CMR INSTITUTE OF TECHNOLOGY	USN										

Internal Assesment Test –III

Sub:	BASIC ELECTRICAL ENGINEERING							Code:	21ELE23
Date:	30 /8/2022	Duration:	90 mins	Max Marks:	50	Sem:	2nd sem	Branch:	EE/EC/AI/AD

Answer any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1	What is earthing? Why earthing is required?. With neat diagram explain the different types of earthing.	[10]	CO5	L2
2 a)	With a neat diagram, describe the main parts of synchronous generator with their functions.	[5]	CO4	L2
2b)	The stator of a 3-phase, 8-pole, 750 rpm alternator has 72 slots, each of which contains 10 conductors. Calculate the rms value of the emf per phase if flux per pole is 0.1 wb sinusoidally distributed. Assume the coil is $5/6^{th}$ full pitched and winding distribution factor of 0.96.	[5]	CO4	L3
3 a)	With a neat diagram explain how a rotating magnetic field is produced in the air gap of ac machine when a three phase supply is given.	[5]	CO4	L2
3 b)	A 4 pole, 3300 V, 50Hz induction motor runs at rated frequency and voltage. The frequency of the rotor currents is 2.5 Hz. Find slip and running speed	[5]	CO4	L3
4 a)	Derive an expression for EMF induced in a single phase transformer. Compare between shell and core type transformers.	[5]	CO3	L1
4b)	List different types of loss in a transformer and explain each one in brief.	[5]	CO3	L2

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5 a)	What will happen if a transformer is supplied with DC input. Justify your answer.	[4]	CO3	L2
5 b)	A 40KVA, 1-phase transformer has core loss of 450 W and full load copper loss 850 W. If the power factor of the load is 0.8. Calculate (i) Full load efficiency (ii) Total losses at half load (iii) Maximum efficiency at unity power factor (iv) Load for maximum efficiency	[6]	CO3	L3
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$KVA = V \cdot I = 40 \times 10^3 \, VA$

5b. ~~P~~, $P_{core\ loss} = 450 W \ (P_i)$

P_{cu}, $P_{copper\ loss} = 850 W$ (Full load)

p.f = 0.8.

(i) Full Load efficiency, $\eta = \frac{o/p}{i/p} = \frac{VI\cos\phi}{VI\cos\phi + P_i + P_{cu}}$

$$\eta = \left(\frac{40 \times 10^3 \times 0.8}{40 \times 10^3 \times 0.8 \times 450 + 850}\right) \times 100$$

$$= \frac{32000}{32000 + 450 + 850} \times 100$$

$$= 96.09\%$$

(ii) Total Losses at half load

Total Losses $= P_i + P_{cu(half\ load)}$ $\qquad x = 1/2 = 0.5$.

$$= 450 + x^2 \cdot P_{cu}$$

$$= 450 + (0.5)^2 \times 850$$

$$= 662.5 \, W$$

(iii) ~~Maximum efficiency at UPF~~

Load for Maximum efficiency

$P_i = P_{cu}$ (at x load)

$P_i = x^2 \cdot P_{cu}$

$450 = (x)^2 \, 850$

$\Rightarrow x = \sqrt{\frac{450}{850}}$

$x = 0.7276$

(iii) Max efficiency at UPF.

Maximum efficiency occurs at $x = 0.7276$.

$p.f = 1$

$P_{cu(x)} = P_{iron}$ Loss. (At Max η)

$$\Rightarrow \eta = \frac{40 \times 10^3 \times 1}{40 \times 10^3 \times 1 + 450 + 450}$$

$$= 97.79\%$$

6 a) $VI = 50 \times 10^3$ VA

$N_s = 20$

$N_p = 300$

$V_p = 2200$ V

$f = 50$ Hz

i) $$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\Rightarrow V_s = \frac{V_p \cdot N_s}{N_p} = \frac{2200 \times 20}{300} = 146.66 \text{ V}$$

(ii) $V_s \cdot I_s = V_p \cdot I_p$

Also, $V_p I_p = 50 \times 10^3$

$$I_p = \frac{50 \times 10^3}{V_p} = \frac{50000}{2200} = 22.72 \text{ A}$$

Also, $$I_s = \frac{50 \times 10^3}{V_s} = \frac{50000}{146.66} = 340.924 \text{ A}$$

iii) Maximum flux density.

EMF at primary side, $V_p = E_p = 2200$.

$\Rightarrow E_p = 4.44 f \phi_m N_p$.

$\Rightarrow 2200 = 4.44 \times 50 \times \phi_m \times 300$

$\phi_m = 0.0330$ Wb.

Assume area = $60 cm^2$

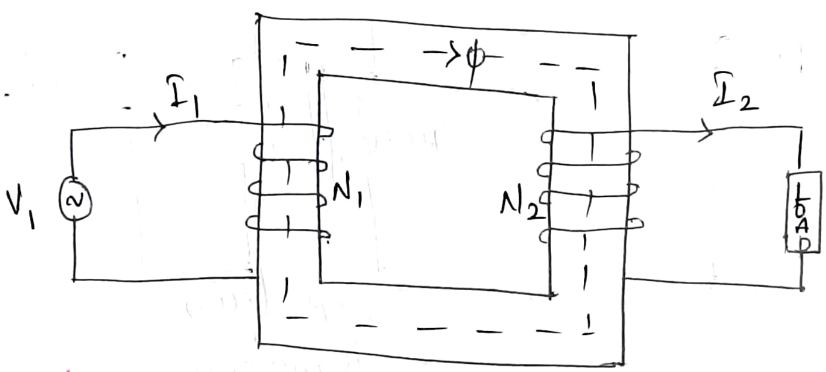
$\Rightarrow$ Flux density = $\frac{\phi_m}{Area} = \frac{0.0330}{60 \times 10^{-4}}$

$= 5.5 wb/m^2$

Coils / winding

primary Coils
→ Coil Connected to Supply.
→ Vertical portion of Steel Core.
→ Top or bottom portions
→ 2 Coils that are Electrically not Connected but are linked with one another through magnetic flux in the Core.

Secondary Coil.
→ Coil Connected to the lo
→ Limbs
→ Yokes.



Operation:—

2 principles Involved in the operation of transformer.

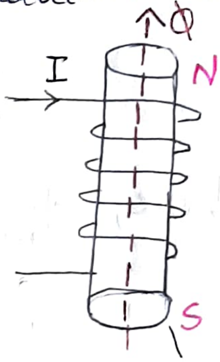
1. electromagnetism :— An Electric Current produces a magnetic field.

2. Electromagnetic Induction :— A change in magnetic field within a Coil Induces an Emf across the Ends of the Coil.

→ A change in the primary Circuit Creates a changing magnetic field, this in turn Induces a Voltage in the Secondary Coil.

I) Electromagnetism :-

- Assum a Conductor is Carrying Current as shown in fig.
- Wrap your fingers around the Conductor in direction of Current ; thumb points in the direction of magnetic field.



II) Electromagnetic Induction :-

a) **Self - Induction** :- WhenEver there is a change in the flux linked with a Coil, an Emf is induced, if the Emf is Induced in the Same Circuit, then it is "Self Induction".

b) **Mutual Induction** :- Assume there are 2 Coils placed nearer to Each other

- first Coil Carries Some Current I, which give rise to a magnetic field B.
- Since the 2 Coils are nearer some flux lines will link with the 2nd Coil also.
- Now as Current changes, dφ linked with the 2nd Coil also changes, hence an Emf Induced in the Second Coil also. } pre-requisites.

- when $N_2 > N_1$ → step - up transformer.
- when $N_1 > N_2$ → Step - down transformer.

EMF

Effect of slip on Rotor frequency :-

→ In Case of I.M, the Speed of rotating magnetic field is, $N_s = \frac{120f}{P}$.

→ At start, when $N=0$, $s=1$ and stationary rotor has maximum relative speed with respect to RMF. Hence maximum Emf gets Induced in the rotor at start.

→ The frequency of this Induced Emf at start is Same as that of Supply frequency.

→ As motor actually rotates with Speed N, the relative Speed of rotor w.r.t RMF decreases and becomes Equal to slip speed $N_s - N$.

→ As the Induced Emf in rotor depends upon rate of change of flux, i.e, relative speed $N_s - N$, it decreases and so as its frequency also decreases.

→ If f_r is the frequency of rotor, Induced Emf and rotor Currents, in running Condition at slip speed $(N_s - N)$ then there exists a fixed relation between $(N_s - N)$, f_r and P.

$$(N_s - N) = \frac{120 f_r}{P}$$

P = Rotor & Stator poles.

Dividing with N_s on both sides

$$\frac{N_s - N}{N_s} = \frac{120 f_r}{P N_s}$$

$$\frac{N_s - N}{N_s} = \frac{120 f_r}{P\left(\frac{120 f}{P}\right)} = \frac{f_r}{f}$$

$$S = \frac{f_r}{f}$$

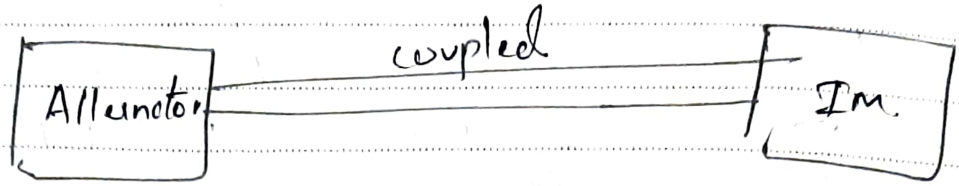
$$\boxed{f_r = S f}$$

→ The frequency of rotor Induced emf in running Condition (f_r) is Slip times the supply frequency (f).

in Induction Motor :-

IM

7b)



IM

$P = 4$.

The frequency of allernator and IM stator is the same

$\Rightarrow f_s = 50\,Hz$.

Alleinator

$P = 6$.

$N_s = 1000\,rpm$.

$f_s = \frac{P \cdot N_s}{120}$

$= \frac{6 \times 1000}{120} = 50\,Hz$

(i) $N_s = \frac{120 f_s}{P} = \frac{120 \times 50}{4}$

$= 1500\,rpm$

ii) N_r at slip $= 0.04$.

$N_r = N_s(1 - s)$

$= 1500(1 - 0.04)$

$= 1440\,rpm$

(iii) $f_r = s \cdot f_s$

$= \left(\frac{N_s - N_r}{N_s}\right) f_s$ // $N_r = 600$

$= \left(\frac{1500 - 600}{1500}\right) 50$.

$f_r = 30\,Hz$