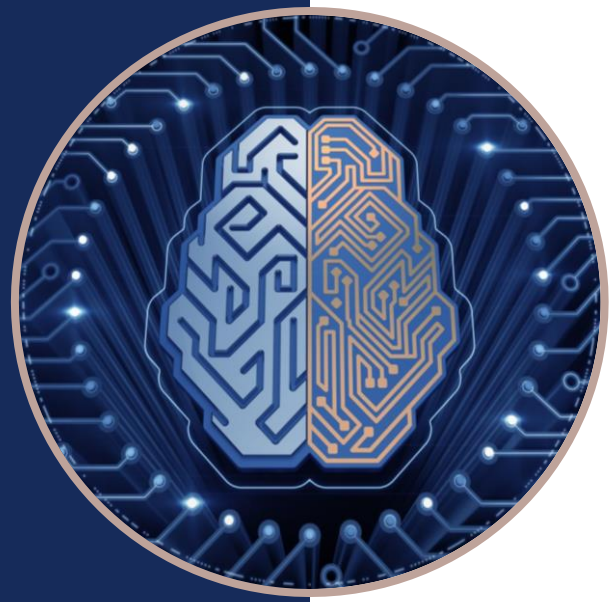


❖ **Article:**

Mathematical Modeling of the Short Circuit Mode of a Voltage Transformer

Elham Jafari ❖

Computer Engineering ❖

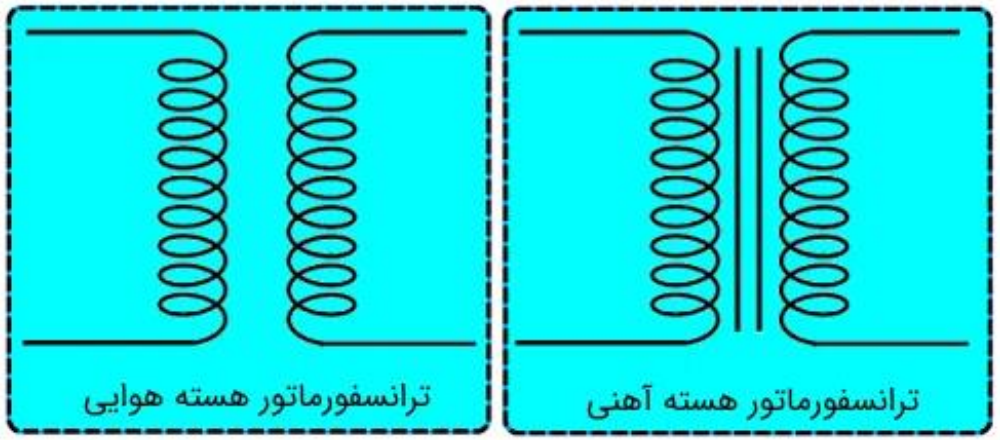
Faculty of Electrical & Computer Engineering ❖

❖ **Transformer:**

A transformer is a passive component that transfers electrical energy from one electrical circuit to another circuit, or multiple circuits. A varying current in any coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force (EMF) across any other coils wound around the same core.

Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. Faraday's law of induction, discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

Transformers are used to change AC voltage levels, such transformers being termed step-up or step-down type to increase or decrease voltage level, respectively.



"Types of Transformers"

❖ Application of Transformer

Transformers are used in a variety of applications, including power generation, transmission and distribution, lighting, audio systems, and electronic equipment.

•Power generation: Transformers are used in power plants to increase the voltage of the electricity generated by the plant before it is sent to the grid.

•Transmission and distribution: Transformers are used in the transmission and distribution of electricity to increase or decrease the voltage of electricity as it is sent from power plants to homes and businesses.

•Lighting: Transformers are used in lighting systems to decrease the voltage of electricity before it is sent to light bulbs.

•Audio systems: Transformers are used in audio systems to increase or decrease the voltage of electricity before it is sent to speakers.

•Electronic equipment: Transformers are used in a variety of electronic devices, including computers, TVs, radios, and cell phones.

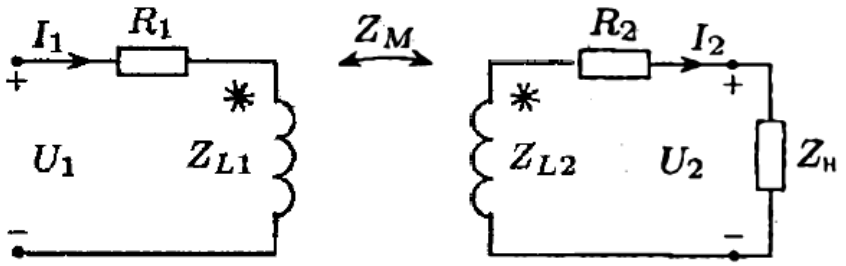
Transformers are a vital part of the electrical grid and are used in a variety of applications to ensure that electricity is delivered safely and efficiently.

❖ Mathematical Modeling

Computer technology progress has contributed greatly to the mathematical modeling Development in all areas of science. The mathematical modeling Allows to research a model of interest with minimizing the utilized resources. Modeling are used when a real experiment performing is impossible, Dangerous or difficult and expensiv.

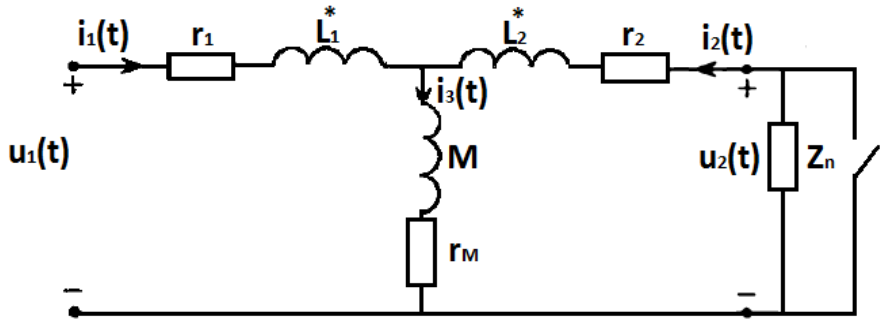
In this article, distress states such as transformer short circuit are investigated and calculated using the short circuit value model.

Allows to research a model of interest with minimizing the utilized resources.
Using the derived mathematical formulas, we will calculate the short circuit current.



"Transform model shown as two inductively coupled coils circuit."

When a transformer works under the operating mode an emergency short circuit may occur. This is a dangerous emergency mode, in which the transformer currents are many times higher than their rated values. In such a situation a sharp decrease in reliability of transformer or even transformer failure may occur. It’s important to know a short circuit current value in case to forecast eventual consequences. Also, it’s useful to determine the relation between short-circuit current and input parameters. That way it will be possible to influence on the current value by transformer rating selection during design.



"Transform model shown as decoupled circuit"

The following formulas are used for modeling:

Separately, the initial conditions for the first winding by formula:

$$\dot{I}_1 = \frac{\dot{U}_1 \cdot (Z_n + X_2 + X_m)}{X_m \cdot X_2 + X_m \cdot Z_n + X_1 \cdot (Z_n + X_2 + X_m)}$$

$$X_1 = Z_{L_1^*} + r_1, X_2 = Z_{L_2^*} + r_2, X_m = Z_m + r_m$$

For the second winding separately, the initial conditions may beIt is found from the following formula:

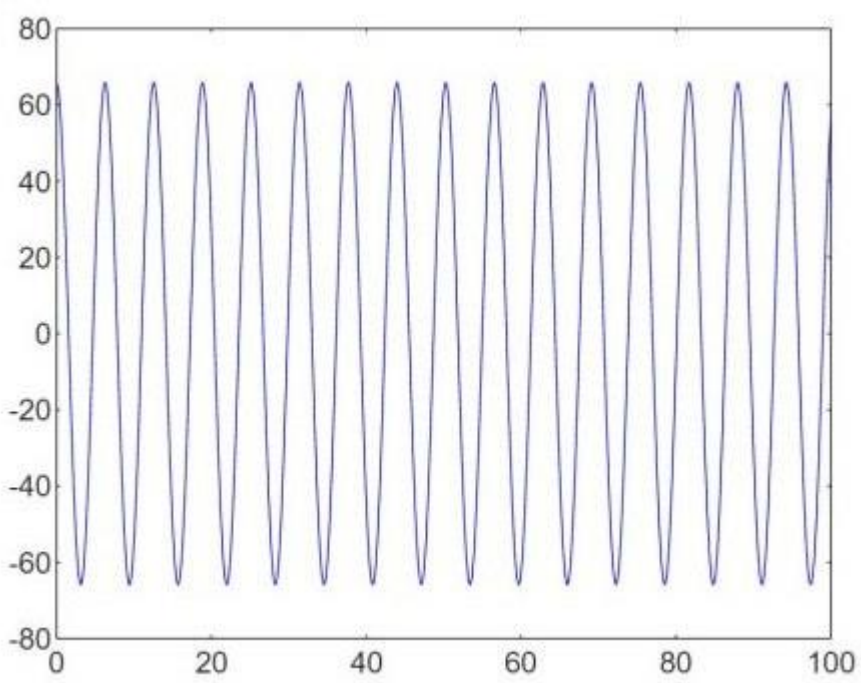
$$\dot{I}_2 = \frac{\dot{U}_1 \cdot X_m}{Z_n \cdot X_m + X_2 \cdot X_m + X_1 \cdot (X_m + X_2 + Z_n)}$$

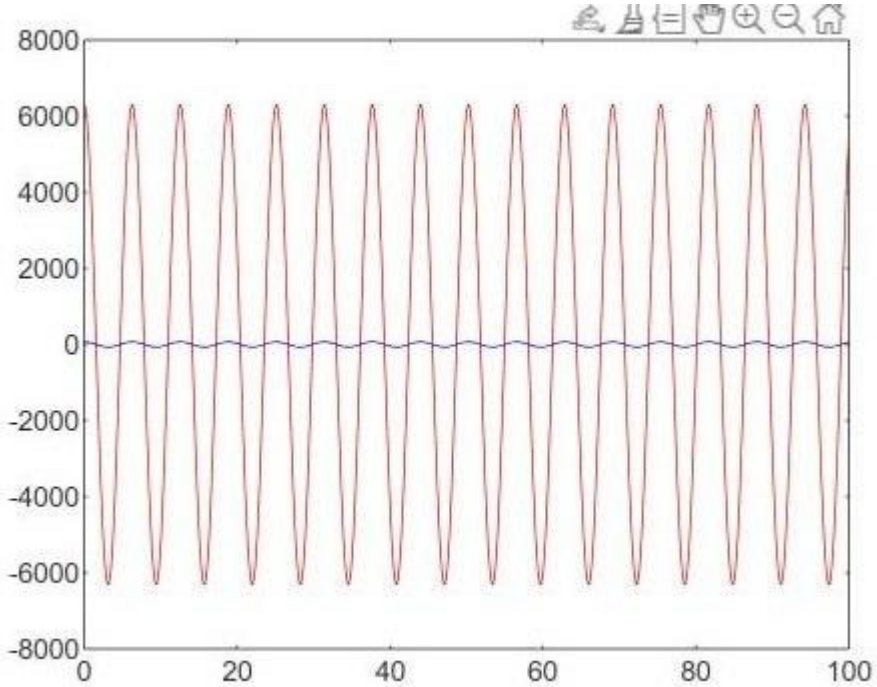
Substitute Zn → 0 in the previously derived formula (4).In this case, the relationship between the short-circuit current and the inputThe conversion parameters are as follows:

$$i_2(t) = \frac{u_1(t) \cdot X_m}{X_2 \cdot X_m + X_1 \cdot (X_m + X_2)}$$

Now we simulate the formulas given in the previous slide as code. (The code file is written with MATLAB and is available in the attachment).
The constant values used in the code are given from Table 1 on page 3.

By performing the mathematical model and implementing the code of the obtained formulas, we show the output in the form of a diagram:





(In the sent file, the photo of the diagrams is given.)

❖ **Conclusion**:

Overall, transformers are an incredibly versatile tool that can be used in a variety of applications. From power generation and transmission to data storage and processing, they play a vital role in modern society. With new technologies emerging all the time, the potential uses for transformers are only limited by our imagination.

In this article, we have tried to check the short circuit condition that occurs in the transformer and with the help of mathematical modeling, we check the increased current value and by implementing its code, we see the output.