



VEBKO ONLINE HELP

“Excitation Test” Tab, Part 1

Category	tester
Section	Current Transformer Module
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1 Transformer Saturation:

Before talking about the Excitation test, it is necessary to review some important subjects related to analyzing behavior of transformers including equivalent circuit and some electric and electromagnetic analyses. You can see a transformer equivalent circuit in the figure. In this circuit, " R_p " and " R_s " refer to the primary and secondary coils resistance respectively which occur as heat loss and increase in the temperature of the coil. " X_p " and " X_s ", on the other hand, indicate a part of the flux whose path is through air and is known as "leakage Flux".

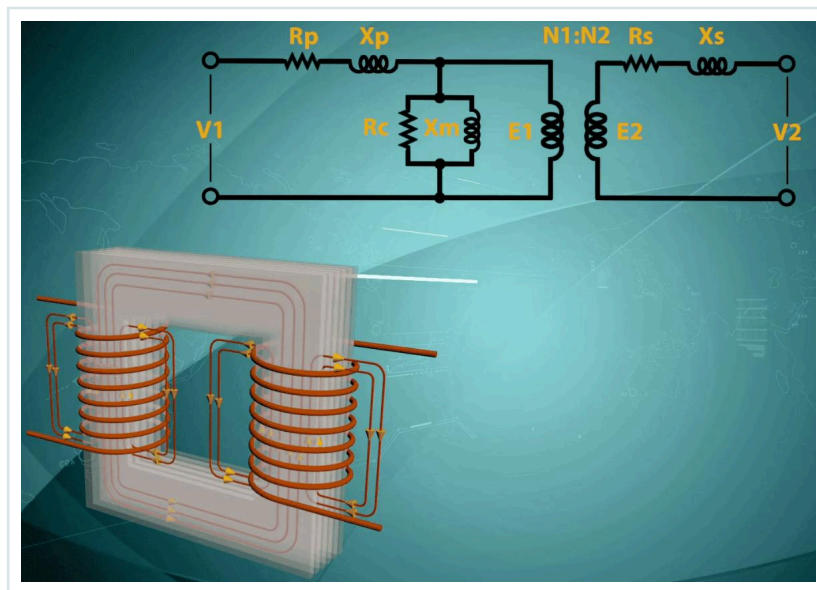


Figure 1

In the parallel branch, " R_c " is the indicator of core loss including eddy current and Hysteresis losses which occur as increase in the temperature of the core. The reason for parallelism of " R_c " is that the losses caused by it are in accordance with the square of the input voltage. " X_m " indicates magnetizing inductance of the wires wrapped around the core of the transformer.



Figure 2

2 Transformer Loading and Its Effect on Transformer Saturation

When the transformer is put "on-load", it causes the secondary current to increase. When it happens, the flux caused by the secondary coil increases as well. Also, after the secondary current increases, the primary current increases as well which leads to an increase in the flux of the primary side. But since the changes in the secondary side current are bigger, the flux of the secondary side will be more than the primary side. Because of the influence of the opposite side of these two in the equivalent flux of the transformer core, the flux of the transformer decreases.

$$\begin{aligned} \Phi_s &= L_s I_s, \text{ if: } I_s \uparrow \Rightarrow \Phi_s \uparrow \\ I_s \uparrow &\Rightarrow I_p \uparrow \left(\frac{I_p}{I_s} = \frac{N_2}{N_1} \right) \\ \Phi_p &= L_p I_p \Rightarrow \Phi_p \uparrow \\ I_s > I_p &\Rightarrow \Phi_s > \Phi_p \Rightarrow \Phi_{eq} \downarrow \end{aligned}$$

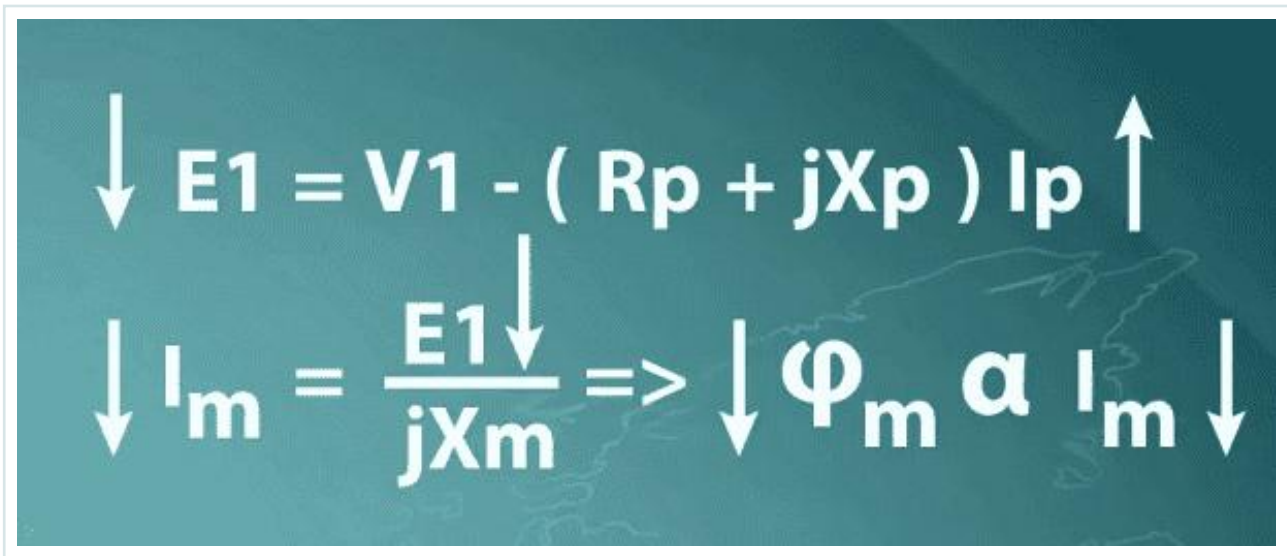
Figure 3

As a result, while the load drawn from the terminals of the power transformer increases, the core recedes from the saturation area. Therefore, in full-load it is possible to use a small core for the transformer, but since transformer is not always used in nominal load, by reducing the core, the decrease in the load, leads to the saturation of transformer. Therefore, to avoid transformer saturation in light load and change the waveform from sine wave, it is necessary to extend the transformer core.

3 CT Saturation Curve

As mentioned before, the power transformer recedes from saturation by increasing the current whereas CT gets closer to the saturation area. The reason for this is related to the voltage of parallel branch where, in the power transformer by increasing the current, voltage of the parallel branch decrease. However, in "CT", by increasing the current, the voltage of the parallel branch in the

secondary side increases and the "CT" saturates.



$$E1 = V1 - (R_p + jX_p) I_p$$

$$I_m = \frac{E1}{jX_m} \Rightarrow \Phi_m \propto I_m$$

Figure 4

"CT" saturation in a power system is caused by increase in the primary current because of occurrence of a fault, which disables the "CT" to move the fault current to the secondary with the correct ratio. Since the saturation point of "CT" is related to voltage and parallel branch current, while doing this test, the secondary voltage increases and the point where by increasing the voltage by 10 percent, the drawn current increases by 50 percent is considered as the saturation point. In future videos the ways to enter the values and do the test for different "CT"s will be provided.

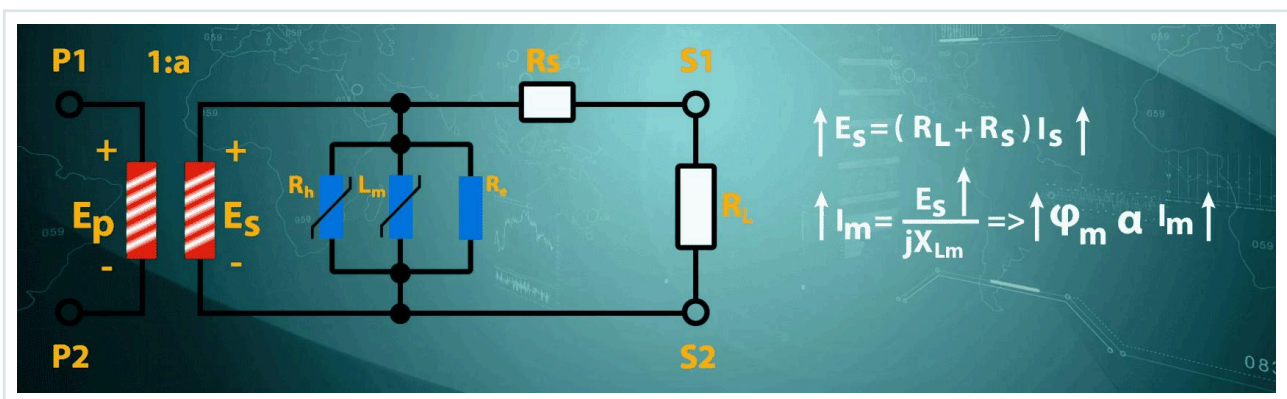


Figure 5

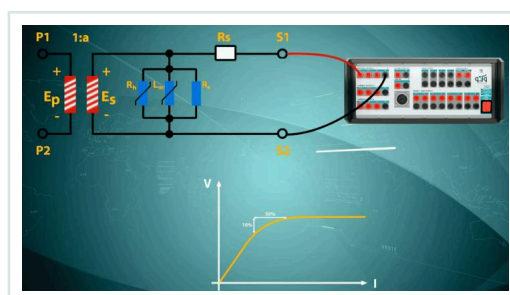


Figure 6

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