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Assignment-3:-

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Q-1:- The core of 5MVA 33KV/11KV, 50Hz single phase transformer has a core cross sectional area of $1m^2$. Find the primary and secondary turns of the coil. and emf per turn of the coil, if maximum flux density allowed can be 1.3 Tesla.

Sol^n → Let No. of secondary turns $= N_2$

Now, Induced emf in secondary winding = 11 KV

Supplied frequency = 50Hz

$$\phi_{max} = \text{Core flux (max)} = \frac{E_2}{4.44 f N_2} = \text{max. flux density} \times a = 1.3 \text{ wb}$$

$$\therefore N_2 = \frac{E_2}{4.44 f \phi_{max}}$$

$$= \frac{11 \times (10)^3}{4.44 \times 50 \times 1.3}$$

$$\simeq 38$$

So, no. of secondary turns = 38

Now, Induced emf in primary winding = 33KV

and let no. of primary turns $= N_1$

$$\phi_{max} = \frac{E_1}{4.44 f N_1}$$

$$\therefore N_1 = \frac{33 \times 10^3}{4.44 \times 50 \times 1.3} \simeq 114.$$

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Thus, no. of primary turns of coil = 114,

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Q-2 → The core of 5MVA 33kV/11kV, 50Hz single phase transformer has turns Ratio as calculated in the above problem. find the primary and secondary current. Consider an ideal transformer

Soln → For an ideal transformer

$$\frac{I_2}{I_1} = \frac{V_1}{V_2}$$ [since there is no loss]

and $$\frac{V_1}{V_2} = \frac{E_1}{E_2}$$ [since, there is no voltage drop in winding]

Also, $$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

$$\therefore \frac{E_1}{E_2} = \frac{114}{38}$$ [from above problem].

$$\therefore \frac{I_2}{I_1} = \frac{114}{38} = 3$$

$$\therefore \boxed{I_2 = 3I_1}$$

VA rating of the transformer = $V_1 I_1 = V_2 I_2$

and given VA Rating = 5MVA

$$\therefore I_1 = \frac{5MVA}{(V_1 = E_1)} = \frac{5 \times 10^3 \times 10^3 \, VA}{33 \times 10^3}$$

$$= 151.5 \, A$$

similarly, $$I_2 = \frac{5 \times 10^3 \times 10^3}{11 \times 10^3} = 454.5 \, A$$

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Q.s. A moving coil ammeter has full scale Reading of 10A with internal Resistance of 1800Ω find the shunt Resistance to put across the internal Resistance to increase the Range to 100A. Also find multiplication factor. Prove that voltage drop is same for ammeter befor and after adding shunt Resistance.

Sol^n→ R_m = internal Resistance of coil = 1800Ω

I_m = full scale Reading of moving coil = 10Ω

Let R_{sh} = Shunt Resistance

Let n be the multiplication factor

$$n = \frac{100}{10} = 10$$

$$\Rightarrow R_{sh} = \frac{R_m}{n-1} = \frac{1800}{10-1} = \frac{1800}{9} = 200\Omega$$

So, shunt Resistance is 200Ω and multiplication factor = 10.

Let V_m be the voltage drop ~~of~~ across R_m

$\therefore V_m = I_m \times R_m = 10 \times 1800 = 18 \times 10^3$ = voltage drop [before adding shunt — (1)

Let V_{sh} be the voltage drop across shunt.

$\therefore V_{sh} = R_{sh} \times I_{sh}$

Now, $I_{sh} = I - I_m$

and $I = nI_m$

$\therefore I_{sh} = (n-1)I_m = 9 \times 10 = 90$

$\therefore V_{sh} = 90 \times 200 = 18 \times 10^3$.

Now, shunt and coil are in parallel so voltage drop after adding shunt Resistance $= 18 \times 10^3$ — (2)

From ① and ②,
Thus, voltage drop before adding shunt = voltage drop after adding shunt $= 18 \times 10^3$

H.P.

Q-4. The Resistance of a moving coil voltmeter is 12 kΩ. It has 90 turns and it is 25 mm long and 15 mm wide. The flux density in the air gap is $0.08\ Wb/m^2$. Calculate the deflection torque produced by the instrument when 230V is applied to the instrument. If 1.5×10^{-6} Nm of force is required for producing one Radian deflection, find the deflection angle.

Soln → Total deflecting torque exerted on the coil $= Bilnb$

where, B = flux density
i = current
l = length
b = breadth, and n = no. of turns

$$i = V/R = \frac{230}{12 \times 1000}$$

$$\therefore \tau_d = 0.08 \times \frac{230}{12 \times 1000} \times 25 \times 10^{-3} \times 15 \times 10^{-3} \times 90$$

$$= 0.05175 \times 10^{-3}$$

$$= 5.175 \times 10^{-5}$$

Now, Control torque of spring is $= \tau_c = K_s \times \theta$

at Equillibrium, $\tau_d = \tau_c$

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Now, $K_s = \frac{1.5 \times 10^{-6}}{1 \text{ Radian}} = \frac{1.5 \times 10^{-6} \times \pi}{180}$

θ = deflection angle $= \frac{T_d}{K_s}$

$= \frac{5.175 \times 10^{-05} \times 180}{1.5 \times 10^{-6} \times \pi}$

$= 1975.9°$

Or

$\theta = 34.5$ Radian.