Model Sets-1

Electrical Motors and Transformer

Q1. Choose the most suitable answer from the following options:

(i) In D.C.machines lap winding is employed for setting:

(a) High current and low voltage rating
(b) Low current and high votage rating
(c) High current and high voltage rating
(d) Low current and low voltage rating

Ans.(a)

(ii) The commutator of a D.C. motor is used to:

(a) Convert A.C. into D.C. (b)Convert D.C. into A.C.
(c) Reduce friction (d) Avoid are at brushes

Ans.(b)

(iii) Armature of a D.C. machine is made of:

(a)Conducting material of platinum (b) Insulating material
(c)Non-Ferrous material (d) Silicon steel

Ans.(d)

(iv) Sparkless commutation can be achieved by using:

(a) Interpoles (b) Compensating winding
(c) High resistance carbon brushes
(d) Any of the above methods

Ans.(a)

(v) In D.C. shunt motor,the torque developed before magnetic saturation is:

(a) Inversely proportional to armature current
(b) Directly proportional to armature current
(c) Inversely proportional to square of armature current
(d) Directly proportional to square of armature current

Ans.(b)

(vi) The current drawn by a 120V D.C. motor with a back emf of 110V and armature resistance of 0.4 Ohm is:

(a) 4A (b) 25A (c) 275 A (d) 300 A

Ans.(b)

(vii) A.D.C.shunt motor may have rising speed-torque characteristics due to:

(a) Very high armature circuit resistance
(b) Very high field circuit resistance
(c) Very high demagnetising armature reaction
(d) Very low demagnetising armature reaction

Ans.(c)

(viii)The function of a starter in D.C. moto is to:

(a) Control it's sped
(b) Increase it's starting torque
(c) Limit the starting current to a safe value
(d) Reduce the armature reaction effect

Ans.(c)

(ix)The mutual flux in a loaded transformer can be varied by varying:

(a) Primary current
(b) Load impedance
(c) Secondary current
(d) Reluctance of magnetic path

Ans.(d)

(x) The core flux of transformer:

(a) Remains constant with load changes
(b) Increase linearly with load
(c) Decrease linearly with load
(d) Increase as the square root of load

Ans.(a)

(xi)The short circuit test on a transformer gives:

(a) Core loss (b) Copper loss
(c) None of (a) and (b) (d) Both (a) and (b)

Ans.(b)

(xii)A distribution transformer is selected on the basis of:

(a) Voltage regulation (b) Efficiency
(c) All day efficiency (d) Power factor

Ans.(c)

(xiii)If iron core o a transformer be replaced by an air core, then hysteresis loss will:

(a) Become zero (b) Increasee
(c) Decreaase (d) Remain unchanged

Ans.(a)

(xiv) Open circuit test in a transformer is performed with:

(a) Rated transforrmer voltage(b) Rated transformer current
(c) Direct current (d) High frequency supply

Ans.(a)

(xv) Auto transforrmer is basically a:

(a) Single winding transformer
(b) Two winding transformer
(c) Three winding transformer
(d) Any of the above

Ans.

(xvi)If rated D.C. voltage is applied to the primary of a transformer in-stead of rated A.C. voltage,then:

(a) Secondary of transformer will burn
(b) Primary of transformer will burn
(c) Secondary voltage will be excessively high
(d) None of these

Ans.(b)

(xvii)A 1 KVA,230V,50Hz,1-ϕ transformer has eddy current loss of 30W.If it is excited by D.C. source it's value will be:

(a) 30W (b)>30W (c)<30W (d)Zero

Ans.(d)

(xviii)The two winding of a transformer are:

(a) Conductively linked (b) Inductively linked
(c) Electrically linked (d) Not linked at all

Ans.(b)

(xix)Which 3- phase connection of transformer create a phase-difference of 30^0 between output and corresponding input line voltages?

(a) Star-star (b)Star-delta
(c) Delta- delta (d)Delta-star

Ans.(b)

(xx) In welding transformer:

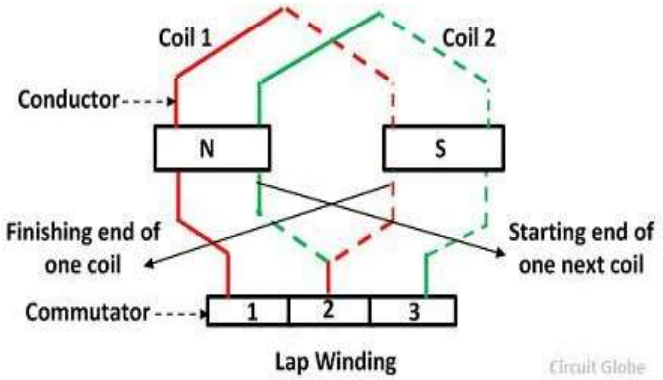
(a) N_1 much larger than N_2 (b) N_2much larger than N_1
(c) $N_1=N_2$ (d) There is no any rule

Ans.

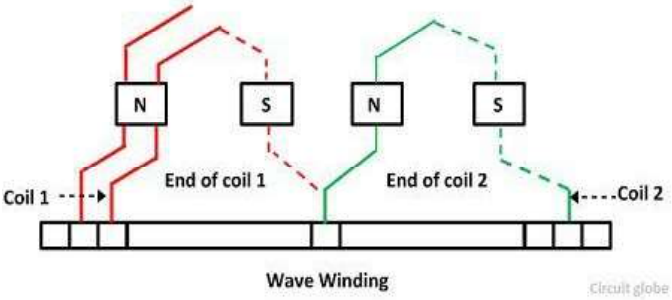
Group-B

Q2.Explain the terms 'Lap winding' an 'Wave winding'with neat sketches.

Ans.Lap Winding: In lap winding, the conductors are joined in such a way that their parallel paths and poles are equal in number. The end of each armature coil is connected to the adjacent segment on the commutator. The number of brushes in the lap winding is equal to the number of parallel paths, and these brushes are equally divided into negative and positive polarity.lap-windingThe lap winding is mainly used in low voltage, high current machine applications.



Wave Winding: In wave winding, only two parallel paths are provided between the positive and negative brushes. The finishing end of the one armature coil is connected to the starting end of the other armature coil commutator segment at some distance apart.wave-windingIn this winding, the conductors are connected to two parallel paths irrespective of the number of poles of the machine. The number of brushes is equal to the number of parallel paths. The wave winding is mainly used in high voltage, low current machines.



OR

Q2.What is reactance voltage?Explain how interpoles help in reducing effect of armature reaction?

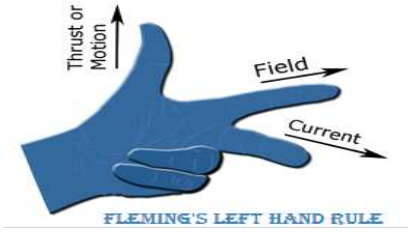
Ans.Reactance Voltage: The voltage rise in the short circuit coil due to inductive property of the coil, which opposes the current reversal in it during the commutation period, is called the reactance voltage.

Interpoles: Interpoles are similar to the main field poles and located on the yoke between the main field poles.They have winding in series with the armature winding.

Interpoles have the function of reducing the armature reaction effect in the commutating zone. They eliminate the need to shift the brush assembly.

Q3.State Fleming's right hand rule.

Ans. Fleming's Left-hand Rule:



When a current carrying conductor such as a wire attached to a circuit moves placed in a magnetic field, an electric current is induced in the wire due to Faraday's law of induction.

Then the left hand is held with the thumb, first finger and second finger mutually perpendicular to each other than the thumb is pointed in the direction of the motion of the conductor relative to the magnetic field i.e direction of the force.

The forefinger is pointed in the direction of the magnetic field.

The middle finger represents the direction of the induced or generated current within the conductor.

OR

Q3.A 200 D.C. shunt motor runs at 600 rpm and draws on armature current of 40 A. Calculate it's speed

when torque is doubled.Given that armature resistance is 0.2 Ohm.

Ans. $T_a \alpha \varphi I_a$

$T_{a2} = 2 T_{a1}$

Therefore,

$$\frac{T_{a2}}{T_{a1}} = 2$$

$$\frac{I_{a2}}{I_{a1}} = \frac{T_{a2}}{T_{a1}}$$

$$\Rightarrow \quad I_{a2} = 80A$$

Using $E_b = V - I_a R_a$

$E_{b2} = 200 - 80 \times 0.2 = 184\,V$

$E_{b1} = 200 - 40 \times 0.2 = 192\,V$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}}$$

$$N_2 = \frac{184}{192} \times 600 = 575\,\text{rpm}$$

Q4.Derive expression for magnetising current working component of current,no-load current and no -load power factor for a transformer on no-load.Draw it's vector diameter.

Ans. Refers to Chapter

OR

Q4.A 50 KVA single phase transforrmer has 1000turns on primary and 200turns on secondary.The primary is connected to 1500V,50Hz supply.Find full load primary and secondary currents and maximum flux in the core.

Ans.Given: Transformer kVA= 50kVA

Primary turns(N_1) = 1000

Secondary turns(N_2) =200

Primary input voltage (V_1) = 1500V

Frequency(f) =50Hz

Secondary voltage:

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

$$\Rightarrow \quad V_2 = \frac{N_2}{N_1} \times V_1$$

$$V_2 = \frac{200}{1000} \times 1500 = 300\,V$$

Primary current $(I_1) = \frac{kVA}{V_1} = \frac{50000}{1500} = 33.33V$

Secondary current $(I_2) = \frac{kVA}{V_2} = \frac{50000}{300} = 166.67V$

We have emf equation for transformer as follows,

$$V_1 = 4.44 \varphi f N_1$$

Where φ is maximum flux

Therefore,

$$\varphi = \frac{V_1}{4.44 f N_1} = \frac{1500}{4.44 \times 50 \times 1000} = 0.00676\,\text{weber}$$

Q5.Explain with neat sketch,the short-circuit test of a two winding transformer.

Ans. Refers to Chapter

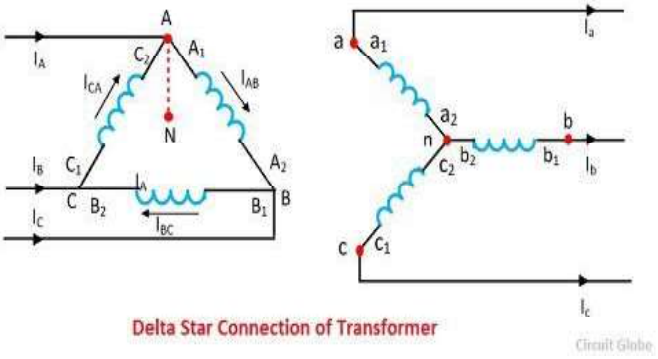
OR

Q5.Explain the principle of operation of auto transformer.What are the merits of auto transformer?

Ans. Refers to Chapter

Q6.Draw the circuit diagram of three-phase delta-star transformer?

Ans. The Δ-Y connection of the three winding transformer is shown in the figure below. The primary line voltage is equal to the secondary phase voltage. The relation between the secondary voltages is $V_{LS} = \sqrt{3}\ V_{PS}$.



OR

Q6.Write the uses of:

(a) Potential transformer

(b) Welding transformer

Ans.(a) Potential transformer

(i) It is used for a metering purpose.

(ii) For the protection of the feeders.

(iii) For protecting the impedance of the generators.

(iv) For synchronising the generators and feeders.

Ans.(b)Welding transformer: Welding Transformers are used in AC machines to change alternating current from the power line into a low-voltage, high amperage current in the secondary winding.

Group-C

Q7.Explain the advantages of using graphite brushes instead of copper brushes in D.C. machines?

Ans.The advantages of using graphite brushes instead of copper brushes in D.C. machines are :

1. **High Melting Point:**The carbon metal is generally having high melting point compared to copper as well as other metal. The carbon brush is having almost 3550 degree C melting temperature and copper having 1080 degree C only. We all know the brushes in dc motor linked to nearly to the commutator. So whenever motor running it will create the spark and friction amid brushes and commutator. If temperature is increase then copper brush cannot with stable that's why we are using these brushes.
2. **Soft metal:**The carbon brush is usually very soft metal compared to copper. So whenever the motor running the friction produced amid brush and commutator. As per the softness of the brush will be not damage the commutator. Incase if we are using copper brush it will spoil the commutator because of its hardness.
3. **Negative temperature co-efficient:**The carbon brush is having negative temperature co-efficient. It means whenever the temperature increases then resistance repeatedly reduced. We know motor running time friction and heat produced and it will increase the temperature of the motor. So, carbon brush reduced resistance due to mounting temperature and current surge will increases.
4. **Shape adopting:**The carbon brush usually coming with rectangular shape but it's having elasticity nature. If we will fix the new the brush near to the commutator as well as once the motor starts to running its automatically adopt the circular shape of commutator.
5. **Self lubricating:**The carbon brush as well as Evolution Brushes is having self lubricating. So it's not required any other Greece or lubricating oil for cooling purpose. So whenever the motor gets off then carbon brushes are automatically get cool down.

OR

Q7.A 4 pole lap connected D.C. machine has an armature resistance of 0.3 Ohm.Find the armature resistance of the machine if it is re-wound for wave connetion.

Ans.Given:

For Lap winding

P=4

Ra =0.3 ohm

$\therefore$ $A_L = P = 4$

For wave winding

$A_W = 2$

Now , we know that

$$\frac{I_{aL}}{I_{aW}} = \frac{A_L}{A_W}$$

$$\frac{I_{aL}}{I_{aW}} = \frac{4}{2}$$

As per question

$$P_{Lap} = P_{Wave}$$

$$I_{aL}^2 R_{aL} = I_{aW}^2 R_{aW}$$

$$R_{aW} = \left(\frac{I_{aL}}{I_{aW}}\right)^2 \times R_{aL}$$

$$R_{aW} = \left(\frac{4}{2}\right)^2 \times 0.3 = 1.2\Omega$$

Q8.Write the applications of:

(a) D.C. series motor

(b) D.C.shunt motor

(c) D.C. differentially compounded motor

Ans.(a) D.C. series motor: These motors are very useful for the applications requiring high starting torque like traction, lifts,hoists, cranes.They are also commonly used for conveyors and in rolling mills.

Ans.(b) D.C.shunt motor: Being constant-speed motors, they are commonly employed for the following applications:

Lathes, driling machines,grinders, shapers, planers, milling machines, metal cutting machines, wood working machines, fans, blowers, compressors, conveyors, vaccum cleaners, centrifugal and reciprocating pumps, etc.

Ans.(c) D.C. differentially compound motor: Cumulative compound motors are suitable for applications requiring a high starting torque and particularly under fluctuating load conditions.They have the advantage over the series motors of a stable no load speed.Some of their applications are:

Driving of steel rolling mills, elevators, punches, shears, conveyors heavy planers, strokers, presses.

Differential compound motors have low starting torque.They are, therefore, rarely used in actual practice.

OR

Q8.A 100KW transformer has a maximum efficiency of 98% at full load. The transformer is on full load for 4hours, on half the full-load for 6hours and one tenth full-load for 14hours per day. Find the all-day efficiency.

Ans.Given:

$Output = 100KW, \eta = 95\%$

$Input = \frac{100}{0.98} = 102.04Kw$

$\therefore Total\ \ loss = 102.04 - 100 = 2.04KW = 2040W$

$\therefore Iron\ \ loss = \frac{2040}{2} = 1020W = 1.02KW$

$F.L.\ copperloss = 1020W = 1.02KW$

Energy Output :

$100 \times 4 + 50 \times 6 + 10 \times 14 = 400 + 300 + 140 = 840kwh.$

$Energy\ Iron\ loss = \frac{1020 \times 24}{1000} = 24.48kwh$

$Energy\ copper\ loss = 1.02 \times 4 + \left(\frac{50}{100}\right)^2 \times 1.02 \times 6 + \left(\frac{1}{10}\right)^2 \times 1.02 \times 100$

$=840+24.48+5.7528=870.2328$

$\therefore$ All day efficiency

$= \frac{Energy\ \ output\ \ for\ \ 24\ \ hours}{Energy\ \ input\ \ for\ \ 24\ hrs.} = \frac{840}{870.2328} = 0.965258$

or, 96.526%

Q9.Derive expression for turn-ratio of a two-winding transformer.

Ans. Refers to Chapter

OR

Q9.What will happen if D.C. series motor run on No-load?Explain armature control method of speed control of D.C. series motor.

Ans. If the DC Series Motor is started at No Load then the motor will speed up to its no-load speed, which may damage the motor. At no-load, the load is actually whatever friction is in the motor such as from bearings, brushes, and air resistance. This friction mostly heats the motor. The motor will speed up to its no-load speed, which may damage the motor.

Armature control method of speed control of D.C. series motor: Refers to Chapter

Q10.A single phase transformer with voltage ratio of 440 V/110V takes a no-load current of 5 A at 0.2 p.f. lagging.If secondary supplies a current of 120A at p.f.of 0.8 lagging,calculate it's primary current.

Ans. $\cos\varphi_2 = 0.8$

$\varphi_2 = \cos^{-1}(0.8) = 36^0 54'$

$\cos\varphi_0 = 0.2$

$\therefore \quad \varphi_0 = \cos^{-1}(0.2) = 78^0 30'$

$K = \frac{V_2}{V_1} = \frac{110}{440} = \frac{1}{4}$

$I_2' = KI_2 = 120 \times \frac{1}{4} = 30\,A$

$I_0 = 5\,A$

Angle between I_0 and I_2'

$= 78^0 30' - 36^0 54' = 41^0 36'$

Using parallelogram law of vectors, we get

$I_1 = \sqrt{5^2 + 30^2 + 2 \times 5 \times 30 \times \cos 41^0 36'} = 34.45\,A$

Q11.Explain the following terms:

(a) Current transformer

(b) 3-phase Auto transformer

Ans.(a) Current transformer: Refers to Chapter

Ans.(b) 3-phase Auto transformer: Refers to Chapter

OR

Q11.Explain the following terms

(a) Isolation transformer

(b) Application of 3-phase auto transformer

Ans.(a) Isolation transformer: Refers to Chapter

Ans.(b) Application of 3-phase auto transformer: Refers to Chapter

Model Sets-2

Electrical Motors and Transformer

Group-A

Q1.Choose the most suitable answer from the following options:

(i) In D.C machines, wave winding is employed for geeting

(a) High current and Low voltage rating
(b) Low current and High voltage rating
(c) High current and High voltage rating
(d) Low current and Low voltage rating

Ans.(b)

(ii) The number of parallel paths for a 6 pole duplex lap winding will be

(a) 2 (b) 6 (c) 12 (d) 24

Ans.(c)

(iii) Which of the following is not a part of D.C machine?

(a) Field winding (b) Armature
(c) Commutator (d) Damper winding

Ans.(d)

(iv) In D.C machines, the sparking at the brushes is due to

(a) Armature Reaction
(b) Presence of Commutator
(c) Reactance voltage
(d) High Resistance carbon brushes

Ans.(c)

(v) In D.C series motor, the Torque developed before magnetic saturation is :

(a) Inversely proportional to armature current
(b) Directly proportional to armature current
(c) Inversely proportional to square of armature current
(d) Directly proportional to square ofarmature current

Ans.(b)

(vi) The speed of a 4-pole D.C series motor at no-load will be

(a) Zero (b) 1500 rpm
(c) 3000 rpm (d) enormously high

Ans.(d)

(vii) The Torque speed characteristics of a D.C shunt motor is

(a) Rectangular hyperbola
(b) A parabola
(c) A drooping straight line
(d) A rising straight line

Ans.(c)

(viii) A 3-point startor is considered suitable for which D.C motor?

(a) Series (b) Shunt
(c) Series as well as compound
(d) Shunt as well as compound

Ans.(d)

(ix) The Inductive Reactance of a Transformer depends on :

(a) EMF (b) MMF
(c) Magnetic flux (d) Leakage flux

Ans.(d)

(x) A transformer is supplying purely resistive load .The power factor on primary side will be :

(a) About 0.95 (Lagging)
(b) About 0.95 (Leading)
(c) Unity (d) Zero

Ans.(a)

(xi) The open circuit Test on a transformer gives:

(a) Core loss (b) Copper loss
(c) Both (a) & (b) (d) None of these

Ans.(a)

(xii) The all day efficiency of a distribution transformer will be high with low

(a) Copper loss (b) Iron loss
(c) Operating temperature
(d) Copper as well as Iron loss

Ans.(b)

(xiii) Eddy current loss in a transformer is reduced when:

(a) Laminations are thin
(b) Laminations are thick
(c) Primary winding number of turns are reduced
(d) Secondary winding number of turns are reduced

Ans.(a)

(xiv) During short circuit test, core loss is negligible because:

(a) Voltage applied across H.V side in very small and hence small mutual flux
(b) Current on L.V side is very small
(c) Power factor is high
(d) Iron becomes completely saturated

Ans.(a)

(xv) In Auto transformer, the power is transferred to load circuit:

(a) Entirely conductively (b) Entirely inductively
(c) By both conduction & Induction
(d) None of these

Ans.(c)

(xvi) The iron core in a transformer provides.....path to the main flux.

(a) Low reluctance (b) High reluctance

(c) Low resistance (d) High resistance

Ans.(a)

(xvii) At 50Hz, a single phase transformer has hysteresis loss of 200W and eddy current loss of 100W.Core loss at 60Hz operation will be:

(a) 432watt (b) 384watt

(c) 200 watt (d) 100watt

Ans.(b)

(xviii) In ideal transformer, windings should have

(a) Maximum resistance on primary side and least resistance on secondary side

(b) Least resistance on primary side and maximum resistance on secondary side

(c) Equal resistance on either side.

(d) No ohmic resistance on either side.

Ans.(d)

(xix) Which of the following connection of a transformer will give highest secondary voltage

(a) Primary delta,secondary delta

(b) Primary delta,secondary star

(c) Primary star,secondary star

(d) Primary star, secondary delta

Ans.(b)

(xx) Instrument transformers are used on a.c circuits for extending the range of

(a) Ammeters (b) Voltmeters

(c) Wattmeters (d) All of the above

Ans.(d)

Group-B

Q2.Explain different types of d.c machines with the help of block diagrams.

Ans. Each DC machine can act as a generator or a motor. Hence, this classification is valid for both: DC generators and DC motors. DC machines are usually classified on the basis of their field excitation method. This makes two broad categories of dc machines; (i) Separately excited and (ii) Self-excited.

Separately excited DC machines: In separately excited dc machines, the field winding is supplied from a separate power source. That means the field winding is electrically separated from the armature circuit. Separately excited DC generators are not commonly used because they are relatively expensive due to the requirement of an additional power source or circuitry. They are used in laboratories for research work, for accurate speed control of DC motors with Ward-Leonard system and in few other applications where self-excited DC generators are unsatisfactory. In this type, the stator field flux may also be provided with the help of permanent magnets (such as in permanent magnet DC motors). PMDC (permanant magnet DC) motors are popularly used in small toys, e.g. a toy car.

Self-excited DC machines: In this type, field winding and armature winding are interconnected in various ways to achieve a wide range of performance characteristics (for example, field winding in series or parallel with the armature winding).

In a self-excited type of DC generator, the field winding is energized by the current produced by themselves. A small amount of flux is always present in the poles due to the residual magnetism. So, initially, current induces in the armature conductors of a dc generator only due to the residual magnetism. The field flux gradually increases as the induced current starts flowing through the field winding.

Self-excited machines can be further classified as –

Series wound dc machines – In this type, field winding is connected in series with the armature winding. Therefore, the field winding carries whole of the load current (armature current). That is why series winding is designed with few turns of thick wire and the resistance is kept very low (about 0.5 Ohm).

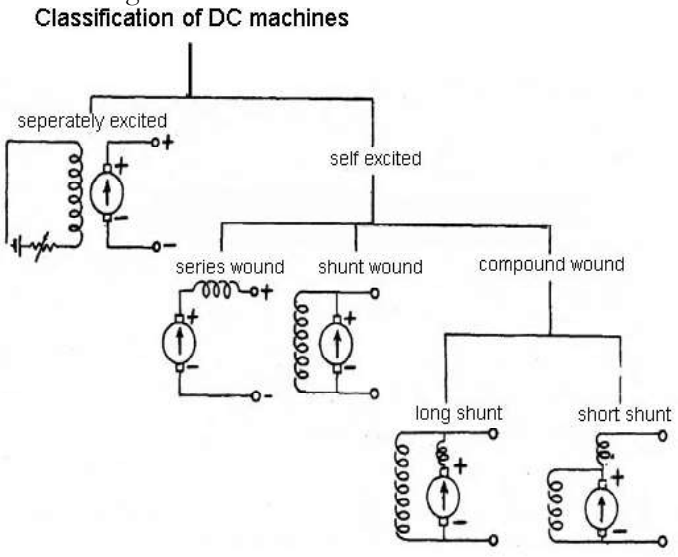
Shunt wound dc machines – Here, field winding is connected in parallel with the armature winding. Hence, the full voltage is applied across the field winding. Shunt winding is made with a large number of turns and the resistance is kept very high (about 100 Ohm). It takes only small current which is less than 5% of the rated armature current.

Compound wound dc machines – In this type, there are two sets of field winding. One is connected in series and the other is connected in parallel with the armature winding. Compound wound machines are further divided as -

Short shunt – field winding is connected in parallel with only the armature winding

Long shunt – field winding is connected in parallel with the combination of series field winding and armature winding.

Classification of DC machines



OR

Q2.What is armature reaction in a d.c machine?Explain the term 'Resistance commutation'.

Ans.Armature reaction: Refers to chapter 1 Q.no 4

Resistance commutation: Resistance commutation is a method to improve the commutation in DC machines (DC motors and DC generators) for reducing sparking during commutation. In this method the low resistance copper brushes are replaced by high resistance carbon brushes. The sparking is reduced due to the high resistance offered by the carbon brushes in the trailing segment of the commutator. As resistance increases with decrease in area of cross-section and vice versa, as commutator segment advances through the carbon brush the resistance for the current path always decreases for leading segment as the contact area increases and increases for the trailing segment as the contact area decreases. Hence it favours the current path to be taken through the leading segment as it cross the commutator segment.

Q3.Explain with neat sketch, speed armature current characteristics of d.c series motor.

Ans. Refers to chapter

OR

Q3.A 220 V D.C series motor draws a current of 50A from supply.Armature resistance and series field resistance are 0.2W and 0.1W respectively.Calculate back emf and mechanical power developed on arm.

Ans. For motor back emf

$$E_b = V - I_a(R_a + R_f)$$

$$E_b = 220 - 50(0.2 + 0.1)$$

$$E_b = 220 - 50 \times 0.3$$

$$E_b = 205V$$

Mechanical power developed

$$P_m = E_b I_a$$

$$P_m = 205 \times 50$$

$$P_m = 10250 Watt$$

Q4. Derive emf equation of a two winding transformer.

Ans. Refers to chapter

OR

Q4.A 10KVA single phase transformer has 200 turns on primary and 40 turns on secondary side.The primary is connected to 1000V, 60Hz mains.Calculate

(i) Primary and secondary currents on full load

(ii) Maximum flux in the core.

Ans.Given :

P=10,000=10KVA

V_1=1000V

N_1=200 turns and N_2=40 turns

(i)Primary Current

$$I_1 = \frac{P}{V_1} = \frac{10000}{1000} = 10A$$

We know the relation

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

$$\therefore \quad \frac{I_2}{10} = \frac{200}{40}$$

$$\therefore \quad I_2 = \frac{200 \times 10}{40} = 50A$$

(ii) Maximum flux in the core

$$\phi_m = \frac{V_1}{4.44 \times f \times N_1} = \frac{1000}{4.44 \times 60 \times 200} = 0.187 w_b$$

Q5. Explain with neat sketch ,open circuit test of a two winding transformer.

Ans. Refers to chapter

OR

Q5.Explain the advantages and disadvantages ofsingle phase auto transformer.

Ans. Refers to chapter

Q6. Draw the connection diagram of star delta transformer.

Ans. Refers to chapter

OR

Q6.Write the uses of

(a) Current transformer

(b) Isolation transformer

Ans.(a) Current Transformer: The current transformers are used in a wide variety of applications ranging from power system control to the precise current measurement in industrial, medical, automotive and telecommunication systems. Some of the applications include

- Extending the range of measuring instruments such as ammeter, energy meter, KVA meters, wattmeter, etc.
- Differential circulating current protection systems.
- Distance protection in power transmission systems.
- Over current fault protection.

Ans.(b)Isolation transformer: Isolation transformers are used in small sizes for isolation in pulse circuits.

- Isolation transformers are used to provide electrical isolation in medical equipment.
- Isolation transformers are used for power supply of devices that are not at ground potential.
- Isolation transformers are used in electronics testing and servicing to provide safety, without which touching a live part of the circuit with hazardous voltage can cause se-

vere damage.

Group-C

Q7.Explain with neat sketch the construction of D.Cmachine.What are the advantages of lap and wave winding?

Ans.Construction of D.Cmachine: Refers to chapter

Advantages of lap and wave winding:

- In lap winding, the coil end is allied to the nearby commutator section, while in the wave winding the armature end coil is located within the commutator section which is located separately.
- The lap winding emf is less when compared with wave winding.
- The cost of winding in the lap winding is expensive than the wave winding due to more conductor.
- The lap winding needs an equalizer for the improved commutation whereas the wave winding needs the replica coil to provide the mechanical stability toward the armature.
- The other name of the parallel winding is lap winding because the connection of the lap winding is parallel. Similarly, the wave is also known as series winding because of the series connection.
- In lap winding, the amount of parallel lanes is equivalent to the entire number of poles of the coil whereas in the wave winding the number of parallel lanes is constantly equivalent to two.
- The amount of brushes in lap winding is equivalent to the number of parallel lanes whereas the amount of brushes in wave winding is equivalent to two.
- The lap winding efficiency is low when compared with wave winding.

OR

Q7.A 4-pole D.C machine running at 1000 rpm has an arm with 90 slots and 6 conductors per slot.The flux per pole is 10 mwb.Calculate terminal voltage as d.c generator.If coils are lap wound and current per parallel path is 100 A, Calculate electrical power generated.

Ans.Given :P = 4

N = 1000 r.p.m

$\phi = 10\times10^{-3} Wb$

A = 4

Z = 90 x 60 =540

We know that

$$E_g = \frac{PZN\phi}{60A}$$

$$= \frac{4\times540\times1000\times10\times10^{-3}}{60\times4} = 90V$$

Current per parallel path = 100 A

Armature current(I_a) $= 100\times4 = 400$

Electric power generated $= E_g \times I_a$

$= 90\times400 = 36000W = 36KW$

Q8. What is D.C motor starter? Explain with neat sketch,3-point starter.

Ans. Refers to chapter

OR

Q8.What are the different methods of speed control of D.C motors?Explain flux control method for speed control of D.C shunt motor.

Ans. Refers to chapter

Q9.A 100KVA distribution transformer has a full load efficiency at unity power factor is 95% the copper and iron losses are equal.Calculate its All day efficiency, is loading at u.p.f is as under → No load for 8hrs,Quarter load for 8hrs,Half load for 04 hrs and full load for 04hrs.

Ans.Given:

Efficiency = 95%

Let us find out the losses from the given commercial efficiency of the transformer

Output $= 100\times1 = 100KW$

$$Input = \frac{100}{0.95} = 105.26KW$$

$\therefore$ $Losses = (105.26 - 100) = 5.26KW$

Since efficiency is maximum, the losses are divided equally between Cu and iron

Cu loss at F.L of 100KVA $= \frac{5.26}{2} = 2.63KW$

Iron loss $= 2.63KW$

Cu loss at one forth of F.L $= \left(\frac{1}{4}\right)^2 \times 2.631 = 0.1644KW$

Cu loss at half of F.L $= \left(\frac{1}{2}\right)^2 \times 2.631 = 0.6577KW$

Quater load for 8hrs

$\therefore$ $Cu\ loss\ for\ 8hrs = 8\times0.1644 = 1.315kwh$

Half of load for 4 hrs

$\therefore$ $Cu\ loss\ for\ 4hrs = 4\times0.6577 = 2.63kwh$

Full load for 4 hrs

$\therefore$ $Cu\ loss\ for\ 4hrs = 4\times2.63 = 10.524kwh$

Total Cu loss in 24 hrs

= 1.315+2.63+10.524=14.409kwh

Iron loss in 24hrs $= 24 \times 2.63 = 62.44 kwh$

Total loss in 24 hr = (14.409+62.49)=46.9

FL output power =100KW

Half load output power 50KW

Quater load output power=25KW

Total output power in 24hr

$= (25 \times 8 + 5 \times 4 + 100 \times 4) = 1000 kw$

$$\therefore Efficiency(\eta) = \frac{Output}{Output + Loss} = \frac{1000}{1000 + 76.9} = 0.92 \Rightarrow 92\%$$

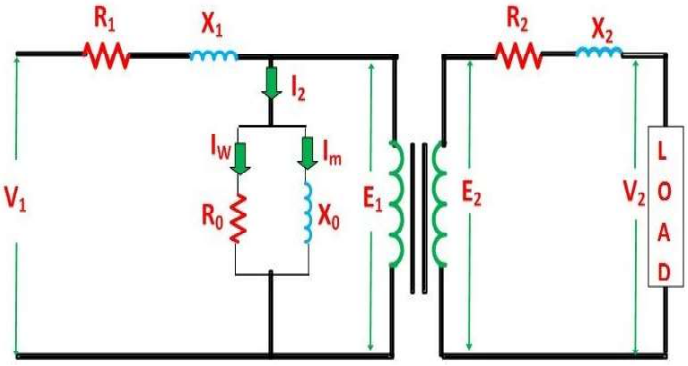
OR

Q9.Explain principle of operation of two winding transformer.Also draw the equivalent circuit diagram of a two winding transformer.

Ans. Transformer works on the principle of Mutual induction between two windings (Primary and secondary) linked by common magnetic flux. When source of alternating voltage is connected to the Primary coil the magnetic flux produced in primary induces flux in secondary coil too. The frequency remain same.

Equivalent Circuit diagram of single phase Transformer: Equivalent circuit diagram of a transformer is basically a diagram which can be resolved into an equivalent circuit in which the resistance and leakage reactance of the transformer are imagined to be external to the winding.

The equivalent circuit diagram of transformer is given below:



Where,

R_1 = Primary Winding Resistance.

R_2= Secondary winding Resistance.

I_0= No-load current.

I_m = Magnetizing Component,

I_w = Working Component,

This I_m & I_w are connected in parallel across the primary circuit. The value of E_1 (Primary e.m.f) is obtained by subtracting vectorially $I_1 Z_1$ from V_1 . The value of X_0 = E_1 / I_0 and R_0 = E_1 /I_w. We know that the relation of E_1 and E_2 is E_2 /E_1 = N_2 /N_1 = K , (transformation Ratio)

From the equivalent circuit , we can easily calculate the total impedance of to transfer voltage, current, and impedance either to the primary or the secondary.

Q10.A single phase transformer has 800 turns on primary and 200 turns on secondary.The no load current is 2 A at a power factor of 0.2 lagging.Calculate primary current and power factor when secondary current is 100 A at a power factor of 0.8 lagging.

Ans.

OR

Q10.A 2000V/200V transformer draws a no load primary current of 0.5 A and absorbs 350W.Find magnetising and working components of no load primary current.Draw its vector diagram.

Ans.Given:

V_1 =200V

I_0 = 0.5A

P_0 =W=350W

We know that

$$P_0 = V_1 I_0 \cos\phi_0$$

$$\Rightarrow 350 = 250 \cos\phi_0 \times 0.5$$

$$\Rightarrow \cos\phi_0 = \frac{350}{250 \times 0.5} = 0.35$$

Magnetising component$(I_u) = I_0 \sin\phi_0$

Since $\cos\phi_0 = 0.35$

$$\phi_0 = \cos^{-1}(0.35) = 69.5^0$$

$$\therefore \sin\phi_0 = \sin\left[\cos^{-1}(0.35)\right] = 0.93$$

$$\therefore I_u = 0.5 \times 0.93 = 0.468 amp$$

Working component$(I_w) = I_0 \cos\phi_0$

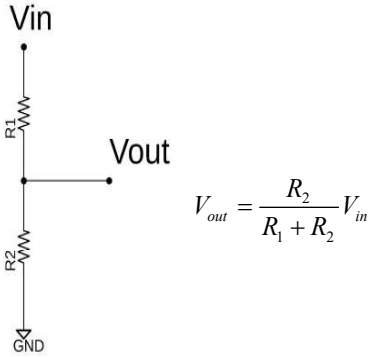
$$\therefore I_w = 0.5 \times 0.35 = 0.175 amp$$

Vector diagram can be drawn as:>>>>>>>>

Q11.Explain the following terms :

(a) Potential divider (b)Welding transformer

Ans.(a) Potential divider: A voltage divider or Potential divider is basically a passive linear circuit consisting of resistors connected in series that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). The applied voltage Vin is distributed among the components of the divider circuit. Voltage dividers are one of the most fundamental circuits in electronics. For the same input voltage, we can get different output voltages by changing the values of the resistors connected in series.



Ans.(b) Welding transformer: Refers to chapter 5 Q.no 4

OR

Q11. Explain the following terms:

(a) Isolation transformer (b) Current transformer

Ans.(a) Isolation transformer: Refers to chapter

Ans.(b) Current transformer: Refers to chapter

Model Sets-3

Electrical Motors and Transformer

Group-A

1. Choose the most suitable answer from the following options :

(i) The armature core of a d.c. machine is laminated to reduce :

(a) hysterisis loss (b) eddy current loss
(c) both eddy current and hysterisis loss
(d) copper loss

Ans.(b)

(ii) Torque-current characteristics of a d-c shunt motor is :

(a) straight line (b) parabola
(c) hyperbola (d) none of the above

Ans.(a)

(iii) EMF induced in each conductor of a d.c. machine is:

(a) an alternating e.m.f. (b) a direct e.m.f.
(c) a pulsating e.m.f. (d) both (b) and (c)

Ans.(a)

(iv) The field coils of a d.c. machine are made of :

(a) Carbon (b) Copper (c) Mica (d) Steel

Ans.(b)

(v) The starter of a d.c. motor is used to limit :

(a) armature current (b) field current
(c) supply voltage (d) none of the above

Ans.(d)

(vi) The starting torque of a d.c. series motor is :

(a) zero (b) low (c) high (d) none of the above

Ans.(c)

(vii) Lap winding is suitable for.....current.....voltage of d.c. machine.

(a) high, low (b) low, high
(c) low, low (d) high, high

Ans.(a)

(viii) If the flux in a d.c. motor is decreased the speed of motor will :

(a) increase (b) decrease
(c) remain unaltered
(d) increase and decrease time to time, creating unstability

Ans.(a)

(ix) Transformer core is made of :

(a) steel (b) brass (c) zinc (d) silicon steel

Ans.(d)

(x) A transformer does not transform :

(a) power (b) voltage
(c) current (d) None of the above

Ans.(a)

(xi) Transformer action requires a :

(a) constant magnetic flux
(b) increasing magnetic flux
(c) alternating magnetic flux
(d) alternating electric flux

Ans.(c)

(xii)The leakage flux in a transformer depends upon :

(a) the applied voltage (b) the frequency
(c) the load current (d) the mutual flux

Ans.(c)

(xiii)GRGO laminations in a transformer are used to minimise :

(a) eddy current loss (b) hysteresis loss
(c) Both (a) and (b) (d) None of the above

Ans.(b)

(xiv)Welding transformer is a :

(a) Step down transformer (b) Step up transformer
(c) Both (a) and (b) (d) None of the above

Ans.(a)

(xv)The voltage transformation ratio of a transformer is :

(a) E_2/E_1 (b) V_2/V_1 (c) N_2/N_1 (d) I_2/I_1

Ans.(b)

(xvi)A 3-phase transformer, over a bank of 3-single phase transformer of equal rating has the advantages of :

(a) low cost (b) less weight
(c) occupation of less space (d) all of the above

Ans.(c)

(xvii)In polyphase transformer 3-phase to 2-phase conversion done by :

(a) Scott connection (b) Star/star
(c) Double scott (d) Star/double delta

Ans.(a)

(xviii)Which of the following connection in transformers is best suited for 3-phase, 4-wire service?

(a) Star-star (b) Delta-delta
(c) Star-delta (d) Delta-star

Ans.(d)

(xix)The function of breather in a transformer is :

(a) to provide oxygen to the cooling coil
(b) to provide cooling air
(c) to arrest, flow of moisture when out-side air enters the transformers
(d) to filter the transformer oil

Ans.(c)

(xx)The efficiency of an auto transformer for the same output compared to a two winding transformer is :

(a) greater (b) lesser
(c) poor (d) none of the above

Ans.(a)

Group-B

Answer all Five Questions.

Q2. Draw a neat sketch of construction of a d.c. machine and table the component parts. Explain it in brief.

Ans. Same as chapter

OR

Q2.Explain the significance of Back e.m.f. pin D.C. motor and write down its equation.

Ans. Same as chapter

Q3.Differentiate between lap winding and wave winding.

Ans. Same as chapter

OR

Q3.Explain the field control method for speed control of a d.c. shunt motor.

Ans.Field Rheostat Controlled DC Shunt Motor: In this method, speed variation is accomplished by means of a variable resistance inserted in series with the shunt field. An increase in controlling resistances reduces the field current with a reduction in flux and an increase in speed. This method of speed control is independent of load on the motor. Power wasted in controlling resistance is very less as field current is a small value. This method of speed control is also used in DC compound motor.

Disadvantages of Field Rheostat Controlled DC Shunt Motor:

(i)Creeping speeds cannot be obtained.
(ii)Top speeds only obtained at reduced torque.
(iiii)The speed is maximum at minimum value of flux, which is governed by the demagnetizing effect of armature reaction on the field.

Q4.Explain the principle of transformer action.

Ans. Refers to Chapter

OR

Q4. A 10 KVA transformer gives 200 secondary volts on no load when a p.d. of 13 volts is applied to the secondary with primary short circuited, the current is 50A and the power is 250watts. Determine the equivalent resistance, reactance and impedance referred to the secondary.

Ans. According to given data :

V_1 = No load voltage at low voltage side = 200V
= Primary voltage

V_{SC}=High voltage side (i.e. secondary) voltage on short circuit
=13V

Isc = High voltage side short circuit current
= 50A

P_{sc} = Short circuit power = 250W

Now, from short circuit data on H.V. side,

we have $Z_{sch.v} = \frac{V_{sc}}{I_{sc}} = \frac{13}{50} = 0.26\Omega$

So, equivalent impedance of transformer referred to secondary

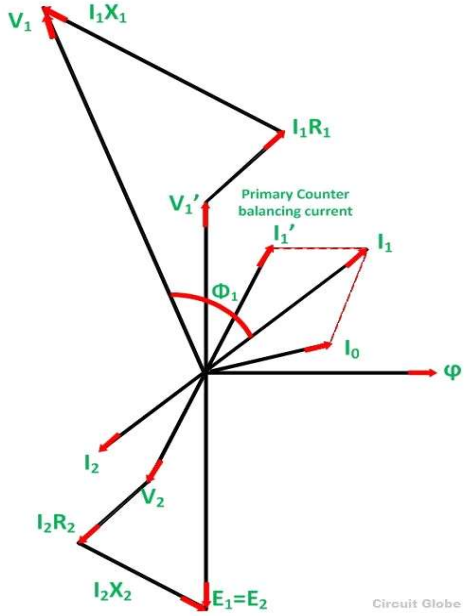
$$Z_{hv} = 0.26\ \Omega$$

Equivalent resistance, $R_{hv} = 0.1\,\Omega$

And Equivalent reactance, $X_{hv} = 0.24\,\Omega$ **...Ans**

Q5.Develop a phasor diagram of a single phase transformer under lagging power factor load.

Ans. The phasor diagram of a single phase transformer under lagging power factor load as given below:



OR

Q5.The net cross sectional area of a single phase 50 Hz transformer is 500 cm² having 400 and 100 turns in the primary and secondary winding respectively. If it is connected to a 230 V, 50 Hz supply calculate the following :

(a) Emf induced in secondary

(b) Maximum value of flux density in the core.

Ans. we know from the equation

$E_1 = 4.44\ Q_m F N_1$ volts.

$Q_m = \frac{E_1}{4.44 F N_1}$ we bers

Substituting the given values in the above expression,

$$Q_m = \frac{230}{4.44 \times 50 \times 400} = 0.0026 Wb$$

∴ Maximum flux density in the core,

$$B_m \frac{Maximum\ \ value\ \ of\ \ flux\ \ in\ \ webers}{Net\ \ cross-sectional\ \ area\ \ of\ \ the\ \ core\ \ in\ m^2}$$

$$= \frac{0.0026}{500 \times 10^{-4}} = 0.052T$$

Hence,

Secondary induced e.m.f, $E_2 = 4.44\ Q_m F N_2$ volts.

$= 4.44 \times 0.0026 \times 50 \times 100$

$= 57.72V = 58$

Q6.What are the advantages and disadvantages of three phase transformer over three single phase transformer.

Ans. Refers to chapter

OR

Q6.Explain, how current transformer is used to measures current in power transformer.

Ans. Refers to chapter

Group-C

Answer all Five Questions.

Q7.Describe a test on a 1-phase transformer that gives its core losses. Discuss the determination of equivalent circuit parameters which can be obtained from this test.

Ans. Refers to chapter

Q8.Explain the following types of three-phase transformer connections :

(a) Star-Star **(b) Delta-Star**

(c) Star-Delta

Ans. Refers to chapter

OR

Q8.Explain the different types of losses in d.c. machine. Define efficiency and find the condition for maximum efficiency.

Ans. The losses in a dc machine (generator or motor) may be divided into three classes viz

(i) Copper losses

(ii) Iron or core losses and

(iii) Mechanical losses.

Copper losses: These losses occur due to currents in the various windings of the machine.

Armature copper loss = Ia^2Ra

Shunt field copper loss = Ish^2Rsh

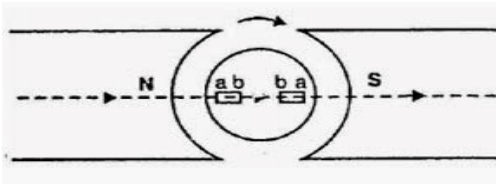
Series field copper loss = Ise^2Rse

Note. There is also brush contact loss due to brush contact resistance (i.e., resistance between the surface of brush and surface of commutator). This loss is generally included in armature copper loss.

Iron or Core losses: These losses occur in the armature of a d.c. machine and are due to the rotation of arma-

ture in the magnetic field of the poles. They are of two types viz.,

(i) Hysteresis loss:Hysteresis loss occurs in the armature of the d.c. machine since any given part of the armature is subjected to magnetic field reversals as it passes under successive poles.Figure shows an armature rotating in two-pole machine. Consider a small piece ab of the armature. When the piece ab is under N-pole, the magnetic lines pass from a to b. Half a revolution later, the same piece of iron is under S-pole and magnetic lines pass from b to a so that magnetism in the iron is reversed.



In order to reverse continuously the molecular magnets in the armature core, some amount of power has to be spent which is called hysteresis loss. It is given by Steinmetz formula. This formula is

Hysteresis loss $P_h = \eta B_{max}^{1.6} fV$

B_{max} = Maximum flux density in armature

f = Frequency of magnetic reversals = NP/120 (where N is in r.p.m.)

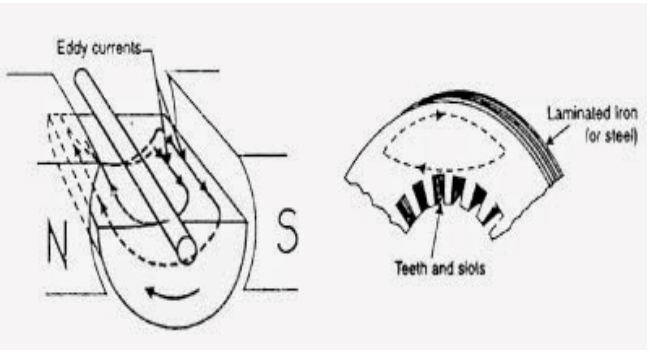
V = Volume of armature in m3

h = Steinmetz hysteresis co-efficient

In order to reduce this loss in a d.c. machine, armature core is made of such materials which have a low value of Steinmetz hysteresis co-efficient e.g.,silicon steel.

(ii) Eddy current loss:In addition to the voltages induced in the armature conductors, there are also voltages induced in the armature core. These voltages produce circulating currents in the armature core as shown in Fig. These are called eddy currents and power loss due to their flow is called eddy current loss.

The eddy current loss appears as heat which raises the temperature of the machine and lowers its efficiency.



If a continuous solid iron core is used, the resistance to eddy current path will be small due to large cross-sectional area of the core. Consequently, the magnitude of eddy current and hence eddy current loss will be large.

The magnitude of eddy current can be reduced by making core resistance as high as practical.

The core resistance can be greatly increased by constructing the core of thin, round iron sheets called laminations. The laminations are insulated from each other with a coating of varnish. The insulating coating has a high resistance, so very little current flows from one lamination to the other.

Also, because each lamination is very thin, the resistance to current flowing through the width of a lamination is also quite large. Thus laminating a core increases the core resistance which decreases the eddy current and hence the eddy current loss.

Eddy current loss $P_e = K_e B_{max} f^2 t^2 V$

where Ke = Constant depending upon the electrical resistance of core and system of units used

Bmax = Maximum flux density in Wb/m2

f = Frequency of magnetic reversals in Hz

t = Thickness of lamination in m

V = Volume of core in m^3

Mechanical losses: These losses are due to friction and windage.friction loss e.g., bearing friction, brush friction etc.windage loss i.e., air friction of rotating armature.These losses depend upon the speed of the machine. But for a given speed, they are practically constant.

Note. Iron losses and mechanical losses together are called stray losses.

Efficiency : The Efficiency of the transformer is defined as the ratio of useful power output to the input power, the two being measured in the same unit. Its unit is either in Watts (W) or KW. Transformer efficiency is denoted by η.

Efficiency is maximum in a transformer when Copper losses = Iron losses.

$$\eta = \frac{Output\ power}{Input\ power} = \frac{Output\ power}{Output\ power + Losses}$$

$$\eta = \frac{Output\ power}{Output\ power + iron\ losses + copper\ losses}$$

$$\eta = \frac{V_2 I_2 \cos\varphi_2}{V_2 I_2 \cos\varphi_2 + P_i + P_c}$$

V_2= Secondary terminal voltage.

I_2= Full load secondary current.

$\cos\varphi_2$ = Power factor of the load.

P_i = Iron loss= eddy current loss + Hysteresis loss = Constant loss.

P_c= Full load Copper losses.

The efficiency is a function of load i.e. load current I_2 assuming cos φ constant. The secondary terminal voltage V_2 is also assumed constant.

So for maximum efficiency,

$$\frac{d\eta}{dI_2} = 0$$

$$\eta = (V_2 I_2 \cos\phi_2) / (V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e})$$

$$\therefore \quad \frac{d\eta}{dI_2} = \frac{d}{dI_2}\left[\frac{V_2 I_2 \cos\phi_2}{V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e}}\right] = 0$$

$$\therefore (V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e}) \frac{d}{dI_2}(V_2 I_2 \cos\phi_2)$$

$$- (V_2 I_2 \cos\phi_2) \frac{d}{dI_2}(V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e}) = 0$$

$$(V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e})(V_2 \cos\phi_2) - (V_2 I_2 \cos\phi_2)(V_2 \cos\phi_2 + 2 I_2 R_{2e}) = 0$$

Cancelling $(V_2 \cos\phi_2)$ from both the terms we get,

$$V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{2e} - V_2 I_2 \phi_2 - 2 I_2^2 R_{2e} = 0$$

$$\therefore P_i + I_2^2 R_{2e} = 0$$

$$\therefore P_i = I_2^2 R_{2e} = P_{cu}$$

So condition to achieve maximum efficiency is that,

Copper losses= Iron losses

Q9.Explain the function of the following :

(a) Breather

(b) Buchhloz relay, in transformer

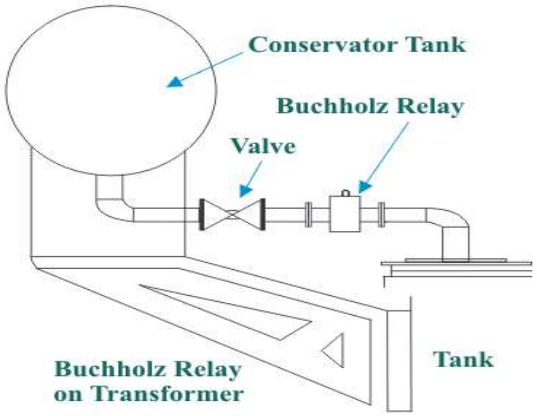
Ans.(a) Breather: The function of breather in transformer is to filter out the moisture from air. Breather consist of silica gel which absorbs the moisture from air.

When there is overloading on transformer, the winding of transformer gets heated so the oil in main tank of transformer also get heated. The hot oil started expanding. There is conservator tank at the top of transformer which allows adequate space for expansion of oil. Therefore during overloading condition the oil move to the conservator tank.

In normal operating condition, the oil come back to main tank from conservator tank. Now, there is vacant space in the conservator tank which is filled with the air. Conservator tank is never completely filled as it has to allow space for expanding oil from main tank.

The air which is there in conservator tank is coming from atmosphere through the breather and breather contains silica gel in it. This silica gel absorbs the moisture from air. The main reason to remove moisture from air is because the moisture degrades the dielectric strength of the transformer oil.

Ans.(b) Buchhloz relay, in transformer: Buchholz relay is used for the protection of transformers from the faults occurring inside the transformer. Short circuit faults such as inter turn faults, incipient winding faults, and core faults may occur due to the impulse breakdown of the insulating oil or simply the transformer oil. Buchholz relay will sense such faults and closes the alarm circuit.



Whenever a fault occurs inside the transformer, the oil in the transformer tank gets overheated and gases are generated. The generation of the gases depends mainly on the intensity of fault produced. The heat generated during the fault will be high enough to decompose the transformer oil and the gases produced can be used to detect the winding faults. This is the basic principle behind the working of the Buchholz relay.

OR

Q9.In a 25 kVA transformer the iron and full load copper losses are 350 W and 400 W respectively. Calculate efficiency at :

(a) Full load unity power factor

(b) Half-full load, 0.8 power factor logging

Also determine the load for maximum efficiency.

Ans. (a) Full load unity power factor :

Full-load output = 25×1.0 = 25kw.

Total full-load losses = 350 + 400

= 750w

=0.75kw.

Full-load input = 25 + 0.75

= 25.75kw.

$$\text{Full load } (\eta) = \frac{25}{25.75} \times 100$$

= 97.0890

(b) Half-full load, 0.8 power factor :

$$\text{output at half full load} = \left(25 \times \frac{1}{2}\right) \times 0.8$$

= 10kw

Total loss at half full load $= 350+\left(\frac{1}{2}\right)^2\times 400$

$= 450W$

$= 0.45kw.$

Input at half full load $= 10 + 0.45$

$= 10.45kw.$

Half full-load $= \frac{10}{10.45}\times 100$

$= 95.6990$

Q10.Explain the construction and working of three point starter with neat sketch.

Ans. Refers to chapter

OR

Q10.A 200 kVA, 3300/240 V, 50 Hz single phase transform has 100 terns on the secondary winding. Assuming an ideal transform calculate :

(a) Primary current

(b) Maximum value of flux

(c) Number of Primary turns

Ans. (a) Primary current $= \frac{200\times 10^3}{3300} = 60.6A$

(b) Maximum value of flux :

$$Q_{max} = \frac{E}{4.44\times f\times N}$$

$$= \frac{3300}{4.44\times 50\times 1375}$$

= 0.01081wb. ...Ans.

(c) Number of Primary turns : $100\times\frac{3300}{240} = 1375$ turns.

Q11.Write short notes on any two of the following :

(a) Current transformer (b) Welding transformer

(c) Cooling of transformer

Ans.(a)Current transformer: Refers to chapter

Ans.(b)Welding transformer: Refers to chapter

Ans.(c)Cooling of transformer: Cooling of Transformer is the process by which heat generated in the transformer is dissipated or treated to the safe value. This is achieved by various cooling methods of transformer available. The major factor for the generation of heat in the transformer is the various losses like hysteresis, eddy current, iron, and copper loss. Among all the various losses the major contributor of the heat generation is the copper loss or I^2R loss.If the temperature of the transformer will continue to increase rapidly, it will result in the degradation of the insulation used in the transformer resulting in the damaging of the various parts and hence the failure of the transformer. Thus, proper removal or treatment of heat is necessary for the efficient working, longer life and higher efficiency of the transformer.

The various coolant used for the cooling purpose of the transformer are air, synthetic oils, mineral oils, gas, water.

Basically, there are two types of transformer one is the dry type and another one is oil immersed type.