ENG231 - Electrical Machines And Transformers - Assesment 2 Lab 4

Baley Eccles - 652137

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Contents

1 ENG231 - Electrical Machines And Transformers - Assesment 2 Lab 4

Data Collected During Lab

1.1 Name Plate

VA ratings	500
Primary voltage (V)	240
Secondary voltage (V)	115
Primary current (A)	2.1
Secondary current (A)	4.4
Turns ratio	2.1

1.2 DC Test

Primary resistance (R_{1dc}) (Ω)	1.5
Secondary resistance (R_{2dc}) (Ω)	0.4

The primary side has a higher resistance than the secondary side, this is because the primary side has more turns.

$$
\begin{aligned}
a &= 2.1 \\
R_{eqHV} &= a^2 R_2 + R_1 \\
R_{eqHV} &= 3.242\Omega \\
R_{eqHV} &= (1/a)^2 R_1 + R_2 \\
R_{eqHV} &= 1.12\Omega
\end{aligned}
$$

1.3 Open Circuit Test

	Primary				Secondary
	V1	I1	Poc	PF	V2
LV side open	110	0.563	10.3	0.165	220
HV side open	240	0.375	12.5	0.138	120

LV side open

$$
\begin{aligned}
a &= \frac{V_2}{V_1} \\
a &= 2
\end{aligned}
$$

HV side open

$$
\begin{aligned}
a &= \frac{V_2}{V_1} \\
a &= 2
\end{aligned}
$$

LV side open

$$
\begin{aligned}
PF &= \frac{P_{oc}}{V_1 I_1} \\
&= 0.16631
\end{aligned}
$$

HV side open

$$
\begin{aligned}
PF &= \frac{P_{oc}}{V_1 I_1} \\
&= 0.13889
\end{aligned}
$$

The calculated power factor is very close to the measured power factor.

LV side open

$$
\begin{aligned}
R_{c1} &= \frac{V_1^2}{P_{oc}} \\
&= 1174.76\Omega \\
X_{m1} &= \frac{V_1}{\sqrt{I_1^2 + \left(\frac{V_1}{R_{c1}}\right)^2}} \\
&= 192.73\Omega
\end{aligned}
$$

HV side open

$$
\begin{aligned}
R_{c1} &= \frac{V_1^2}{P_{oc}} \\
&= 4680\Omega \\
X_{m1} &= \frac{V_1}{\sqrt{I_1^2 + \left(\frac{V_1}{R_{c1}}\right)^2}} \\
&= 633.92\Omega
\end{aligned}
$$

TODO

1.4 Short Circus Test

	Primary				Secondary
	V1	I1	Psc	PF	I2
LV side Short circuited	7	1.76	10	0.863	3.5

$$
\begin{aligned}
R_{eq} &= \frac{P_{sc}}{I_1^2} \\
&= 3.228\Omega \\
X_{eq} &= \sqrt{\left(\frac{V_1}{I_1}\right)^2 - R_{eq}^2} \\
&= 5.123\Omega
\end{aligned}
$$

$$
\begin{aligned}
PF &= \frac{P_{sc}}{V_1 I_1} \\
&= 0.81169
\end{aligned}
$$

The calculated power factor matches the measured one. TODO

1.5 Performance Test / Full Load Test

```
clear
clc
close
V2=[120, 120, 119, 118, 118, 117, 116, 115];
P1=[12, 80, 102, 147, 191, 277, 409, 537];
P2=[0, 67, 90, 133, 177, 262, 386, 509];
I2=[0, 0.56, 0.753, 1.12, 1.5, 2.2, 3.3, 4.4];
Eff=P1./P2;

subplot(2, 1, 1);
plot(I2, V2, 'o', 'LineWidth', 2);
xlabel('Secondary Current (A)');
ylabel('Measured Secondary Voltage (V)');
title('Measured Secondary Voltage vs. Secondary Current');
grid on;

subplot(2, 1, 2);
plot(I2, Eff, 'o', 'LineWidth', 2);
xlabel('Secondary Current (A)');
ylabel('Efficiency');
title('Efficiency vs. Secondary Current');
grid on;

title('Voltage and Efficiency vs. Secondary Current');
```

1.6 Three-phase Transformer Configurations

1.6.1 Y-Y Connected Transformer

	Primary Side				Secondary Side	
Quantity	Expected	Observed		Quantity	Expected	Observed
VRN	139	139		Vrn	139	139
VWN	139	141		Vwn	139	142
VBN	139	139		Vbn	139	139
VRW	240	243		Vrw	240	243
VWB	240	243		Vwb	240	243
VBR	240	240		Vbr	240	240

1.6.2 Δ-Y Connected Transformer

	Primary Side				Secondary Side	
Quantity	Expected	Observed		Quantity	Expected	Observed
VRW	181	183		Vrn	181	180
VWB	181	181		Vwn	181	183
VBR	181	181		Vbn	181	181
				Vrw	315	315
				Vwb	315	315
				Vbr	315	320

1.6.3 Y-Δ Connected Transformer

	Primary Side				Secondary Side	
Quantity	Expected	Observed		Quantity	Expected	Observed
VRN	139	141		Vrw	139	141
VWN	139	142		Vwb	139	140
VBN	139	140		Vbr	139	140
VRW	240	245				
VWB	240	243				
VBR	240	242				

1.6.4 Δ-Δ Connected Transformer

	Primary Side				Secondary Side	
Quantity	Expected	Observed		Quantity	Expected	Observed
VRW	240	243		Vrw	240	243
VWB	240	243		Vwb	240	243
VBR	240	240		Vbr	240	240