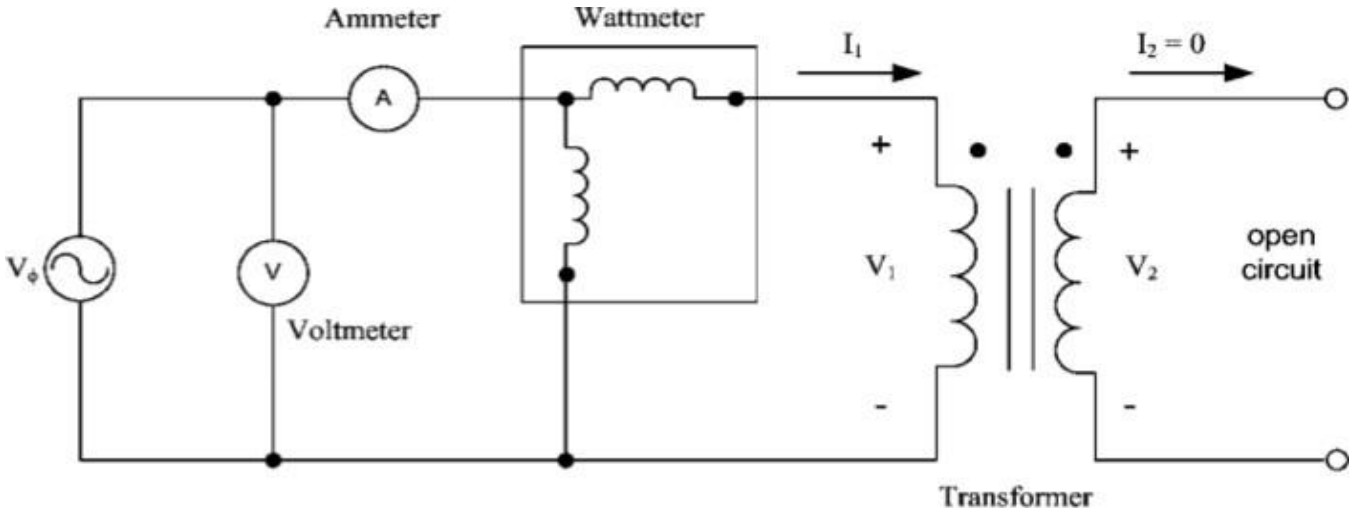
Title of the Exercise: Separation of Iron losses in single phase transformer

Date: 09/11/2020

Aim: To separate the iron losses occurring in a single phase transformer into hysteresis and eddy current loss using MATLAB/Simscape power system tool.

Tool used : MATLAB and SIMULINK

Electrical Circuit:



Parameters used for the study:

Transformer rating = 50KVA

V_1=2400V	(primary voltage in Rms)
V_2=240V	(Secondary voltage in Rms)
f=50 Hz	Frequency
$R_1 = 0.7488$ ohm	(Primary winding resistance)
$X_{11} = 1.00224$ ohm	(Primary winding reactance)
$R_2 = 0.007488$ ohm	(Secondary winding resistance)
$X_{12} = 0.0100224$ ohm	(Secondary winding reactance)
$X_M = 5{,}008$ ohm	(Magnetizing reactance)
$R_c = 33{,}391$ ohm	(Resistance for core losses)

Theoretical Analysis:

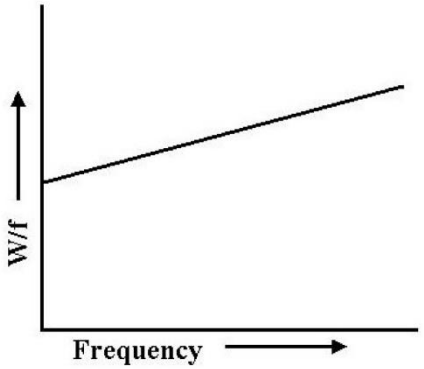
When a transformer is operated at no load, power drawn from the supply is equal to the no load losses, which are equal to the sum of constant losses (iron losses) and negligible amount of copper losses in the primary winding.

Iron losses = Hysteresis loss + Eddy current loss

$w_i = Af + Bf^2$ With flux density being kept constant.

$\frac{w_i}{f} = A + Bf$ similar to y = mx+c

$B_{rated} \propto \frac{V}{f}$ is kept constant.



Calculations (predetermination):

From the graph,
The equation of the line is –
(y - 1.388)(10) = (x – 20)(0.687)

10y – 13.88 = x(0.687) – 13.74

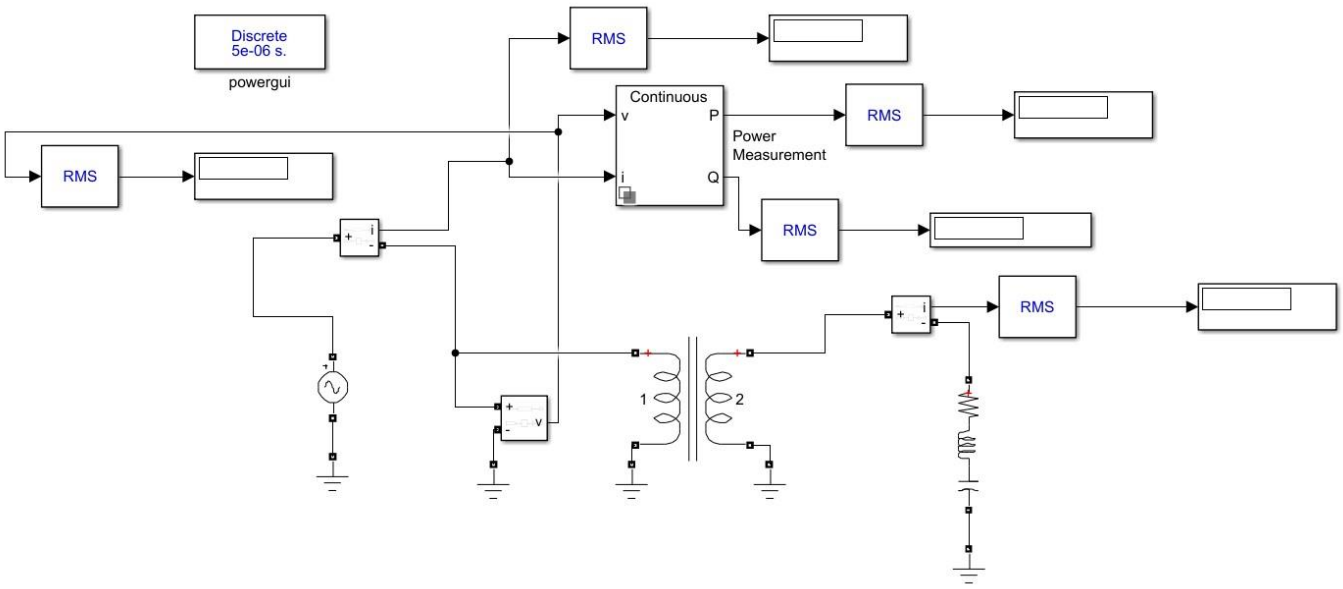
Therefore,
y = (0.0687)x + 0.014

Comparing this equation with $\frac{w_i}{f} = A + Bf$,
Therefore, values of A and B –
A = 0.014
B = 0.0687

Procedure:

- Step1-Initialize the input parameters and write coding for the as per requirement of plots in m file and save it.
- Step 2-open new Simulink and make mathematical modelling as per circuit diagram and save it
- Step 3-Run the m file first, after that run Simulink file.
- Step 4- Vary the value of AC source voltage and frequency such that V/f is constant, and then tabulate the corresponding value of power from wattmeter.
- Using the 'plot' command in MATLAB, plot the graph between W_i/f vs f.

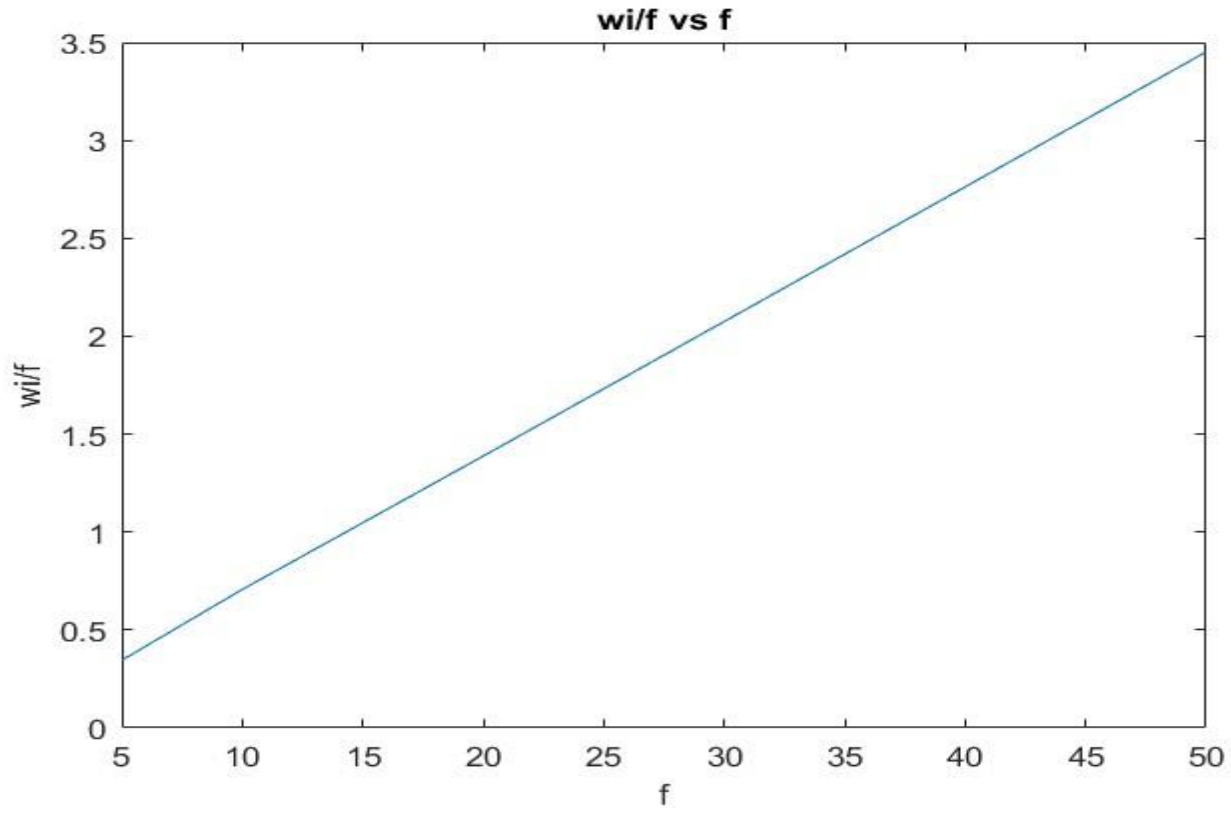
Simulink file:



M file:

```
Wi=[1.726 7.069 27.72 62.25 110.5 172.6];
f=[5 10 20 30 40 50];
%w=wi/f
w=[0.3452 0.7069 1.388 2.075 2.7625 3.452];
plot(f,w)
xlabel('f')
ylabel('wi/f')
title('wi/f vs f')
```

Results and Discussions:



Observations:

V_p	f	V_p/ f	W_i	W_i/f
2400	50	48	172.6	3.452
1920	40	48	110.5	2.7625
1440	30	48	62.25	2.075
960	20	48	27.72	1.288
480	10	48	7.069	0.7069
240	5	48	1.726	0.3452

Conclusion:

Hence, the iron losses have been separated into hysteresis and eddy current losses.

Inference:

Therefore, a graph between Wi/f vs f represents a straight line whose y - intercept gives value of A and it's slope gives the value of B.

A and B are indicated in the below equation,

$$\frac{w_i}{f} = A + Bf$$

References:

- https://in.mathworks.com/
- Analysis and design of control systems using MATLAB – By Rao V.Dukkipati