Assignment:- 01 Dt:- 12th April 2022

(1) What is the function of armature winding in a dc generator? Distinguish betn a lap and wave armature winding with regards to the number of parallel paths?

Ans:- The armature winding wound on the core is given current through a DC supply. This current carrying winding as under the influence of the magnetic field develops a force that developes a rotational torque. This torque enables the machine to rotate.

& the second rides is to generated an electromotive force (E.M.F)

In the armature, an electromotive force is created by the relative motions of the armature & the field. when the machine or motor is used as a motor.

(An armature is define as the component of an electric machine that carries alternating current.)

Difference betn Lap & Wave Winding.

LAP WINDING	WAVE WINDING
(i) The number of parallal paths in lap winding is equal to the number of poles.	The number of parallal path is always equal to two (2).
(ii) The number of carbon brush in lap winding is equal to the number of poles.	(ii) The number of carbon brushes requirement in wave winding is 2 due to two parallal paths.
(iii) Equilazier ring is required for obtained better communication.	(iii) No need for equalizer ring.
(iv) Lap winding are use for low voltage & high current rating machines.	(iv) Wave winding is required for ~~low~~ high voltage but low current rating machines.
(v) Generated emf equation for simple lap winding is $E_g = \frac{P\phi ZN}{60A}$	(v) Generated emf equation for simple wave winding is $E_g = \frac{P\phi ZN}{60\times 2} = \frac{P\phi ZN}{120}$
(vi) The conductor current in each parallal path is (I/A).	(vi) The conductor current in each parallal path is is $(I/2)$ in wave winding.
(vii) If lap coil are traversed the movement is foreward & backward alternatively.	(vii) If wave coil are traversed the movement is forward only.
(viii) The commutator pitch for lap winding is always one.	(viii) The commutator pitch for for wave winding is almost equal to 2 pole pitch
(ix) It is more costly due to requirment of equalizer ring & more carbon brushes.	(ix) It is comparactively cheap than Lap winding.
	(x) Wave winding is more advantageous over lap winding.

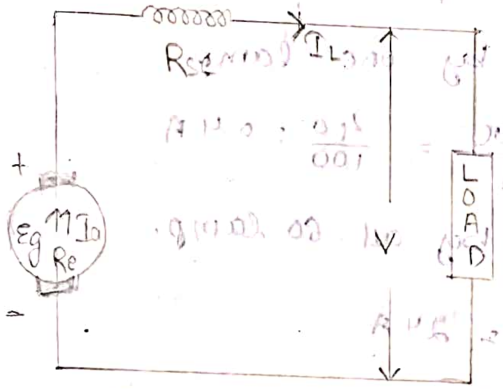
(2) Draw the circuit digram of the different Self-excited dc generator in common uses?

Ans:- Self excited dc generator is basically into 3 types :-

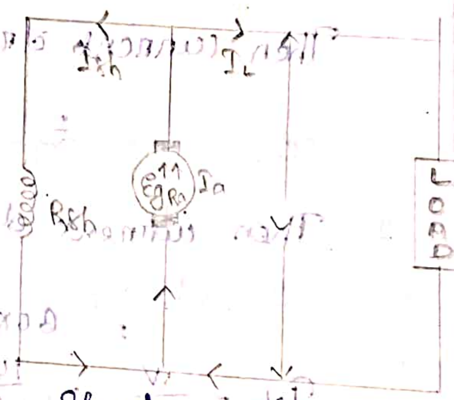
(1) Series wound dc generator.
(2) Shunt wound dc generator
(3) Compound wound dc generator.

(1) Series wound dc generator :-

→ In series wound dc generator the field winding is connected in series with armature winding.



Series wound generator



Shunt wound generator

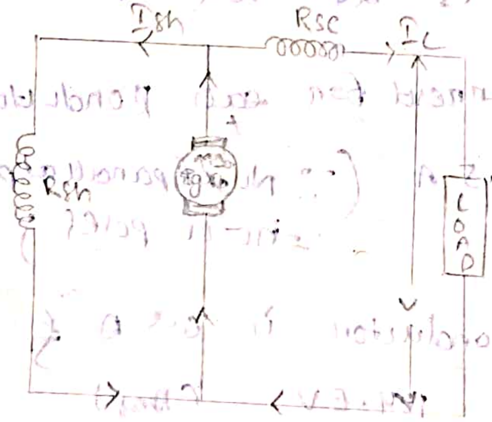
(2) Shunt wound generator :-

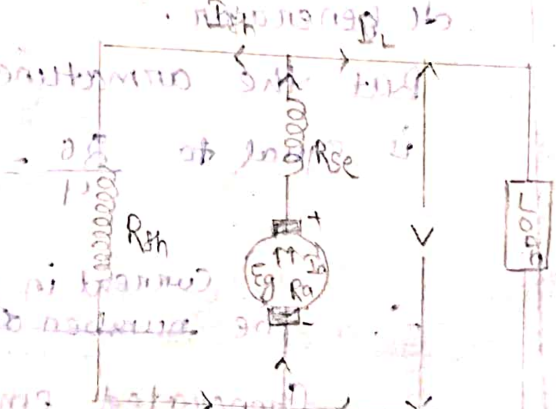
→ In shunt wound generator the field winding is connected in parallal with armature winding.

(3) Compound generator :-

→ In a compound generator, there are two types of field winding on each pole.

→ One is in series & another is in parallal with armature winding.





Compound wound Generator.

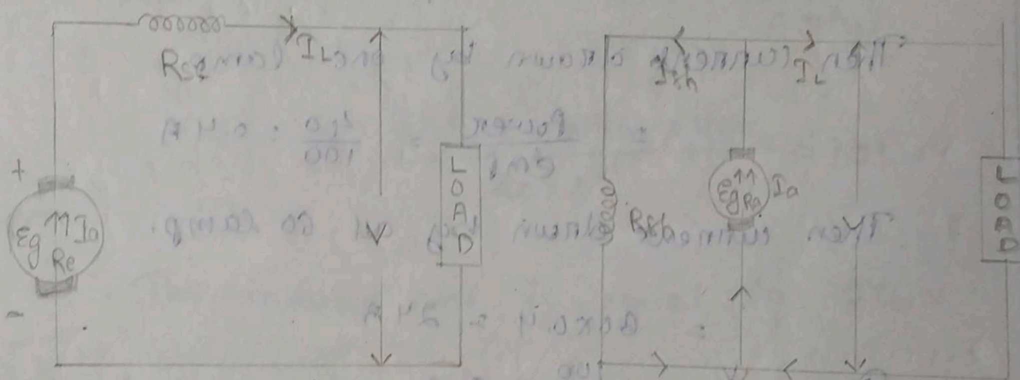
(2) Draw the circuit digram of the different Self-excited dc generator in common use?

Ans:- Self excited dc generator is basically into 3 types:-

(1) Series wound dc generator
(2) Shunt wound dc generator
(3) Compound wound dc generator.

(1) Series wound dc generator:-

→ In series wound dc generator the field winding is connected in series with armature winding.



Series wound generator   Shunt wound generator

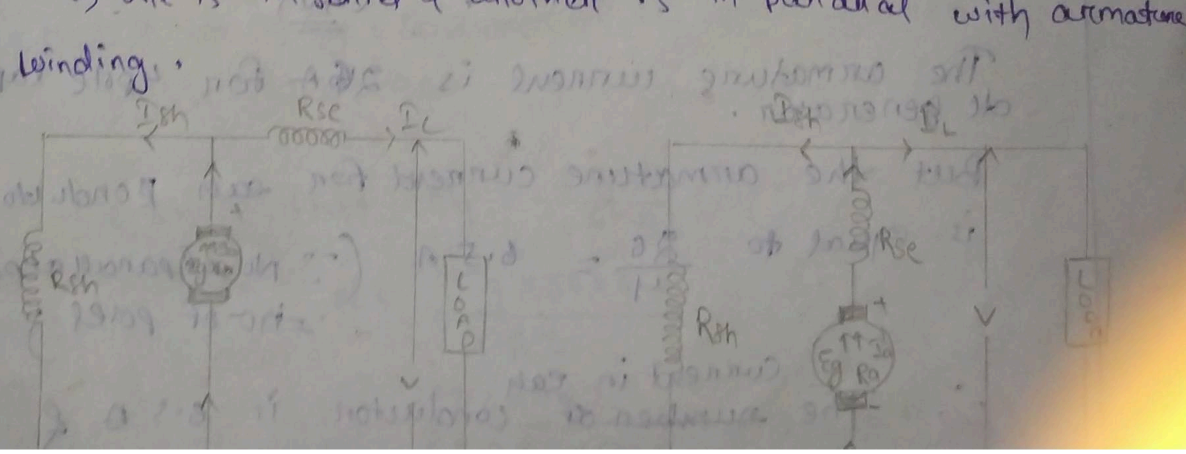
(2) Shunt wound generator:-

→ In shunt wound generator the field winding is connected in parallal with armature winding.

(3) Compound generator:-

→ In a compound generator, there are two types of field winding on each pole.

→ One is in series & another is in parallal with armature winding.



(3) A 4-pole shunt generator has a lap wound armature with resistance of 0.1 Ω & field circuit resistance of 50 Ω. The generator supplies 100V, 40 watt lamp. Find the current in each armature conductor and the generated emf. The brush contact drop is 1 volt/brush?

Ans:- Given data :-

$R_a = 0.1\ \Omega$

$R_{sh} = 50\ \Omega$

$V = 100\ V$

60, 40 watt lamp

Then current drawn by one lamp

$= \frac{Power}{emf} = \frac{40}{100} = 0.4\ A$

Then current drawn by all 60 lamp.

$= 60 \times 0.4 = 24\ A$

$I_{sh} = \frac{V}{R_{sh}} = \frac{100}{50} = 2\ A$

$I_a = I + I_{sh} = 24 + 2 = 26\ A$

The Generated emf $= E_g = V +$ loss $+$ drop

$= V + I_a R_a +$ brush drop

$= 100 + (26 \times 0.1) + (2 \times 1)$

$= 104.6\ V$ (Ans)

The armature current is 26A for 4pole lap wound dc generator.

But the armature current for each conductor is equal to $\frac{26}{4} = 6.5\ A$ (∵ No. of parallel path = no of poles)

∴ The ~~number of~~ current in each conductor is 6.5 A & Generated emf is 104.6 V (Ans)

(4) An 8 pole lap wound dc generator has 960 conductors, a flux of 40 miliweber and is driven at 400 rpm. Find induced emf?

Ans:- Given data:

$P = 8$

lap wound generator.

$Z = 960$

$\phi = 40$ mwb $= 40 \times 10^{-3}$ wb

$N = 400$ rpm

$A = 8$

Then generated emf : $E_g = \frac{P\phi ZN}{60A}$

$= \frac{8 \times 40 \times 10^{-3} \times 960 \times 400}{60 \times 8} = 256$ V

∴ The induced emf is equal to 256 V

(5) An 8 pole wave connected dc generator has 900 armature conductors and a flux per pole of 0.04 wb. At what speed it must be driven to generate 500 v?

Ans:- Given data:

$P = 8$

wave connected.

$A = 2$

$\phi = 0.04$ wb

$E_g = 500$

$Z = 900$

$N = ?$

we know that $E_g = \frac{P\phi ZN}{60A}$

Then $N = \frac{E_g \times 60 \times A}{P\phi Z}$

$= \frac{500 \times 60 \times 2}{8 \times 0.04 \times 900} = 208.3$ ~~209~~

∴ The speed ~~number of conductor~~ is ~~209~~ 208.3 rpm

(6) The armature of a 60 pole dc generator has a wave winding containing 650 conductors. calculate the Eg when flux/pole is 0.055 wb & speed is 300 rpm. Calculate the speed at which the armature must be driven to generated emf of 550 v & flux is reduced to 0.05 wb.

Ans:- $A = 2$ (wave winding)

$P = 6$

$Z = 650$

(i) $\phi = 0.055$ & $N = 300$

$$E_g = \frac{P\phi Z N}{60 \times A} = \frac{6 \times 0.055 \times 650 \times 300}{120} = 536.25\,V$$

∴ The generated emf is equal to 536.25V.

Again

$E_g = 550\,V$

$\phi = 0.05\,V$

$P = 6$

$Z = 650$

Then $$N = \frac{E_g \times 60 \times A}{P \phi Z} = \frac{550 \times 60 \times 2}{6 \times 0.05 \times 650}$$

$= 338.46 \approx 339$ rpm

∴ ~~The number of conductor is equal to 339~~

∴ The speed of the motor is equal to 338.46 rpm.

(7) An 8 pole dc generator has per pole of flux is 40 mwb & winding is connected in lap with 960 conductors. Calculate the generated emf on open circuit when it runs at 400 RPM. If the armature is wave wound at what the machine has driven to generate the same voltage?

Ans:- Given data:

$P = 8$

$A = 8$ (lap wound)

$\phi = 40 \times 10^{-3}$ wb

$Z = 960$

$N = 400$ rpm

Then the generated emf $= E_g = \frac{P\phi Z N}{60 A}$

$$\Rightarrow \frac{8 \times 40 \times 10^{-3} \times 960 \times 400}{60 \times 8} = 256 \text{ V}$$

(ii) If wave wound then $A = 2$

$P = 8$

$\phi = 40 \times 10^{-3}$ wb

$E_g = 256$ V

$Z = 960$

Then $N = \frac{E_g \times 60 \times A}{P\phi Z} = \frac{120 \times 256}{8 \times 40 \times 10^{-3} \times 960}$

$= 100$ rpm.

∴ The required emf is 256 & speed is 100 rpm.

26/4/2022

Assignment : 02 Date:-

(2) function of pole shoes in dc machine?

Ans:- Naturally pole shoe is a projection over pole core and is always with connection with pole body and fills the gap betn the yoke & the pole body.

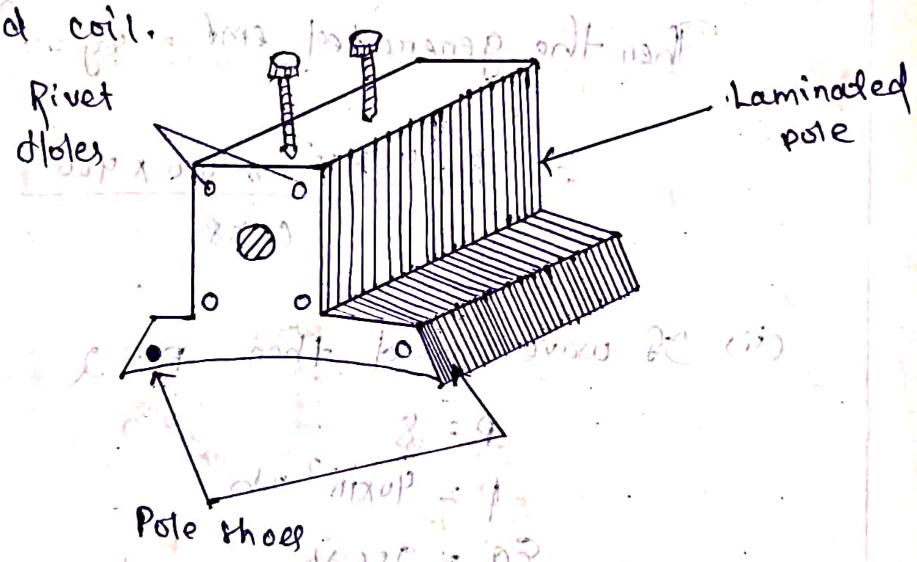
functions of pole shoes:-

→ It supports the field coil.

→ It spreads out the magnetic flux in the air gap.

→ It reduces the reluctance of the magnetic path.

→ A combination of pole body and pole shoes is termed as field magnet. This behaves as a field magnet whet direct current is passed through the field coil.



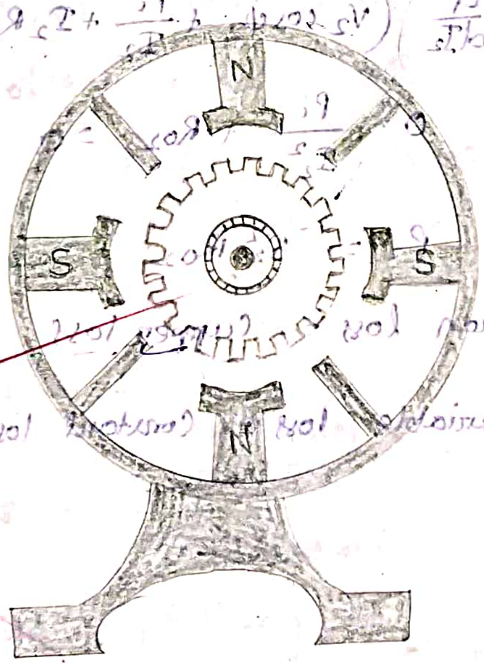
(3) State the working principle of dc motor?

Ans:- A DC motor is defined as a class of electrical motors that convert direct current electrical energy into mechanical energy.

Working Principle :-

When kept in a magnetic field, a current carrying conductor gains torque and developed a tendency to move. In short, when electric field and magnetic fields interact, a mechanical force arises. This is the principle on which the dc motors works.

(William Sturgeon inverted the first dc motor in 1886.)



(4) What is the ~~maximum~~ conditions for maximum efficiency ?

Ans:-

Efficiency of a transformer (full load)

$$\eta = \frac{\text{full load VA} \times PF}{(\text{full load VA}) \times PF + P_i + P_c}$$

$$= \frac{V_2 I_2 \cos\phi_2}{V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{02}}$$

$$= \frac{V_2 \cos\phi_2}{V_2 \cos\phi_2 + \frac{P_i}{R_2} + I_2 R_{02}}$$

Condition for maximum efficiency is that

$$\frac{d}{dI_2}(\text{denominator}) = 0 \quad (V_2 \rightarrow \text{constant}).$$

$$\therefore \frac{d}{dI_2}\left(V_2 \cos\phi_2 + \frac{P_i}{I_2} + I_2 R_{02}\right) = 0$$

or $0 - \frac{P_i}{I_2^2} + R_{02} = 0$

or $P_2 = I_2^2 R_{02}$

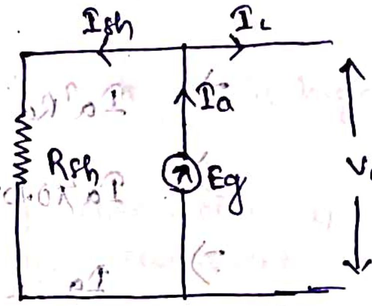
$\Rightarrow$ Iron loss = Cupper loss

$\Rightarrow$ Variable loss = Constant loss.

(1) A dc shunt generator has full load current of 196 A at 220 V. the stray losses are 720 watt & the shunt field ~~will~~ resistance is 55 Ω if it has a full load efficiency of 88 %, find the armature resistance and also find the load current corresponding to maximum efficiency ?

Ans:-

Given data:-



$I_{FL} = 196\,A$

$V_L = 220\,V$

Stray loss = 720 watt

$R_{sh} = 55\,\Omega$

(η) efficiency = 88 %

$R_a = ?$

$I_{sh} = \frac{V_L}{R_{sh}} = \frac{220}{55} = 4\,A$

$I_a = I_{sh} + I_L = 196 + 4 = 200\,A$

Output of the generator $= V_L I_L$

$= 220 \times 196 = 43120$ watt

Efficiency $= \eta = \frac{\text{output}}{\text{Input}}$

$\Rightarrow 0.88 = \frac{43120}{\text{output} + \text{losses}}$

$\Rightarrow 0.88 = \frac{43120}{43120 + \text{losses}}$

$\Rightarrow \text{losses} = \left(\frac{43120}{0.88}\right) - 43120$

$\Rightarrow$ losses = 5880 watt

We know total loss = stray loss + $I_a^2 R_a + I_{sh}^2 R_{sh}$

$5880 = 720 + \{(200)^2 \times R_a\} + (4^2 \times 55)$

$5880 = 1600 + 40000\,R_a$

$\Rightarrow R_a = \frac{5880 - 1600}{40000} = 0.107\ \Omega$

$$\boxed{R_a = 0.107\ \Omega}$$

Conditions for maximum efficiency

$\Rightarrow$ Constant loss = variable loss

$\Rightarrow I_a^2 R_a = I_{sh}^2 R_{sh} + 720$

$\Rightarrow I_a^2 \times 0.107 = 880 + 720$

$\Rightarrow I_a = \sqrt{\frac{1600}{0.107}} = 122.28\ A$

$\therefore I_a = 122.28\ A$ (Ans)

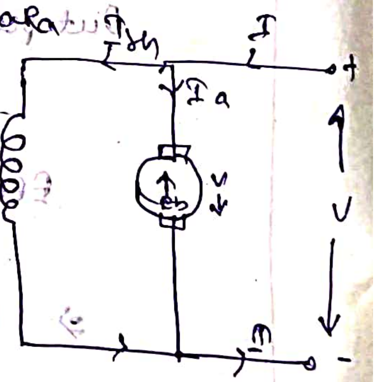
(5) Write the voltage equation of a dc motor?

Ans:- The voltage 'V' applied across the motor armature has to

(i) overcome the back emf E_b and

(ii) supply the armature ohmic drop $I_a R_a$.

$$V = E_b + I_a R_a$$



This is known as voltage equation of a motor

By multiplying I_a in both sides we get

$$V I_a = E_b I_a + I_a^2 R_a$$

where $V I_a$ = Electrical Input to armature

$E_b I_a$ = Electrical equivalent of mechanical power developed in the armature.

$I_a^2 R_a$ = Cu. loss in armature

(6) Explain about different characteristics of dc series motor?

Ans:- The outstanding characteristics of a series motors is :—

(i) It has high torque at low speeds and vice-versa.

(ii) It is well suited for traction purpose such as electric trains.

(iii) Acceleration is rapid because the torque is high at low speeds.

(iv) the series motor automatically slow down as the train goes up an incline surface, yet turns at top speed on the flat ground.

(v) The power of a series motor tends to be constant

(vi) Because high torque is accompained by low speed & vice-versa.

(vii) Series motors are also used in electric cranes,

(viii) Light loads are lifted quickly & heavy loads are more slowly.

(7) Applications of Compound Motor?

Ans:- The main applications of a compound motors are

- For intermittent high torque loads.
- for shears and punches.
- Elevators.
- conveyors.
- Heavy Planners.
- Rolling mills.
- Ice machines.
- Printing press
- AC (Air compressors)

(8) Derieve the torque eqn developed in the shaft of armature?

Ans:- **Armature torque of a motor:-**

let torque developed = Ta N/m

Speed = N rpm.

Then power developed = $T_a \times 2\pi N$ watt

We also know that electric power converted into mechanical power in the armature,

$= E_b I_a$ watt.

we get $T_a \times 2\pi N = E_b I_a$

we know $E_b = \frac{P\phi 2N}{60A}$

$\Rightarrow T_a \times 2\pi N = \frac{P\phi 2N}{60A} \times I_a$

or $T_a = \frac{1}{2\pi} \times \frac{P\phi 2}{60A} \times I_a$

$\Rightarrow T_a = \frac{I_a}{120\pi} \times \frac{P\phi 2}{60A}$ N.m

$$T_a = \frac{I_a}{120\pi} \times \frac{P\phi 2}{60A} \text{ N.m}$$

Shaft torque of a motor:-

Tsh = Shaft torque

$$T_{sh} = \frac{\text{output in watts}}{2\pi N/60} \text{ N.m}$$

$$= \frac{60 \text{ output}}{2\pi N} \text{ N.m}$$

Note:- $T_a - T_{sh}$ = lost torque (due to Iron & friction losses)

(1) Emf equation of a transformer?

Ans:- Let N_1 = No of turns in primary coil.

N_2 = No of turns in secondary coil.

ϕ_m = Maximum flux in core in weber.

$= B_m \times A$

f = frequency of ac input (Hz)

$\phi_m = \phi_m \sin \omega t$

The instantaneous emf (e_1) induced in the primary is

$$e_1 = -N_1 \frac{d\phi}{dt} = -N \frac{d}{dt}(\phi_m \sin\omega t)$$

$$= -\omega N_1 \phi_m \cos\omega t = -2\pi N_1 \phi_m \cos\omega t$$

$$= 2\pi f N_1 \phi_m \sin(\omega t - 90^\circ)$$

It is clear from the above eqn. that maximum value of induced emf in the primary is

$$E_{m1} = 2\pi f N_1 \phi_m$$

The rms value of E_1 of the primary emf is

$$E_1 = \frac{E_{m1}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}} = 4.44 f N_1 \phi_m$$

Simillarly, $e \propto -\frac{d\phi}{dt}$

$e = -N\, 4.44 f \phi_m$

or $e = -N \frac{d\phi}{dt}$

$\therefore E_2 = 4.44 f \phi_m N_2$

The required eqn of transformer.

(Ans)

Assignment-4

Q-1 Explain Practical transformer on load & draw the phasor digram?

Ans:- Practical transformer on load :

Two cases : (i) When such a transformer is assumed to have no winding resistance and leakage flux.

(ii) When the transformer has winding resistance leakage flux.

(i) No winding resistance & leakage flux :-

→ Practical transformer with the assumption that resistance & leakage reactances of the winding are negligible.

Assumption, $V_2 = E_2$ & $V_1 = E_1$

→ Let us take the usual case of inductive load which causes (the 2°) current I_2 to lag the 2° voltage V_2 by ϕ_2

→ The total current I_1 must meet two requirements.

(a) It must supply the no load current to meet the iron losses in the transformer & to provide flux in the coil.

(b) It must supply a current I_2 in counter the demagnetizing effect of 2° current I_2 the magnitude of I_2 will be such that

$$N_1 I_2 = N_2 I_2$$

$$R_2 = \frac{N_2}{N_1} I_2 = K I_2$$

Phasor digram:-

E_1 & E_2 → Lag behind the mutual flux ϕ by 90°.

I_1 & I_2 → 1° & 2° current

$I_2 = KI_2$ & it antiphase with

E_2, I_0 => No load current of the transformer.

→ The value 'K' is assumed to be unity

So that

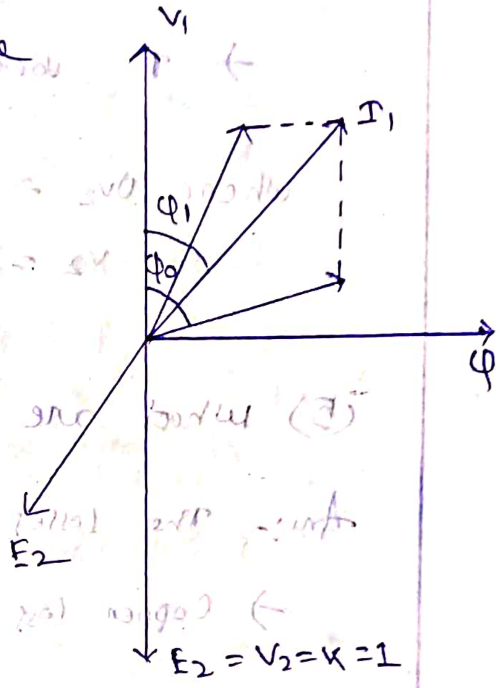
1° phasor S = 2° phasor

1° Power factor = $\cos\phi_1$

2° Power factor = $\cos\phi_2$

1° input power = $V_1 I_1 \cos\phi_1$

2° o/p power = $V_2 I_2 \cos\phi_2$



Q:2 What is equivalent secondary reactance?

Ans:- When secondary resistance or reactance is transfered to the primary, it is divided by K^2. It is then called equivalent secondary reactance.

It is denoted by R_2' or x_2

(3) What is Stepup & Stepdown transformer?

Ans:- (i) Step up transformer: In this transformer the input voltage is increased. Here input voltage

is less than output voltage

(ii) Step down transformer:- Here the input voltage is decreased. Here input voltage is more than output voltage.

(4) Define voltage regulation :-

Ans:- It is the arithmetic difference betn the no-load secondary voltage & the primary voltage on load expressed as % of no load voltage

→ voltage regulation $= \frac{OV_2 - V_2}{OV_2} \times 100$

where OV_2 → No-load secondary voltage

V_2 = secondary voltage on load

(5) What are the losses of ~~transmission~~ transformer :-

Ans:- The losses occur in a transformer :-

→ Copper loss → Eddy current loss, Hysteresis loss

→ Copper losses → In the resistance of the winding

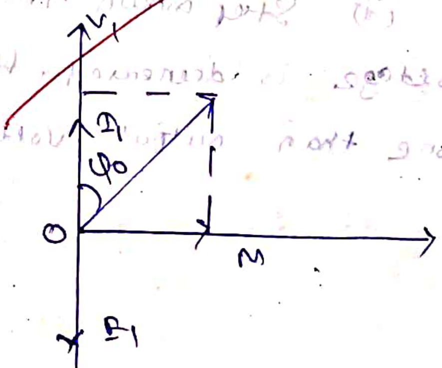
(6) Explain variable losses :-

Ans:- When the transformer is loaded, current flows in primary & secondary winding, there is loss of electrical energy due to the resistance of the primary winding & secondary winding & they are called variable losses.

→ In a transformer copper losses are variable.

(7) Draw the phasor diagram of practical transformer in no load condition.

Ans:-



(8) Derive voltage transformation ratio?

Ans:- Induced emf $= \frac{E_2}{E_1} = \frac{V_2}{V_1} = \frac{N_2}{N_1} = K$.

→ Here the constant 'K' is called as voltage transformation ration.

→ for an ideal transformer.

$K = 1$ [i.e $N_2/N_1 = 1$ then $E_2 = E_1$]

(9) Derive the emf equation of transformer?

Ans:- $\phi = \phi_m \sin \omega t$

induced emf in primary winding is

$$e_1 = -N_1 \frac{d\phi}{dt} = -N_1 \frac{d}{dt}(\phi_m \sin\omega t)$$

$$= -\omega N_1 \phi_m \cos\omega t = -2\pi N_1 \phi_m \cos\omega t$$

$$= 2\pi f N_1 \phi_m \sin(\omega t - 90°)$$

The maximum value of $\sin\theta = 1$

⇒ maximum induced emf in primary winding

$$e_{m1} = 2\pi f N_1 \phi_m$$

The rms value of induced emf in primary winding

$$E_1 = \frac{e_{m1}}{\sqrt{2}} = \frac{2\pi f N_1 \phi_m}{\sqrt{2}} = 4.44 f N_1 \phi_m$$

Similarly

$$E_2 = 4.44 f N_2 \phi_m$$

$$E_1 = 4.44 f N_1 \phi_m$$

(10) What is ideal transformer ?

Ans :- An ideal transformer is one that has

-) No winding resistance
-) No leakage flux
-) No iron losses.

(11) What is the working principle of transformer ?

Ans :- When an alternating voltage V_1 is applied in the primary site, an alternating flux ϕ is set up in the core.

-) This alternating flux links both windings & induced emfs E_1 & E_2 in them according to Faraday's law of electromagnetic induction.

(12) Derive the condition for maximum efficiency ?

Ans :- O/P power $= V_2 I_2 \cos\phi_2$

If R_{o2} is the total resistance of the transformer refered to secondary site.

Total Cu loss $= P_c = I_2^2 R_{o2}$

Total loss $= P_i + P_c$

$\therefore$ Transformer efficiency $\eta = \frac{V_2 I_2 \cos\phi_2}{V_2 I_2 \cos\phi_2 + P_i + I_2^2 R_{o2}}$

~~Total loss~~

for normal transformer V_2 = constant

-) for a load of given p.f efficiency depends upon a load current

$\frac{d}{dI_2}\left(V_2 \cos\phi_2 + \frac{P_i}{I_2} + I_2 R_{o2}\right) = 0$

$\Rightarrow P_i = I_2^2 R_{o2}$

$\therefore$ Iron loss = Copper loss

Assignment:- 4

(1) What is impedance ratio?

Ans:- Impedance matching audio transformers always give their impedance ratio value from one winding to another by the square of the their turns ratio. That is their impedance ratio is equal to its turns ratio squared and also its primary to secondary voltage ratio squared as shown.

$$\frac{Z_2}{Z_1} = \left(\frac{N_2}{N_1}\right)^2 = K^2$$

let Z_2 = Secondary impedance of a transformer

$\Rightarrow Z_2 = \frac{V_2}{I_2}$

$\Rightarrow Z_1 = \frac{V_1}{I_1}$

$\Rightarrow \frac{Z_2}{Z_1} = \frac{\frac{V_2}{I_2}}{\frac{V_1}{I_1}} = \frac{V_2}{I_2} \times \frac{I_1}{V_1}$

$\Rightarrow \frac{Z_2}{Z_1} = \frac{V_2}{V_1} \times \frac{I_1}{I_2} = K^2$

Similarly $\frac{R_2}{R_1} = K^2$, $\frac{X_2}{X_1} = K^2$

(2) Explain about sitting of X_2, R_2 with respect to with reference to primary side?

Ans:- When secondary quantities are referred to primary resistance / reactances are divided by K^2. Voltage are divided by K & currents are multiplied by K.

Actual Secondary voltage $V_2 = K V_2'$

Actual Secondary current $I_2 = I_2'/K$

$I_2' = K I_2$

$R_2' = \frac{R_2}{K^2}$ & $X_2' = \frac{X_2}{K^2}$

$V_2' = \frac{V_2}{K}$

$Z_2' = \frac{Z_2}{K^2}$

(3) Draw the equivalent crt of ideal transformer with prefer to primary side ?

Ans:- The equivalent circuit digram of a transformer is a simplified circuit in which the impedance, resistance leakage reactance of transformer can be more easily calculated.

$$I_2 = I_2' K.$$

$$Z_2' = K^2 Z_2$$

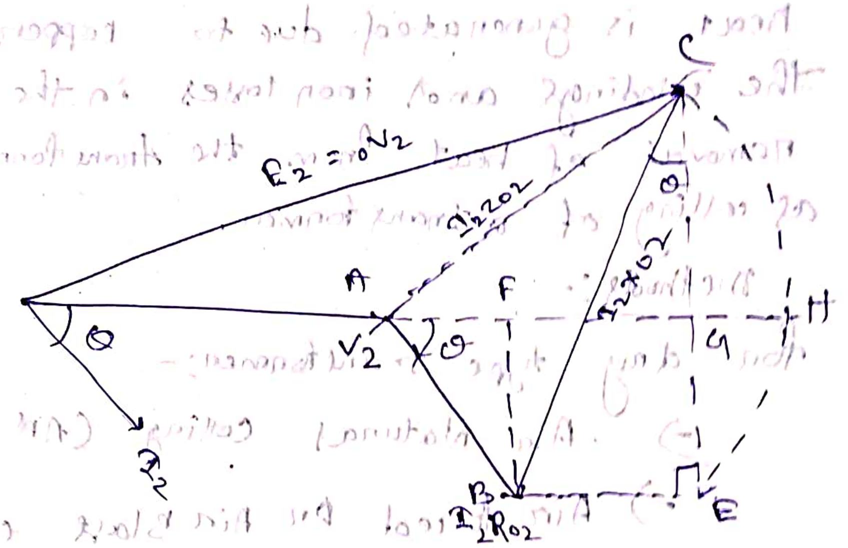
$$\Rightarrow Z_2 = \frac{Z_2'}{K^2}$$

$$R_2 = \frac{R_2^2}{K^2}$$

$$x_2 = \frac{x_2'}{K^2}$$

(4) Explain about the exact voltage drop with phasor diagram ?

Ans:-



During no-load condition, induced voltage at the primary of secondary winding ~~at the primary~~ are equal to the applied voltage of secondary terminal voltage respectively. If ${}_0V_2$ be the secondary terminal voltage at no load, we can write $E_2 = {}_0V_2$. Let V_2 be the secondary voltage on load.

Here $AG = AF + FG = AF + BE$

$$= I_2 R_{02} \cos\theta + I_2 X_{02} \sin\theta \quad \text{— eqn - A}$$

The approximate voltage drop shown in eqn - A for lagging power factor only.

For leading pf the approximate voltage drop will be

$$= I_2 R_{02} \cos\theta - I_2 X_{02} \sin\theta. \quad \text{— eqn B}$$

% voltage drop in secondary is

$$\frac{I_2 R_{02} \cos\theta \pm I_2 X_{02} \sin\theta}{{}_0V_2} \times 100$$

$$= V_r \cos\theta \pm V_x \sin\theta$$

(5) Explain about the colling method of transformer?

Ans:- When a transformer is in operation, heat is generated due to copper losses in the windings and iron losses in the core. The removal of heat from the transformer is known as colling of a transformer.

Methods:-

for dry type transformer:-

-> Air Natural colling (AN colling)
-> Air forced or Air Blast colling

for oil immersed type transformers

-> Oil Natural Air Natural (ONAN) colling
-> Oil Natural Air forced (ONAF) colling
-> Oil forced Air forced (OFAF) colling
-> Oil forced water forced (OFWF) colling