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https://www.youtube.com/watch?v=LZWylTLyTfg

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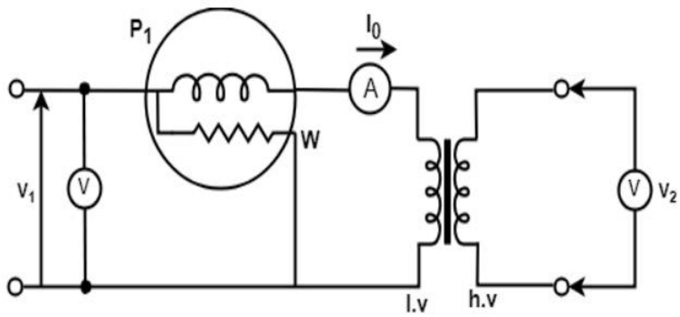
EEE 3003 Electromechanical Energy Conversion

SHORT CIRCUIT AND OPEN CIRCUIT (NO LOAD) TEST

Introduction

This report encapsulates the design, implementation, and analysis of Short Circuit and Open Circuit tests for a single-phase transformer circuit using Matlab. The aim of our project is to evaluate the performance of the transformer circuit, identify issues, propose solutions, and determine potential improvements for future iterations.

Open Circuit Testing: Purpose and Procedure



The open circuit test, also known as the no-load test, is conducted to determine the core losses (iron losses) and the no-load current of the transformer. This test helps in estimating the magnetizing current and core losses on the low-voltage side of the transformer.

The primary side of the transformer is connected to a variable voltage source, and the secondary side is left open-circuited.

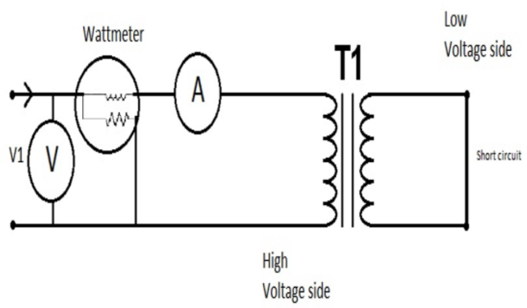
The voltage on the primary side is gradually increased until the rated no-load current flows.

The open circuit test provides information about the core losses, magnetizing current, and power factor at no-load conditions.

Short Circuit Test: Purpose and Procedure:

The short circuit test, also known as the impedance test, is conducted to determine the impedance (or impedance voltage) of the transformer. This test helps in estimating the copper losses and the equivalent circuit parameters on the low-voltage side of the transformer.

The primary side of the transformer is connected to a variable voltage source, and the secondary side is short-circuited.



The voltage on the primary side is gradually increased until the rated current flows through the short circuit on the secondary side.

Measurements of the primary and secondary voltages and currents are taken during the test.

The short circuit test provides information about the equivalent impedance and copper losses, helping in the calculation of the equivalent circuit parameters

Problem

In a single phase transformer problem, the task is to open the high-voltage side (primary) and close the low-voltage side (secondary) to determine the core and copper impedances in the circuit. Subsequently, the goal is to bring down the circuit's equivalent values to the high-voltage side and finding voltage regulation and phasor diagram.

2.13 A 1ϕ, 100 kVA, 1000/100 V transformer gave the following test results:

open-circuit test (HV side open)

100 V, 6.0 A, 400 W

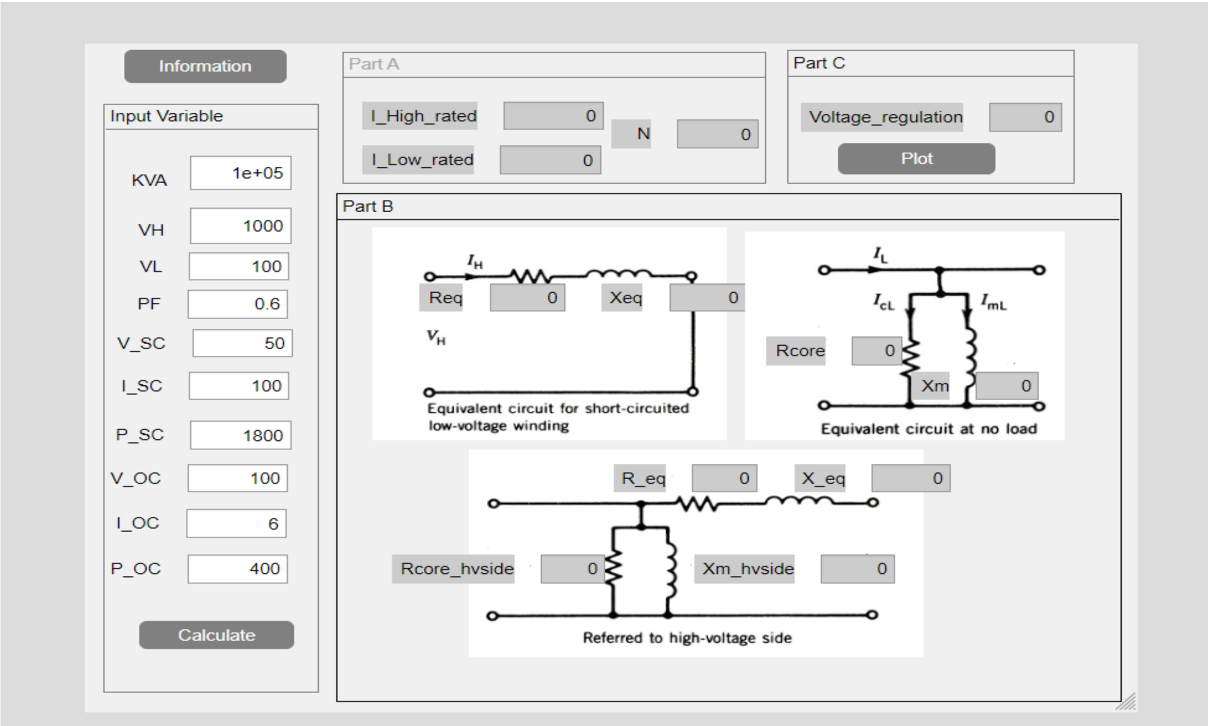
short-circuit test

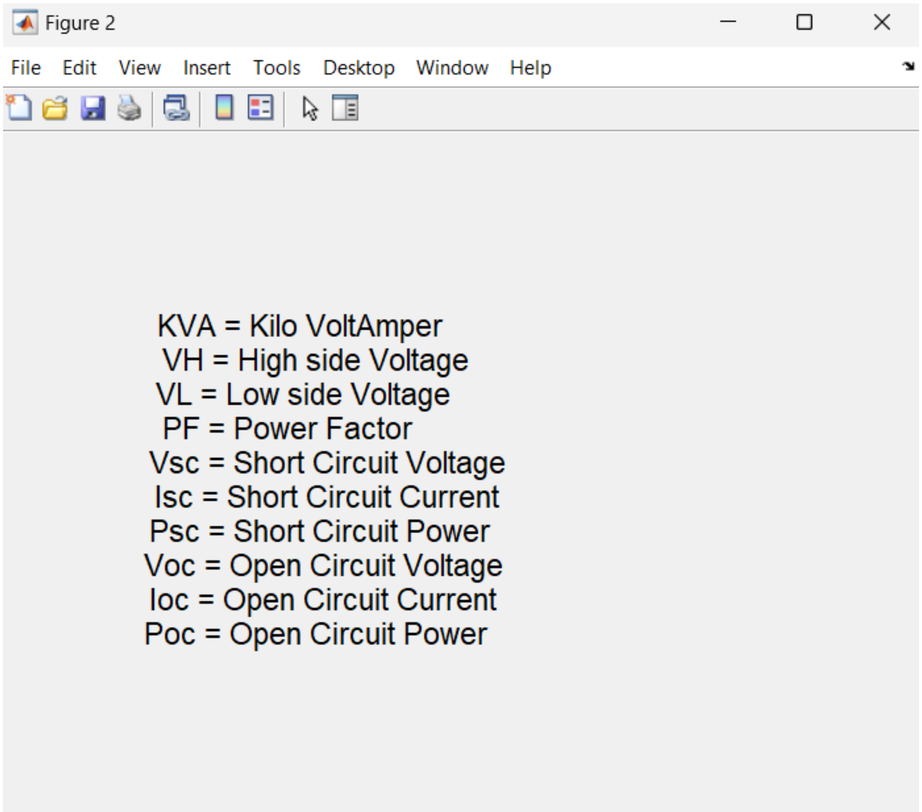
50 V, 100 A, 1800 W

(a) Determine the rated voltage and rated current for the high-voltage and low-voltage sides.
(b) Derive an approximate equivalent circuit referred to the HV side.
(c) Determine the voltage regulation at full load, 0.6 PF leading.
(d) Draw the phasor diagram for condition (c).

Solution Approach

Interface Design: Developed a user-friendly interface to collect user inputs and display test results. The interface allows users to input necessary parameters and presents results in an understandable format.





-Matlab Integration: Coded the necessary functions to communicate with Matlab, enabling the execution of tests within the Matlab environment.

\labproje.m

```
clc
clear all
close all
% Given data

S = 100*10^3 ;
VH= 1000;
VL= 100;
Ihrated = S / VH ;
Ilrated = S / VL ;
N = VH / VL;
power_factor = 0.6;


V_SC = 50;      % Short circuit test voltage (V)
I_SC = 100;     % Short circuit test current (A)
P_SC = 1800;    % Short circuit test power (W)

V_OC = 100;     % Open circuit test voltage (V)
I_OC = 6;       % Open circuit test current (A)
P_OC = 400;     % Open circuit test power (W)
%Part A
% Short circuit test calculations
Zeq = V_SC / I_SC;
Req = P_SC / (I_SC^2);
Xeq = sqrt(Zeq^2 - Req^2);

% Open circuit test calculations
Rcore = (V_OC^2) / (P_OC);
Icl = V_OC / Rcore;
Iml =  sqrt(I_OC^2 - Icl^2);
Xmagnetization = V_OC / Iml;
% Part B
```

```
% Part B
Rcore_hside_value =Rcore *N ^2;
Xmagnetization_hside_value =Xmagnetization *N ^2;

Empedance= Req + j*Xeq;
rad_emp = atan(Xeq/Req); % radian form
deg_emp = rad2deg(rad_emp); % degree form
rad_current = acos(power_factor); % radian form
deg_current = rad2deg(rad_current); % angle form
radsum= rad_emp + rad_current;


V2prime= VL* N;
I2prime = Ilrated / N;
Voltage =I2prime * Zeq;
Vreel = V2prime +Voltage*cos(radsum) ;
Vimg = Voltage*sin(radsum);
V1= sqrt(Vreel^2+Vimg^2); % magnitude of V1
angle_v1 = atan(Vimg/Vreel);  % radian form
deg_v1 = rad2deg(angle_v1);

Voltreg = (V1-V2prime)*100/(V2prime); % Voltage regulation formula

% Display the results
```

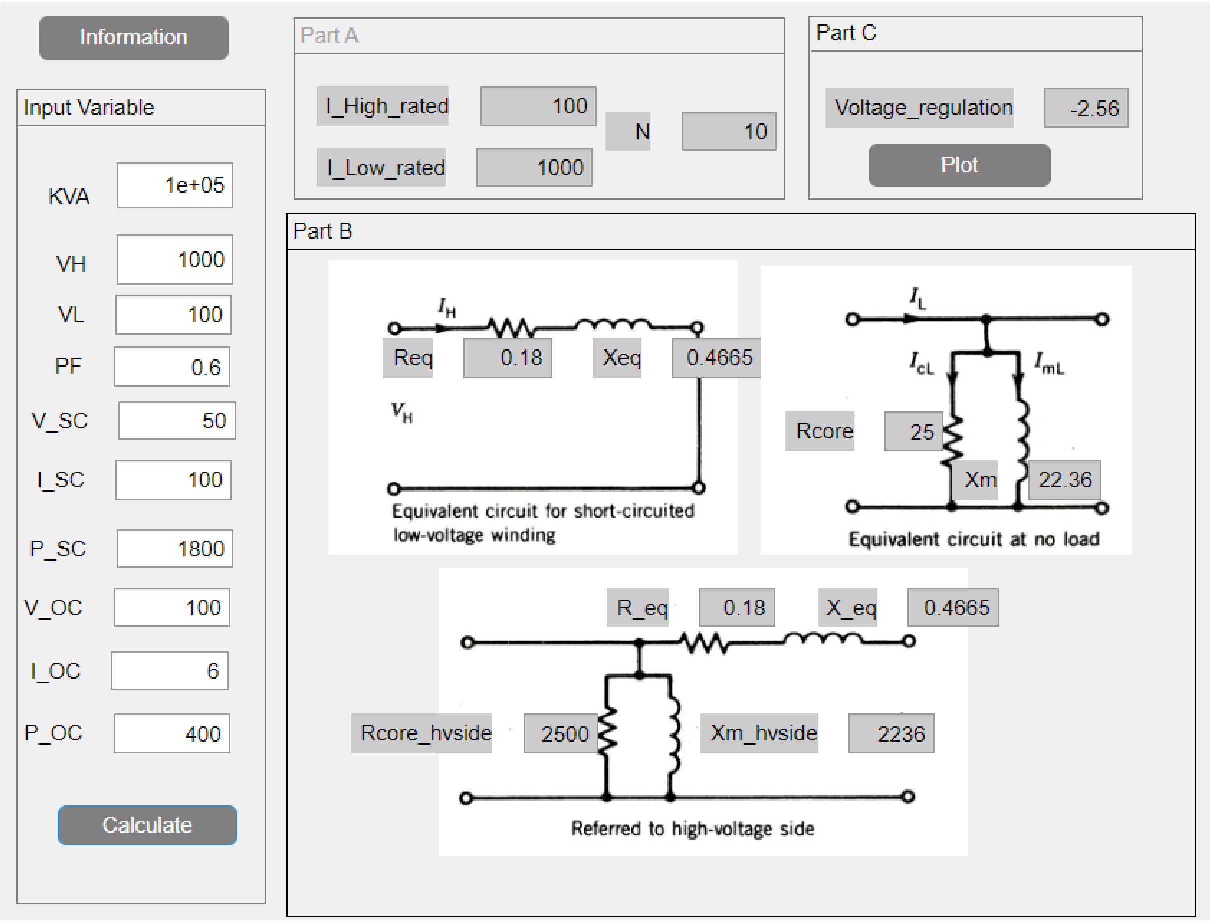
```
%Voltage regulation

V1_phasor = V1 * exp(1i * angle_v1);
v2prime_phasor =  V2prime * exp(1i * 0);
I2_phasor = I2prime * exp(1i *rad_current);
figure;


quiver(0, 0, real(V1_phasor), imag(V1_phasor), 0, 'b', 'LineWidth', 2);

axis equal;
hold on

quiver(0, 0, real(v2prime_phasor), imag(v2prime_phasor), 0, 'r', 'LineWidth', 2);
title('Voltage V2');
axis equal;
hold on
% Current phasors
quiver(0, 0, real(I2_phasor), imag(I2_phasor), 0, 'g', 'LineWidth', 2);
title('Phasor Diagram');
axis equal;

legend('V1', 'V2', 'I2');
```

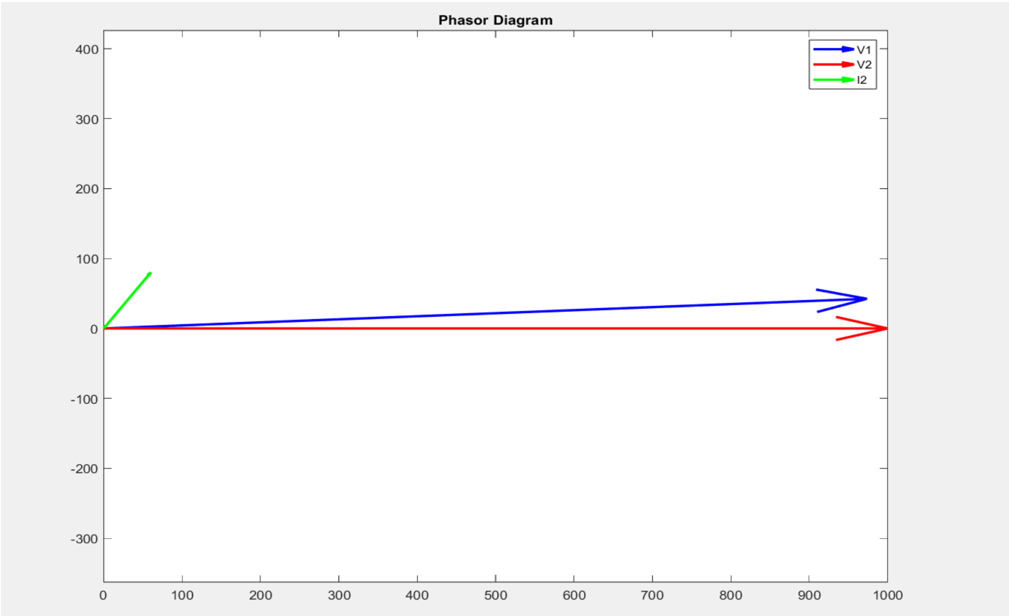
Application Results

Short Circuit Test: Successfully conducted the short circuit test by inputting required parameters. The obtained data illustrated how the circuit behaves under short circuit conditions.

-Open Circuit Test: Similarly, the open circuit test was performed, providing insights into the performance of the transformer circuit under open circuit conditions.

```
Command Window
V high side rated : 1000 V
V low side: 100 V
 I High rated : 100 A
 I low rated: 1000 A
 Equivalent Resistance (Req): 0.1800 ohms
Equivalent Reactance (Xeq): 0.4665 ohms
Core Resistance (Rcore): 25.0000 ohms
Magnetization Reactance (Xmagnetization): 22.3607 ohms
Equivalent Resistance  with high voltage side : 2500.00 ohms
Equivalent Reactance  with high voltage side: 2236.07 ohms
fx
```


Information
Input Variable
KVA 1e+05
VH 1000
VL 100
PF 0.6
V_SC 50
I_SC 100
P_SC 1800
V_OC 100
I_OC 6
P_OC 400
Calculate
Part A
I_High_rated 100
I_Low_rated 1000
N 10
Part C
Voltage_regulation -2.56
Plot
Part B
Req 0.18
Xeq 0.4665
Equivalent circuit for short-circuited low-voltage winding
Rcore 25
Xm 22.36
Equivalent circuit at no load
R_eq 0.18
X_eq 0.4665
Rcore_hvside 2500
Xm_hvside 2236
Referred to high-voltage side


Phasor Diagram
V1
V2
I2
400
300
200
100
0
-100
-200
-300
0
100
200
300
400
500
600
700
800
900
1000

Findings and Future Improvements

Test results demonstrated the expected performance of the transformer circuit. However, conducting more comprehensive tests with larger datasets could provide deeper insights.

Future Improvements: Employing more sophisticated algorithms for data analysis, enhancing user interface for ease of use, and considering automation of the test process along with the inclusion of additional test scenarios.

Conclusion

This project facilitated the evaluation of a single-phase transformer circuit's performance through Short Circuit and Open Circuit tests, providing valuable insights into its overall functionality. The results obtained not only shed light on the circuit's performance but also offer opportunities for future enhancements.