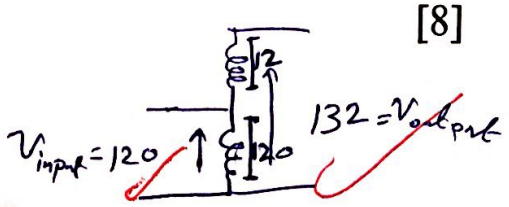
Q1) A 120/132 V, 1100 VA Autotransformer is constructed from a Conventional Transformer (CT). Find the current rating of the HV winding of CT. Illustrate your solution by drawing the necessary circuit. [8]

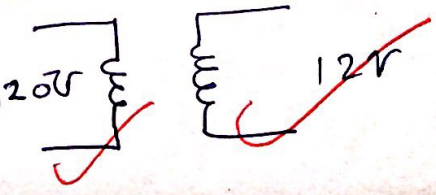
$V_{Input} = 120 = V_c$

$V_{se} = 132 - 120 = 12V$



$\frac{S_{I/O}}{S_W} = \frac{N_c + N_{SE}}{N_{SE}} \rightarrow S_W = 1100 * \left(\frac{12}{12+120}\right)$

$S_W = 100 VA$



$I_{H.V} = \frac{S_W}{V_H} = \frac{100}{120} = 0.833 A$

Q2) A 3-ph transformer bank is to handle 500 kVA and have a (34.5/13.8) kV voltage ratio.

2.1 Find the rating of EACH individual transformer for open Δ-connection. [5]

$S_{each\ transformer} = \frac{S_{3\phi.transformer}}{2}$

For open-Δ bank:

rating voltage of transformer [1] AB = (34.5/13.8) kV

transformer [2] = (34.5/13.8) kV

$\frac{S_{V-V}}{S_{\Delta-\Delta}} = \frac{\sqrt{3} V_\phi I_\phi}{3 V_\phi I_\phi}$

$S_{V-V} = 288.675 kVA$

$\frac{S_{V-V}}{S_{2\,trans.}} = \frac{288.675\sqrt{3} V_\phi I_\phi}{2 V_\phi I_\phi}$

$S_{each\ transformer} = 166.66 kVA$

2.2 If the 3-ph transformer is Y-Δ and used as step-down, find the rated secondary phase current. [4]

$V_{\phi primary} = \frac{34.5k}{\sqrt{3}} = 19.918 kV$

$V_{\phi secondary} = 13.8kV \rightarrow I_{\phi secondary} = \frac{S}{3 V_{\phi secondary}} = \frac{500k}{3} / 13.8k = 12.077A$

2.3 If the 3-ph transformer is Dy and its pu impedance Z=0.01+j0.07 find the transformer's impedance in Ω referred to LV side. [4]

L.V side is Y connection

$Z_{pu} = \frac{Z_{actual}}{Z_{base}} \Rightarrow Z_{actual} = 380.88 (0.01 + j0.07)$

$Z_{base} = \frac{3 V_{\phi b}^2}{S_{\phi b}} = \frac{\left(\frac{13.8k}{\sqrt{3}}\right)^2}{\frac{500k}{3}}$

$Z_{base} = 380.88 \Omega$

$Z_{actual} = 3.8088 + 26.6616 j \Omega$

Q3) Three single phase transformers each one is rated at 25 kVA (24000/277) V are connected in Δ-Y. In the O/C test the LV side was the primary and the following readings were obtained:

$V_{Line} = 480$ V $I_{Line} = 4.1$ A $P_{3ph} = 945$ W

3.1 Find the corresponding per phase values of the readings. [4]

$V_{\phi,LV} = 277$ V , $I_{\phi,LV} = \frac{S_\phi}{V_{\phi,LV}} = 90.252\,A = \frac{25\,kVA}{277}$

$P_\phi = \frac{945}{3} = 315\,W$

3.2 Use (3.1) to find the values of transformer resistance & reactance. [5]

$R = \frac{V^2}{P} \rightarrow R = \frac{(277)^2}{315} = 243.58\,\Omega$

$|Y| = \frac{I_\phi}{V_\phi} = 0.325\,S$

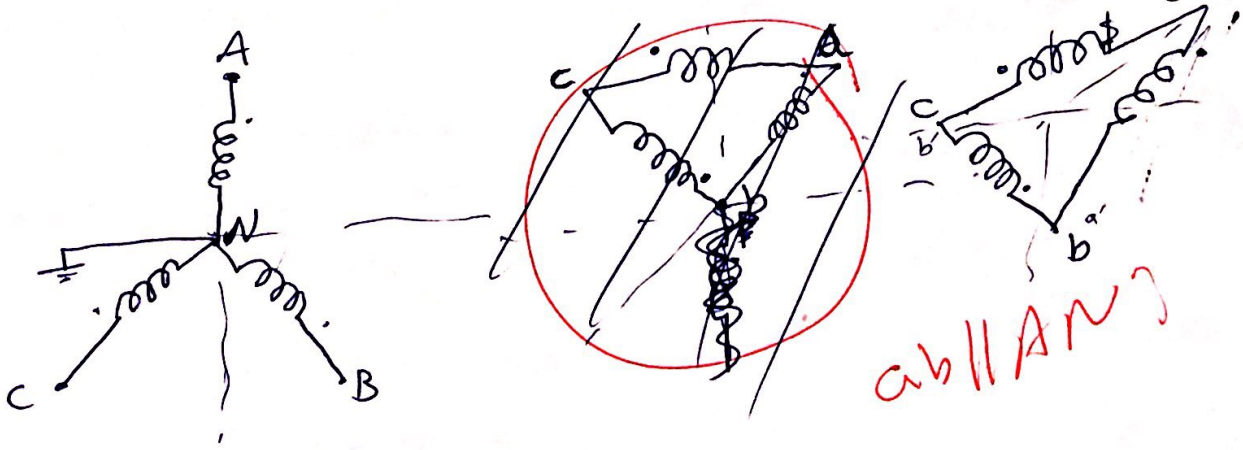
$|Y| = \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X}\right)^2} \rightarrow \frac{1}{X} = \sqrt{|Y|^2 - \left(\frac{1}{R}\right)^2} \Rightarrow X = 3.069\,\Omega$

Q4) For the connection designation YNd1:

4.1 Explain what it means. [4]

3 phase transformer with brought out neutral in the high voltage side and this high voltage side in star connection and low voltage side with delta connection without neutral and H.V leads L.V by 30°.

4.2 Draw its equivalent connection diagram by showing the proper terminal markings according to conventional method. [6]



Q5) a-For the given direction of current in Fig. 1, identify the POLARITY of poles and direction of ROTATION for the machine if it is operated as GENERATOR [4]

by R.H.R

Fore Finger → magnetic field

Thumb → ~~direction of motion~~ Force direction

middle → ~~induced~~ generated Voltage

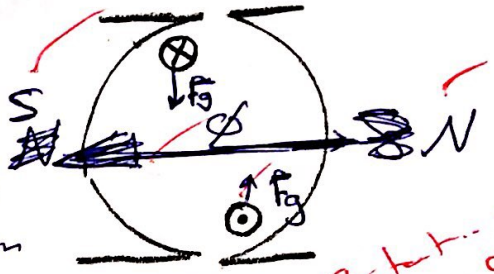


Fig. 1

Rotation CW / CCW

b-A simple single turn DC machine has the following dimensions:

$r = 0.5$ m $\quad l = 1$ m $\quad R_A = 0.3\ \Omega$ $\quad B = 0.5$ T

b.1 If the machine has 4 poles, find the flux per pole. [4]

$\phi = B A_p \rightarrow A_p = \frac{2\pi r l}{2P} = \frac{\pi r l}{2} = \frac{0.5 * 1 * \pi}{2} = \frac{1}{4}\pi$

$\phi = \frac{1}{4}\pi * 0.5 = \frac{1}{8}\pi$ A.t/~~wb~~

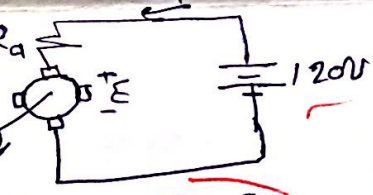
b.2 If the machine has 4 poles, the applied voltage is 120 V and the armature current is 40 A, evaluate the speed of the machine. [6]

$V = 120$V $\quad I_a = 40$A

$E = B l v = \frac{2}{\pi}\omega\phi_{APB}$

$= \omega r l$

$= \omega \frac{2}{\pi} A_{PB}$ $\quad A_p = \frac{\pi r l}{2P}$



$E = 120 - I_a R_a$

$\omega = \frac{120 - I_a R_a}{\frac{E\phi}{\frac{4}{\pi}}} = \frac{120 - 40 \times 0.3}{2 \frac{1}{8}\pi * \frac{2}{\pi}}$

$120 + R_a I_a + E = 0$

$\omega = 216$ rev/s

c-A six-pole dc machine has 72 coils on its armature, 10 turns/coil and each turn has a resistance of 0.02 Ω. If the machine has Simplex Lap winding:

c.1 Evaluate the armature resistance per path. [4]

$P = 6 \quad \#C = 72$ turns/coil = 10 $\quad R = 0.02$/turn $\quad$ ms1

it is lap → $a = mp = 1 * 6 = 6$ paths

armature resistance $= 0.02 * 10 * 72 = 14.4\ \Omega \rightarrow \frac{14.4}{6} = 2.4\ \Omega$/path

c.2 If the rated current of the coil is 5 A, find the rated current of the machine. [2]

current for each coil = 5A → there are 72 coils

$I_{rated\ for\ the\ machine} = 72 * 5 = 360$ A