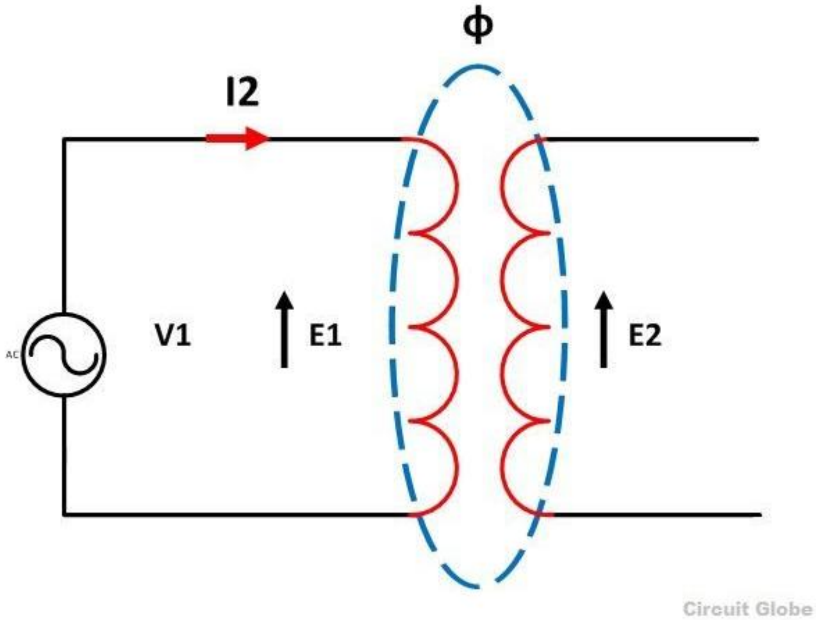
https://circuitglobe.com/working-principle-of-a-transformer.html

WORKING PRINCIPLE OF A TRANSFORMER

The basic principle on which the transformer works is **Faraday's Law of Electromagnetic Induction** or mutual induction between the two coils. The working of the transformer is explained below. The transformer consists of two separate windings placed over the laminated silicon steel core

The winding to which AC supply is connected is called primary winding and to which load is connected is called secondary winding as shown in the figure below. It works on the **alternating current only** because an alternating flux is required for mutual induction between the two windings.

When the AC supply is given to the primary winding with a voltage of V_1, an alternating flux ϕ sets up in the core of the transformer, which links with the secondary winding and as a result of it, an emf is induced in it called **Mutually Induced emf**. The direction of this induced emf is opposite to the applied voltage V_1, this is because of the Lenz's law shown in the figure below:



Physically, there is no electrical connection between the two windings, but they are magnetically connected. Therefore, the electrical power is transferred from the primary circuit to the secondary circuit through mutual inductance.

The induced emf in the primary and secondary windings depends upon the rate of change of flux linkage that is ($N\, d\phi/dt$).

$d\phi/dt$ is the change of flux and is same for both the primary and secondary windings. The induced emf E_1 in the primary winding is proportional to the number of turns N_1 of the primary windings ($E_1 \propto N_1$). Similarly induced emf in the secondary winding is proportional to the number of turns on the secondary side. ($E_2 \propto N_2$).

TURN RATIO

It is defined as the ratio of primary to secondary turns.

$$\text{Turn ratio} = \frac{N_1}{N_2}$$

If $N_2 > N_1$ the transformer is called **Step-up transformer**

If $N_2 < N_1$ the transformer is called **Step down transformer**

TRANSFORMATION RATIO

The transformation ratio is defined as the ratio of the secondary voltage to the primary voltage. It is denoted by K.

$$K = \frac{E_2}{E_1} = \frac{N_2}{N_1}$$

As ($E_2 \propto N_2$ and $E_1 \propto N_1$)

$$V_1 = Primary\ Voltage$$

$$V_2 = Secondary\ Voltage$$

$$I_1 = Primary\ Current$$

$$I_2 = Secondary\ Current$$

$$N_1 = Primary\ Winding\ Turns$$

$$N_2 = Secondry\ Winding\ Turns$$

$$\frac{N_1}{N_2} = \frac{I_2}{I_1} = \frac{V_1}{V_2}$$

……………………………

Coefficient of coupling	$k = \frac{\phi_{1-2}}{\phi_1}$
Mutual inductance	$L_M = k\sqrt{L_1 L_2}$
Turns ratio	$n = \frac{N_{sec}}{N_{pri}}$
Voltage ratio	$\frac{V_{sec}}{V_{pri}} = \frac{N_{sec}}{N_{pri}}$
Secondary voltage	$V_{sec} = nV_{pri}$
Current ratio	$\frac{I_{pri}}{I_{sec}} = n$
Secondary current	$I_{sec} = \left(\frac{1}{n}\right)I_{pri}$
Reflected resistance	$R_{pri} = \left(\frac{1}{n}\right)^2 R_L$
Turns ratio for impedance matching	$n = \sqrt{\frac{R_L}{R_{pri}}}$
Transformer efficiency	$\eta = \left(\frac{P_{out}}{P_{in}}\right)100\%$

9. If the efficiency of a transformer at full load 0.8 pf lagging is 95%, its efficiency at full load, 0.85 pf leading will be-

(1) 95% (2) 90%

(3) 85% (4) 100%

Ans: 1

10. Circular coil sections are used for transformer manufacture because they-

(1) Have toughest mechanical shape
(2) Are easy to form and wind
(3) Reduce eddy current losses
(4) Reduce copper losses

Ans: 1

11. In a two winding transformer with transformation ratio k, the induced emf per turn in secondary winding is-

(1) Greater than emf per turn in the primary winding
(2) Same as the emf per turn in the primary winding
(3) k times the emf per turn in the primary winding
(4) 1/k times the emf per turn in the primary winding

Ans: 2

12. Compared to the secondary side, the primary side of a step down transformer will have-

(1) Higher current and lower voltage
(2) Lower current and higher voltage
(3) Higher current and higher voltage
(4) Lower current and lower voltage

Ans: 1

13. A transformer has a core loss of 64 W and copper loss of 144 W while carrying and overload of 20%. The load at which the transformer will have maximum efficiency is-

(1) 120% (2) 66.67%
(3) 53.33% (4) 80%

Ans: 4

14. If a 500 kVA, 400 Hz transformer is operated at 100 Hz, the kVA rating will be-

(1) 500 kVA
(2) 125 kVA
(3) 2000 kVA
(4) 250 kVA

Ans: 2

15. In a D.C. generator, brushes are shifted from the geometric neutral positions to-

(1) Obtain the highest generated voltage
(2) Avoid sparking
(3) Reduce armature reaction
(4) Reduce field current

Ans: 2

16. If the armature current of a D.C. shunt motor having an armature resistance of 0.25 ohms increases from 40 Amps to 60 Amps, its back E.M.F decreases by-

(1) 5 Volts
(2) 10 Volts
(3) 15 Volts
(4) 125 Volts

Ans: 3

17. A four-pole lap wound armature has 480 conductors and a flux per pole of 25 m Wb. While running at 600 RPM, the emf generated will be-

(1) 30 Volts
(2) 60 Volts
(3) 120 Volts
(4) 240 Volts

Ans: 3

18. The speed of a DC motor is-

(1) Directly proportional to the emf as well as the flux
(2) Inversely proportional to the emf as well as the flux
(3) Directly proportional to the emf and inversely proportional to the flux
(4) Inversely proportional to the emf and directly proportional to the flux

Ans: 3

19. The mechanical power developed by a DC motor is maximum when the back emf is-

(1) Twice the applied voltage
(2) Same as the applied voltage
(3) Square root of applied voltage
(4) Half the applied voltage

Ans: 4

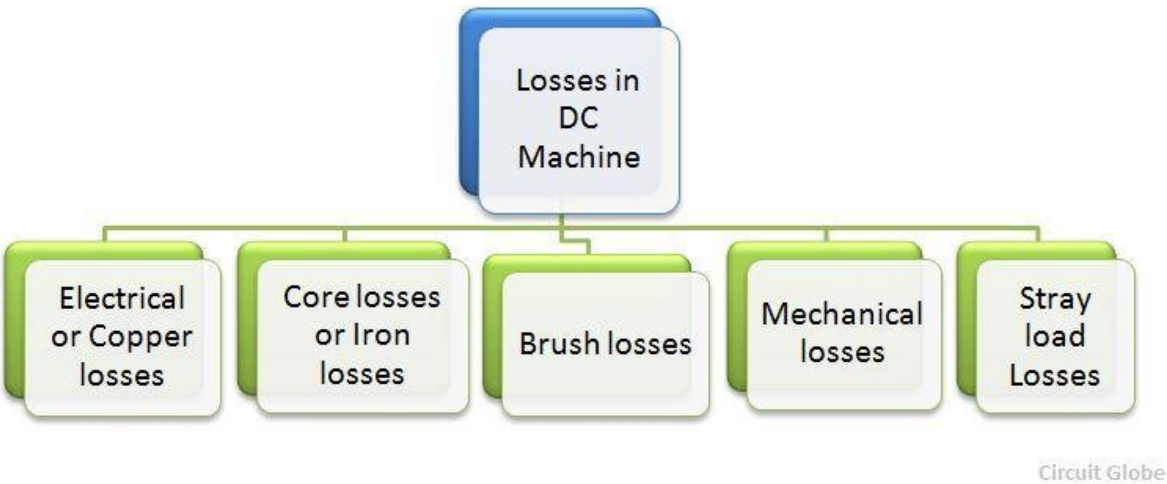
20. Hysteresis losses in a DC machine-

(1) Are not present
(2) Take place in the armature only
(3) Take place in the field poles only
(4) Take place both in field and armature

Ans: 2

LOSSES IN DC MACHINE

The **losses** that occur in a DC Machine is divided into five basic categories. The various losses are **Electrical** or **Copper losses** (I^2R losses), **Core losses** or **Iron** losses, **Brush** losses, **Mechanical** losses, **Stray** load losses. These losses are explained below in detail.



MAGNETIC LOSSES OR CORE LOSSES OR IRON LOSSES IN DC MACHINE

The core losses are the **hysteresis** and **eddy current** losses. These losses are considered almost constant as the machines are usually operated at constant flux density and constant speed. These losses are about 20 per cent of the full load losses.

Mechanical Losses in DC machine

The losses that take place because of the mechanical effects of the machines are known as mechanical losses. Mechanical losses are divided into bearing friction loss and windage loss. The losses occurring in the moving parts of the machine and the air present in the machine is known as Windage losses. These losses are very small.

Stray Losses in DC machine

These losses are the miscellaneous type of losses. The following factors are considered in stray load losses.

- The distortion of flux because of the armature reaction.
- Short circuit currents in the coil, undergoing commutation.

These losses are very difficult to determine. Therefore, it is necessary to assign the reasonable value of the stray loss. For most machines, stray losses are taken by convention to be one per cent of the full load output power.

https://circuitglobe.com/losses-in-dc-machine.html

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https://www.electricalexams.co/losses-in-dc-machine/

1. Hysteresis Losses
2. Eddy current Losses

Hysteresis Losses:-

- The armature core is made up of magnetic material and is subjected to variations in magnetic flux. When the armature rotates it comes under North and South poles alternately.
- Hysteresis loss occurs due to the alternate magnetization of the atoms, forming domains in the magnetic material of the core. Each domain behaves like a tiny magnet that aligns itself with the magnetic flux in which it is placed.
- As the flux changes its direction (due to the changing of position of the rotor when the rotor rotates), these tiny magnets rotate to and fro.
- Power is wasted due to this movement and this process develops heat in the armature core. Hysteresis loss depends upon flux density and frequency of variation of flux.
- When the armature core passes under one pair of poles, the core is said to complete one cycle of frequency reversal. The frequency of magnetic reversal $f = PN/120$ Hz, where P is the number of poles. N is the speed of the armature in RPM.

The Hysteresis Losses can be obtained as

Hysteresis Loss = $K_h.V.f.B_m^{1.6}$

Where

K_h = hysteresis constant given in J/m^2. Its value depends on the nature of the material.

Ke = constant called co-efficient of eddy current. Its value depends on the nature of the material.

V = volume of the magnetic material in m^3.

t = thickness of the lamination in m.. f = frequency of the magnetic reversal in cycles/second.

B_m = max. flux density in the magnetic material in Wb/m^2.

- These losses vary as the square of the flux density (B^2), volume of the core material and, for the rotor, as the 1.5th power of the speed of rotation ($n^{1.5}$).
- To reduce hysteresis losses, high-grade steel with higher silicon content is used to reduce the friction of the magnetic materials and therefore reduce the heat produced in changing the magnetic fields of the motor iron.

To reduce the eddy currents, the laminations are sliced thinner and electrically insulated from one another. In addition, by lengthening the core, there is less flux density in the core material and reduced losses due to magnetic effects.

Losses in DC machine cause 2 main effect:-

1. It increases the temperature inside the machine which affects the performance and life of the material of the machine, particularly insulation. Hence, the machine rating is directly affected by the losses.
2. Ultimately, losses are a waste of energy. In other words, it is a waste of money because these losses increase the operating cost of the machine.

TYPES OF LOSSES IN DC MACHINE

There are five categories of losses occurring in a dc motor similar to a dc generator.

1. Electrical or Copper losses (I^2R Losses)
2. Core Losses or Iron Looses
3. Mechanical losses
4. Brush Losses

5. Stray Load Losses

Electrical or Copper losses (I^2R Losses)

- Resistive losses in the armature and field windings of the machine are called electrical or copper losses or Ohmic losses.
- This loss varies with the variation of load on the machine and is called variable loss. When a motor is loaded, its armature current increases. This increases the losses due to the armature resistance, so the copper losses in a motor increase with load. It varies as the square of the load current. If the load current is halved, the $I^2_aR_a$ loss will be one-fourth and so on.
- For a shunt machine, the field copper loss will be constant if field resistance is not varied.
- The power lost across the contact potential at the brushes of the machine (brush losses) is also included in these losses.
- The resistance of the armature winding can be measured by the ammeter-voltmeter method. By knowing the value of R. at room temperature, its value at operating temperature can be calculated.
- This loss is about 20% to 30% of full-load losses.
- In general, the various cooper losses in the DC machine are as follows.
  1. Armature copper loss = $\mathbf{I^2_aR_a}$
  2. Shunt field copper loss = $\mathbf{I^2_{sh}R_{sh}}$
  3. Series field copper loss = $\mathbf{I^2_{se}R_{se}}$
  4. Interpole winding copper loss = $\mathbf{I^2_iR_i}$
  5. Brush contact loss = $\mathbf{I^2_aR_b = 2I_aV_b}$
  6. Compensating winding copper loss =$\mathbf{I^2_aR_c}$

Core Losses or Iron Looses

Core losses are also known as iron losses or Magnetic losses. Core losses can be classified into two types:-

To reduce the eddy currents, the laminations are sliced thinner and electrically insulated from one another. In addition, by lengthening the core, there is less flux density in the core material and reduced losses due to magnetic effects.

Eddy current loss:

Eddy current loss is due to the presence of circulating current in the core material. The armature core cuts the magnetic flux during its rotation and EMF is induced in the body of the core according to the laws of electromagnetic induction. This emf is very small but it sets up a large current in the body of the core. This EMF causes a circulating current i_c in the core which is wasted as $i_c^2.r_c$ and produces heat.

Eddy current losses can be obtained as

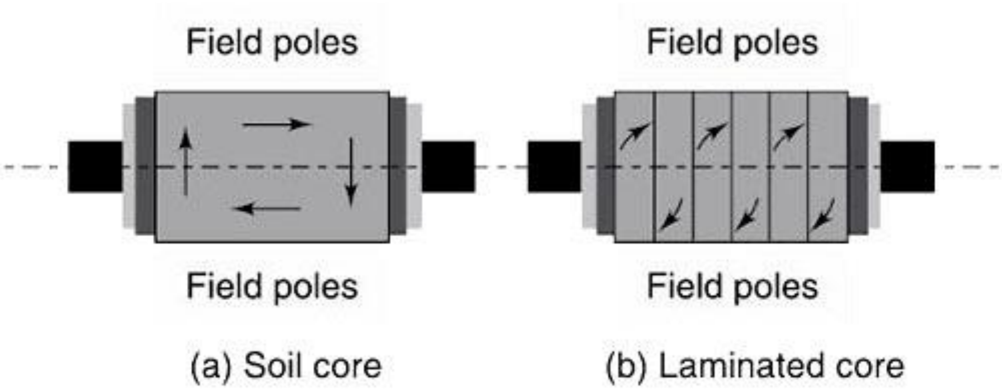
Eddy current losses = $K_e \times B_m^2 \times f^2 \times t^2$

Where

K_e = Eddy current constant

t = thickness of the core

B_m = max. flux density in the magnetic material in Wb/m^2.



Eddy current loss

Mechanical Losses:

The mechanical losses in a dc machine are the losses associated with mechanical effects. Mechanical losses occur at the bearing and shaft and air friction (windage loss) due to rotation of the armature.

There are two basic types of mechanical losses:

1. Friction
2. Windage.

Frictional losses take place due to the rotation of the armature. These losses are a bearing-friction loss, brush-friction loss, and windage-friction loss. Windage-friction loss takes place due to the rotation of the armature in air. Windage-friction loss is proportional to the cube of the speed. Brush-friction loss and bearing-friction loss are proportional to the speed. This loss is about 20%

Constant and Variable Losses

For a DC Machine,

Total Losses = Constant losses + Variable losses

Constant losses are those losses that always occur irrespective of the load conditions and whose value remains constant for a given machine. Mechanical losses, core losses, and shunt field copper losses are included in constant losses.

Variable losses are those losses which increase as the load on the machine is increased. They are electrical losses including armature copper losses, the field winding copper losses, interpole winding copper losses, compensating winding copper losses, and brush contact losses.

Copper losses increase proportionally to the square of the armature current while brush contact losses increase proportionally to armature current. At full load, constant losses are 4% to 20% and variable losses are 3% to 6%.

Stray load losses do not have a fixed value. They are somehow related to armature current and speed. Since they are complicated to compute and are very small in value, they are mostly ignored.

Brush Losses

The brush drop loss is the power loss across the contact potential at the brushes of the machine. It is given by the equation

$$P_{BD} = V_{BD}.I_A$$

Where

P_{BD} = Brush drop loss

V_{BD} = Brush Voltage drop

I_A = Armature current

Point to Remember

- Armature copper loss about 30 to 35% of full-load losses.
- Field copper loss about 20 to 30%t of full-load losses.
- Iron losses, about 20 to 30% of full-load losses.
- Mechanical losses, about 10 to 15% of full-load losses.

21. Commutation condition at full load of a large D.C machine can be checked by-

(1) Swinburne's test
(2) Brake test
(3) Hopkinson's test
(4) None of the above

Ans: 3.

22. The most economical method of braking a D.C motor is-

(1) Regenerative braking
(2) Dynamic braking with separate excitation
(3) Plugging
(4) Dynamic braking with self-excitation

Ans: 1

23. A DC motor draws a high current at the time of starting because-

(1) Back emf is more than the applied voltage
(2) Back emf is less than the applied voltage
(3) Back emf is zero
(4) Back emf is equal to applied voltage

Ans: 3

24. A DC series motor is provided with field diverter resistance. For a constant load torque, the speed will be minimum when value of the diverter resistance is equal to-

(1) Zero
(2) Infinity
(3) The field resistance
(4) The armature resistance

Ans: 2

25. The frequency of rotor current of a 50 Hz, 4-Pole induction motor running at 1440 RPM will be-

(1) 50 Hz
(2) 60 Hz
(3) 48 Hz
(4) 2 Hz

Ans: 4

26. A double cage rotor is used in squirrel cage induction motors to obtain-

(1) Higher starting torque (2) Lower starting currents
(3) Better power factor (4) Two different operating speeds

Ans:

27. Which one of following will be the normal operating speed of a 3 phase 415 V, 50 Hz, 4 pole induction motor-

(1) 2880 RPM (2) 1500 RPM
(3) 1460 RPM (4) 1520 RPM

Ans: 3

28. An additional resistance in the rotor circuit of a slip ring induction motor-

(1) Increases the starting torque (2) Reduces the starting torque
(3) Increases the full load torque (4) Increases the full load current

Ans: 1

29. What fits the following descriptions with respect to a three phase induction motor-
Maximum at standstill; Zero at synchronous speed; Very small at no-load operation-

(1) Torque (2) Frequency of rotor current
(3) Stator current (4) Speed of rotating stator flux

Ans: 2

30. The change in dimension in the process of magnetization is called-

(1) Skin effect (2) Magnetostriction
(3) Hall's effect (4) Piezoelectric effect

Ans: 2

31. Which of the following materials has the maximum magnetic permeability?

(1) Grain oriented silicon steel (2) Pure Iron
(3) 4% Silicon steel (4) None of the above

Ans: 1

32. High frequency transformer cores are generally made from-

(1) Nickel-iron alloy (2) Ferrites
(3) Nickel-cadmium alloy (4) Mu metal

Ans: 2

33. Which one of the following is added as a donor (n-type) impurity to a semiconductor-

(1) Boron (2) Silicon
(3) Germanium (4) Antimony

Ans: 4

34. Nichrome is the commonly used material for the manufacture of-

(1) Lamp filaments (2) Transformer windings
(3) Heater coils (4) Battery cell connectors

Ans: 3

35. A passive network has-

(1) Only one or more current sources in it
(2) Only one or more voltage sources in it
(3) Neither current nor voltage sources in it
(4) Both current and voltage sources in it

Ans: 3

36. A measured AC voltage of 30 Volt, 50 Hz can be represented mathematically, with respect totiem 't' as-

(1) 30 sin 50 t (2) 52 sin 50 t
(3) 52 sin 314 t (4) 42 sin 314 t

Ans: 4

37. The power factor of a circuit having a 90 ohm resistance in series with a 90 ohm

reactance is-

(1) 0.5 (2) 127.3
(3) 0.707 (4) 45.0

Ans: 3

38. The approximate power factor of an incandescent lamp is-

(1) 0.6 (2) 0.7
(3) 0.2 (4) 1.0

Ans: 4

39. A smoothing filter for DC power supply will have-

(1) Inductance and capacitance in series
(2) Inductance and capacitance in parallel
(3) Inductance in series and capacitance in parallel
(4) Inductance in parallel and capacitance in series

Ans: 3

To smooth the output of the rectifier a reservoir capacitor is used - placed across the output of the rectifier and in parallel with the load.

https://www.electronics-notes.com/articles/analogue_circuits/power-supply-electronics/capacitor-smoothing-circuits.php

40. The AC resistance of conductor is more than the DC resistance due to-

(1) Ferranti effect (2) Skin effect
(3) Thermionic effect (4) Hall effect

Ans: 2

41. In an AC circuit, the ratio of KWh/KVAh represents the-

(1) Power factor (2) Load factor
(3) Form factor (4) Diversity factor

Ans: 1

42. Which law states that the vector sum of voltages in any closed circuit is equal to zero?

(1) Ohm's law (2) Thevenin's theorem
(3) Lenz's law (4) Kirchoff's law

Ans: 4

43. What is the impendence of an inductance of 0.02 Henry at 50 Hz?

(1) 6.28 ohms (2) 1 ohm
(3) 3.14 ohms (4) 2 ohms

Ans: 4

44. If three impedances – one purely resistive, one purely inductive and one purely capacitive, each of 10 ohms value is connected in series and a 30 V, 50 Hz supply applied across it, the resultant current will be-

(1) 10 amps at u p f (2) 10 amps at 45^0 lag
(3) 1 amp at u p f (4) 1 amp at 45^0 lag

Ans: 1

45. Which type of rotor is most suitable for turbo-alternators that are designed to run at high speeds?

(1) Salient pole type
(2) Cylindrical pole type
(3) Both salient and cylindrical pole type
(4) None of the above

Ans: 2

46. For synchronizing two alternators, which of the following is not a requisite condition?

(1) Bothe machines generate at the same frequency
(2) Both machines have the same per unit reactance
(3) Both voltages have the same phase rotation
(4) Both the voltages are equal in magnitude

Ans: 2

47. A 10 pole, 25 Hz alternator is directly coupled to and is driven by a 60 Hz synchronous motor. The number of poles in the synchronous motor is-

(1) 48 poles
(2) 36 poles
(3) 12 poles
(4) 24 poles

Ans: 4

48. For a synchronous motor, the inverted V-curve is the relation between-

(1) Field current and power factor
(2) Field current and armature current
(3) Armature current and power factor
(4) Armature voltage and field current

Ans: 1

49. The magnitude of induced emf in the stator of a synchronous motor-

(1) Is equal to the supply voltage
(2) Is lower than the supply voltage
(3) Is higher than the supply voltage
(4) May be higher or lower than supply voltage

Ans: 4

50. A spark gap is provided across insulators to-

(1) Increase the breakdown strength
(2) Protect against surge voltages
(3) Reduce corona effect
(4) Increase the creepage distance

Ans: 2