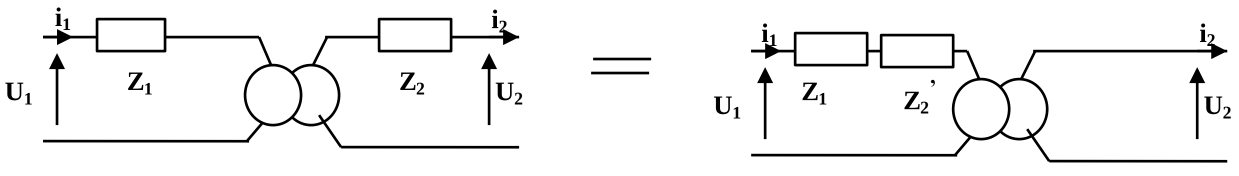
Solution de la fiche de TD 2

Exercice N^{O}1 :

Z_1= 0.72+j0.92 Ω.
Z_2= 0.007+j0.009Ω.

1- Coté primaire (HT) : Zp

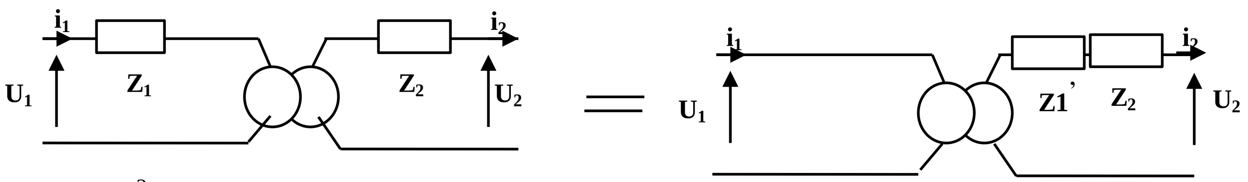


$Z_p= Z_1+Z_2' = Z_1+ Z_2/m^2$

$m= U_2/U_1$ = 240/2400= 0.1

Z_p= 1.42+j1.82 Ω.

2- Coté secondaire (BT) : Z_s



$Z_s= m^2 Z_1+ Z_2$

Z_s= 0.0142+j0.0182 Ω.

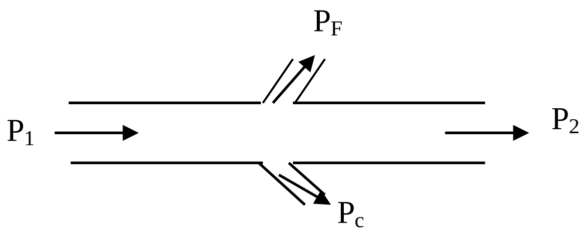
Exercice N^{O}2 :

1- m= $\frac{U20}{U10} = \frac{U2}{U1} = \frac{N2}{N1} = \frac{I1}{I2}$

m = $\frac{U20}{U10} = \frac{225}{1500} = 0.15$ (transformateur abaisseur)

$I_{2N} = \frac{Sn}{U2N} = \frac{44000}{225} = 195.5\ A.$

2- P_F = 300 w
3- m= $\frac{I1cc}{I2cc}$ = > $I_{2cc}=I_{1cc}$ /m= 200 A.
4- P_c= 225 w.
5- $P_2= U_2I_2\cos\Phi_2$ = > P_2=35.4 kw.
6- P1= P2+ Ʃ pertes = > P1= 35.9 kw



7-$\eta=\frac{P2}{P1}$; η = 98.5%.

Exercice N^{O}3 :

1.

1.1 Rapport de transformation :

$m= U_{20}/U_1 =44/220= 0.2.$

$N_2= m*N_1= 0.2*520= 104$ spires.

1.2

$r_1= U_1/I_1= 5/10=0.5\ \Omega.$

$P_{10}= P_F+ r_1\ I_{10}^2$

Soit $P_F= P_{10}-r_1 I_{10}^2 = 80- 0.5\ I_{10}^2 = 79.5$ w.

(Les pertes joule pour cet essai sont négligeables, elles représentent 1% des pertes totales).

Les pertes mesurées lors de l'essai en court- circuit sont :

$P_{1cc} = P_c+P_F$

$P_F= K^* U_1^2 => K= P_F/U_1^2 =80/ 220^2= 1.65\ 10^{-3}$ (pour l'essai à vide)

Pour l'essai en court-circuit $U_{1cc}= 40$ v d'où $P_F= 1.65\ 10^{-3} *40^2 =2.64$ w

Soit $P_c =P_{1cc}- P_F=250 -2.64= 247.4$w

(Les pertes fer pour cet essai sont négligeables elles représentent 3% des pertes totales).

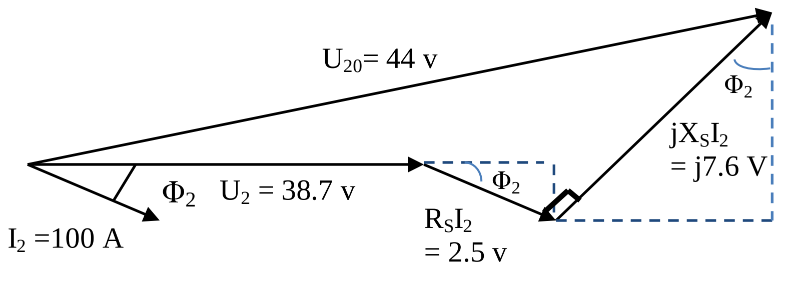
1.3 Les valeurs de X_S et R_S

$P_{1cc}= R_S *I_{1cc}^2 => R_S = P_{1CC}/I_{2CC}^2 = m^2 * P_{1CC}/I_{1CC}^2= 0.2^2 *250/20^2 =25\ m\Omega.$

$mU_{1CC} = Z_S* I1_{CC} / m => ZS = m^2 * U_{1CC}/I_{1CC}= 80\ m\Omega.$

$XS =\sqrt{ZS^2 - RS^2} = 76\ m\Omega.$

2.1 $U_2 = U_{20} - (2.5*0.9+7.6*0.4)= 38.7$ v , Le courant I_2 est en retard parce que la charge est inductive



$P_2= U_2*I_2*\cos \Phi_2 = 3.46$ kw.

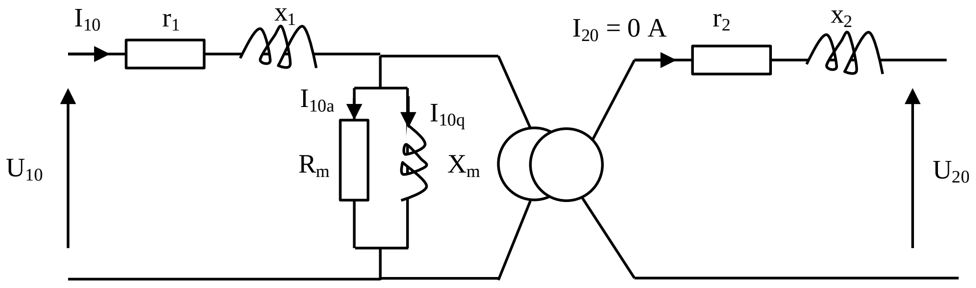
2.2

$P_1=P_2+P_F+P_C$ = 3460+80+250= 3.78 kw.

Cos $\Phi_1 = P_1/ U_1 I_1$ =3786 /220.20 = > cos Φ1= 0.86. (I1 = m* I2= 0.2*100 = 20 A)

Exercice N^{O}4 :

1- Schéma equivalent à vide



$P_{10}= U_{10} I_{10} \cos\Phi_{10} = U_{10} I_{10a}$

$\cos\Phi_{10}= P_{10} /(U_{10} I_{10)}$ = 171/ (1400*2) = > $\cos\Phi_{10}$ =0.06107

$I_{10a}=I_{10} \cos\Phi_{10}$ =2*0.06107= 0.12214 A

I_{10q}= I10 sin Φ_{10} = 2*0.9981= 1.99626 A

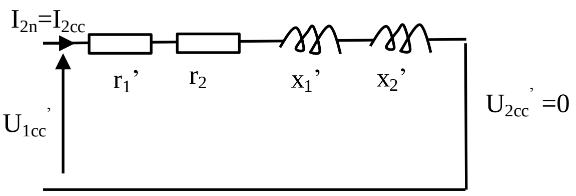
$P_{10}= R_m* I_{10a}{}^2$ = > $R_m = P_{10}/ I_{10a}{}^2$ = > $R_m = 171/ 0.12214^2$ = > R_m= 11462.52 Ω

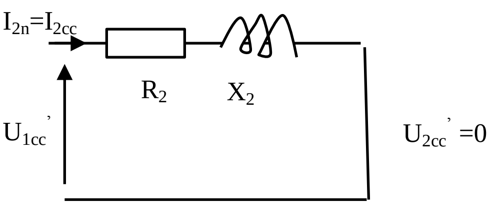
Où

$R_m= U_{10}{}^2/P_{10}$ = > $R_m =1400^2/ 171$= > R_m = 11462 Ω

$R_m I_{10a}= X_m I_{10q}$ = > $X_m= R_m I_{10a}/ I_{10r}$ = > X_m = 701.3 Ω

2- Schéma équivalent en court- circuit :





$U_{1cc}{}^{'}$ = m U_{1CC} = 0.1*30= 3v.

$P_c = R_2 I_{2CC}{}^2$ = > $R_2= P_c / I_{2CC}{}^2$ = > R_2= 400 / 200^2 = > R_2 = 0.01 Ω.

$r_2=r_1' = R_2/ 2$ = 0.01/ 2 = > $r_2=r_1'$ = 0.005 Ω.

$r_1'= m^2r_1$= > $r_1 = r_1' / m_2$ = > r_1 = 0.5 Ω.

$Z_2= U_{1cc}{}^{'} / I_{2CC}$ = 3/200 = 0.015 Ω

$X_2 = \sqrt{Z2^2 + R2^2} = \sqrt{0.015^2 + 0.01^2} = 0.0112\ \Omega$

$x_2 = x_1' = X_2/2 = 0.01/2 => x_2 = x_1' = 0.056\ \Omega$.

$x_1' = m^2 x_1 => x_1 = x_1' / m_2 => x_1 = 0.56\ \Omega$.

Exercice N^{O}5:

1- Puissance utile du transformateur :
$P_2 = U_2\ I_2 \cos \Phi_2 = 130 . 350 .1 => 45500$w.

2- Pertes totales par effet joule :

$P_j = r_1 I_1^2 + r_2 I_2^2 = 6. 10^2 + 0.01\ 350^2 => P_j = 1825$ w

3- Le rendement

$\eta = P2/ (P2 + \sum \text{pertes}) = 45500 / (45500+400+1825) => \eta = 95.5\ \%$

4- $P_F = 400$ w (déterminée à vide)

$\eta_{max} \longrightarrow P_F = P_J$

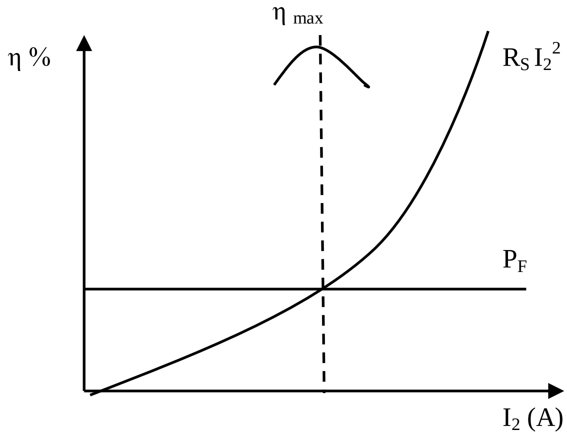
$Pj = (m^2 r_1 + r_2) I_2^2$

$\swarrow$ R_S

$m = N_2/N_1 = 24/840 = 0.0285$

$=> I_2 = 165$ A

$\eta_{max} => P_F = PJ\ (P_c) => \eta_{max} = 96.4\ \%$



Exercice N^{O}6:

1- Amplitude du champ magnétique
En utilisant le théorème de Boucherot
$U_1 = 4.44 * N_1 * S * f * \beta$, on déduit
$\beta = U_1 / (4.44 * N_1 * S * f) => \beta = 1.6$ T.

2- $N_2/N_1 = U_2/U_1 => N_2 = N_1 U_2/U_1 => N_2 = 595$ spires
3- $I_{1n} = S_n/U_{1n} => I_{1n} = 28$ A , $I_2 = I_{1n}/m => I_2 = 400$ A.
4- Pour un transformateur parfait
$P_1 = P_2$ et $Q_1 = Q_2$
$P2 = 700 .350 .0.6 = 147$ kw $=> P_1 = P_2 = 147$ kw.
$Q2 = 700.350. 0.8 = 196$ kVAR $=> Q_1 = Q_2 = 196$ kVAR .

Exercice N^{O}7:

1- En utilisant le théorème de Boucherot

$U_1 = 4.44 *N_1* S *f* \beta$, on déduit

$N_1= U_1/ (4.44 * S*f* \beta)= 5000/(4.44*60\ 10^{-4} * 50*1.1)$ = > N_1= 3413 spires

2- Rapport de transformation m et le nombre de spires secondaire N_2

$m= U_{20}/ U_1 = 230/5000 =0.046$

$N_2= m* N_1$ = > N2 = 0.046* 3413 = 157 spires

3- facteur de puissance à vide de ce transformateur $\cos\Phi_{10}$

$P_{10}= U_1 . I_{10}. \cos \Phi_{10}$ = > $\cos \Phi_{10} = P_{10} / (U_1 . I_{10})$ = > $\cos \Phi_{10} = 250 / (5000*0.5)$= = > $\cos \Phi_{10} = 0.1$.

4- $S_n = U_{2n}\ I_{2n}= U_{1n}\ I_{1n}$ == > $I_{2n} = S_n/ U_{2n}$ == > I_{2n}= 91.3 A.

5- $R_s= P_{1cc}/ I_{2cc}^2 = 300/ 91.3^2$ == > R_s= 36 m Ω.

6- $Zs= m * U_{1cc}/ I_{2cc}$ == > Zs = 0.1 Ω.

Xs = $\sqrt{Zs^2 + Rs^2}$ = 94 mΩ.

7- Rendement de ce transformateur:

Il faut d'abord déterminer la tension au borne de la charge U_2 en utilisant la méthode graphique :

$\Delta U_2= U_{20}- U_2 = Rs\ I_2 \cos \Phi_2 + Xs\ I_2 \sin \Phi_2$

$\Delta U_2 = 36\ 10^{-3} * 91.3* 083 + 94\ 10\text{-}3*91.3*0.56$ == > ΔU_2 = 7.51 v

$U_2= U_{20}- \Delta U_2 = 230- 7.51 = 222.5$ v.

$P_2= U_2\ I_2 \cos \Phi_2 = 222.5* 91.3* 0.83 = 16.860*10^3$ w

$P_1 = P_2 + \sum \Delta p= 16.86\ 10^3 +250+300 = 17.41\ 10^3$

Le rendement $\eta = P_2/P_1$ == > η = 96.8 % .