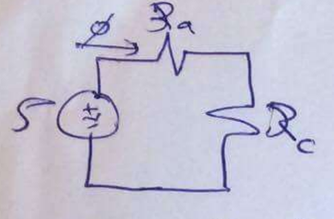
Q1)Fill in the following BLANKS [17]

1. The basic principle which describe how magnetic fields are used and related to motor action is[~~Flux~~ when a coil ~~with~~ carrying current put it [illegible] , in a magnetic field then mechanical force moves it.
2. Counterpart of electrical resistance in magnetic circuit is [reluctance
3. The extra area of an air gap in magnetic circuit is called [Fringing ~~flux~~ area
4. The region between unsaturated and saturated is called [Knee region
5. The shape of the curve between μ_r and H is as follows $B = \mu H$
6. The type of core losses which α f^2 is called [eddy current] and second reduced by means of [~~laminations between each pairs insulated material~~ Flux
7. Flux Linkage is [the Flux that ~~follows~~ flows in the core and cut coil turns of primary
8. Transformers which are used in measurement are called [volt ampere transformers
9. The type of transformer which has single rectangular core is [core type
10. The reactance of transformer primary circuit is used to represent [~~leakage~~ leackage Flux on the primary side
11. The magnetization current of transformer has [sinusoidal] shape.
12. The type of test used to determine excitation current is [open circuit test
13. In per-unit system the base value of [apparent power] does not change at every [side ~~or level~~] in the system.
14. Negative regulation of a transformer occurs when [change the load from resis to inducti
15. Inrush current is minimum when [No phase shift

Q2) A series magnetic circuit consists of a ferromagnetic core and an air gap which has the same area as the core and equal 12.6 cm^2.If the followings are given: applied mmf=240.8 At, core's reluctance equal 66300 At/wb and flux equal 0.00063 wb, find air gap length. [10]

$\mathcal{R} = \frac{l_c}{\mu A}$, $\phi = \frac{\mu A N i}{l_c}$

$\mathcal{F}_{\mathcal{R}_a} = \frac{\mathcal{F} * \mathcal{R}_a}{}$



$\mathcal{F} = \phi(\mathcal{R}_a + \mathcal{R}_c)$

$240.8 = 0.00063(\mathcal{R}_a + 66300)$

$\mathcal{R}_a = 3159222$ At/wb

$\mathcal{R}_a = \frac{l_a}{\mu_0 A} \rightarrow l_a = 5.002 \times 10^{-4}$ m

Q3) A 20-kVA, (8000/240)V, 60 Hz transformer has the following parameters referred to HV side: R_C =160 kΩ and X_m=38.4 kΩ . If an O/C test is performed on this transformer using CONVENTIONAL procedure, evaluate the expected readings of the measuring instruments at this test. Illustrate your answer by drawing the necessary circuit. [18]

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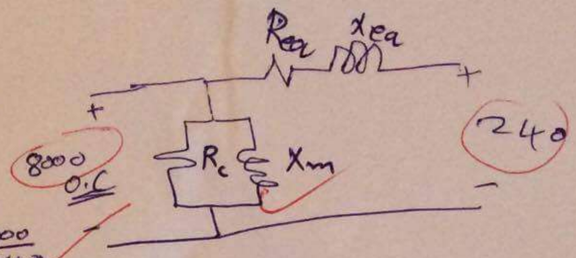
O.C on L.V side by convention

$V = 240V$ by convention on L.V side



$I_{o.c} = \frac{V_{o.c}}{Z_{L.V}}$

$= \frac{240}{(144 + J34.56)}$

$I_{o.c} = 1.62\angle{-13.49}$

$Z_{L.V}$:

$R_{L.V} = \frac{160k\Omega}{(33.333)^2}$ $a = \frac{8000}{240}$ $a = 33.333$

$= \frac{R_{H.V}}{a^2}$

$R_{c.LV} = 144.0\Omega$

$P = \frac{V^2}{R} = 400$ Watt

$X_{m.LV} = \frac{X_{H.V}}{a^2}$

$X_{m.LV} = 34.56\ \Omega$

O.C oN L.V side

$V = 240V$

$I = 1.62$

$P = 400$ watt

$PF = 0.972$ leading

$R_{C.LV} = 144.0$

$X_{m.LV} = 34.56$

Q4) A 5000 kVA (115/13.8) kV transformer has PU impedance equal to Z=0.01+j 0.05 based on the transformer rating.
If the terminal voltage on the secondary is 13.8 kV and the power supplied is 4000 kW at 0.8 pf lagging, then by drawing the equivalent circuit using ACTUAL values and referred to the secondary, evaluate:
a-Voltage regulation. [10]
b-Efficiency. [5]

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#power_unit

$S_b = 5000 kVA$

$V_b = 13.8 kV$

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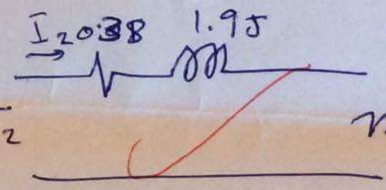
$$Z_b = \frac{V_b^2}{S_b} = 38.088 \Omega$$

$$Z_{pu} = \frac{Z_{actual}}{Z_{base}}$$

$$Z_{actual} = (0.01 + J0.05) * 38.088 = 0.38 + 1.9J \Omega$$ → referred to secondary



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a) $$VR\% = \frac{|V_{2NL}| - |V_{2FL}|}{|V_{2FL}|} * 100\%$$

2 $V_{2FL} = 13.8 kV$

2 V_{2NL} = ? by KVL

$$E_2 = I_2(0.38 + 1.9J) + V_2$$ (13.8kV)

$$I_2 = \frac{P}{V * PF} = \frac{4000 * 10^3}{13.8 * 10^3 * 0.8}$$

$I_2 = 362.31 A$ (1%)

$E_2 = 13954.67 \angle 2.827 V$

$|E_2| = 13954.67 V$

$$VR\% = \frac{13954.67 - 13800}{13800} * 100\%$$

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$VR\% = 1.12\%$

$$\frac{4000}{4000 + i^2 R}$$

$$\eta = \frac{P_{output}}{P_{input}} = \frac{output}{output + P_c + P_{electrical}} = \frac{V_2 I_2 \cos\theta}{V_2 I_2 \cos\theta + \ldots} = \frac{13800 * 362.31 * 0.8}{13800 * 362.31 * 0.8 + \ldots}$$

... (4000 ...) = 80%

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