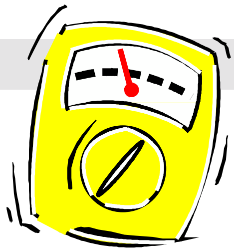


2.5 No-load characteristic

Record the no-load characteristic $I_0 = f(U_0)$ of the transformer in the *TRANSFORMER BOARD*. A regulating transformer (0...230 V AC) is required as a voltage source in this experiment.

Experiment:

- Set up the circuit shown in fig. 2.5.1.

  Note: The board remains switched off in this experiment.
- Set the no-load voltage U_0 according to the voltage values requested in the table 2.5. Measure the no-load current I_0. Enter the values in the table.
- Transfer the values from the table to the grid provided in fig. 2.5.2.
- Draw the no-load characteristic $I_0 = f(U_0)$.

WARNING:
Experiments may only be set up with the unit switched off. This also applies for conversion of experiments!

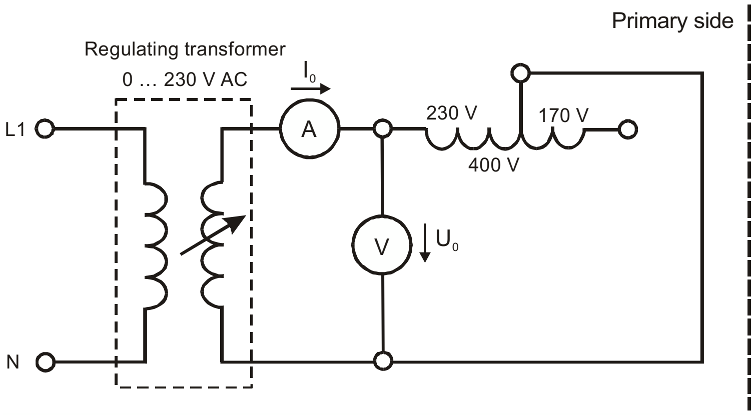


Figure 2.5.1 Measuring circuit

U_0 / V	0	25	50	75	100	140	160	180	200	220	230
I_0 / mA											

Table 2.5

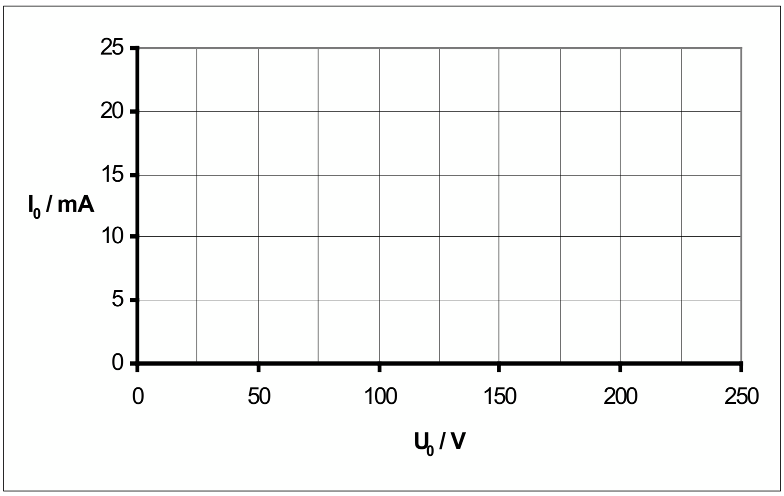


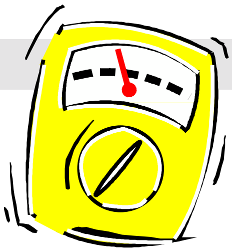
Figure 2.5.2 No-load characteristic $I_0 = f(U_0)$

Question:

Why is the current characteristic not a straight line?

Answer:

2.6 No-load losses



Determine the iron losses using the no-load experiment and calculate the variables of the equivalent circuit diagram from it. The iron losses can be determined directly because the resistive losses of the winding are negligibly small in no-load. A power meter or Watt meter (e. g. hps type 8705) is required to measure the active power P_0.

Experiment:

- Set up the circuit shown in figure 2.6.
- Switch the board on.
- Measure the no-load current I_0, the applied primary rated voltage U_{1N} and the active power P_0.

$$I_0 = \ldots\ldots\ldots\ldots\ldots mA$$
$$U_{1N} = \ldots\ldots\ldots\ldots V$$
$$P_0 = \ldots\ldots\ldots\ldots\ldots W$$

- Calculate the no-load power factor cos φ_0.

$$\cos\varphi_0 = \frac{P_0}{I_0 \cdot U_{1N}} = \ldots\ldots\ldots\ldots$$

- Calculate the partial currents I_{Fe} and I_μ of the equivalent circuit diagram.

$$I_{Fe} = I_0 \cdot \cos\varphi_0 = \ldots\ldots\ldots\ldots mA$$
$$I_\mu = I_0 \cdot \sin\varphi_0 = \ldots\ldots\ldots\ldots mA$$

- Calculate the transverse resistance R_{Fe}.

$$R_{Fe} = \frac{U_{1N}^2}{P_0} = \ldots\ldots\ldots\ldots k\Omega$$

WARNING:
Experiments may only be set up with the unit switched off. This also applies for conversion of experiments!

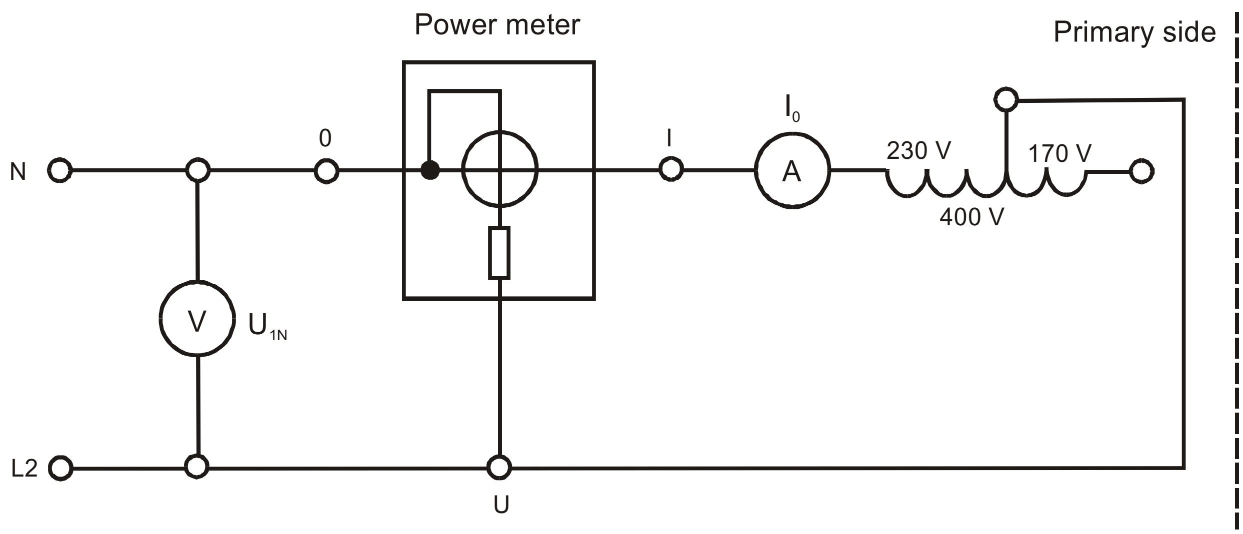
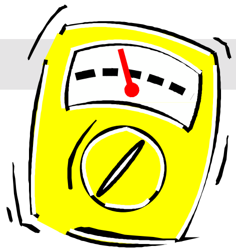


Figure 2.6 Measuring circuit

2.7 Short-circuit experiment



The copper losses of a transformer can be determined with the short-circuit experiment. To do this the secondary winding is short-circuited and the voltage on the primary winding increased from 0 V until the rated current flows on the secondary side. Due to the very low voltage on the primary winding the iron losses can be neglected.

WARNING: At full rated voltage a very high short-circuit current flows which may destroy the transformer!

Experiment:

- Set up the circuit shown in figure 2.7.1.
- Increase the voltage with the regulating transformer until the rated current I_{1N} = 0.14 A (manufacturer specification) flows.

  Note: Do the experiment quickly to keep heat influence to a minimum!

WARNING:
Experiments may only be set up with the unit switched off. This also applies for conversion of experiments!

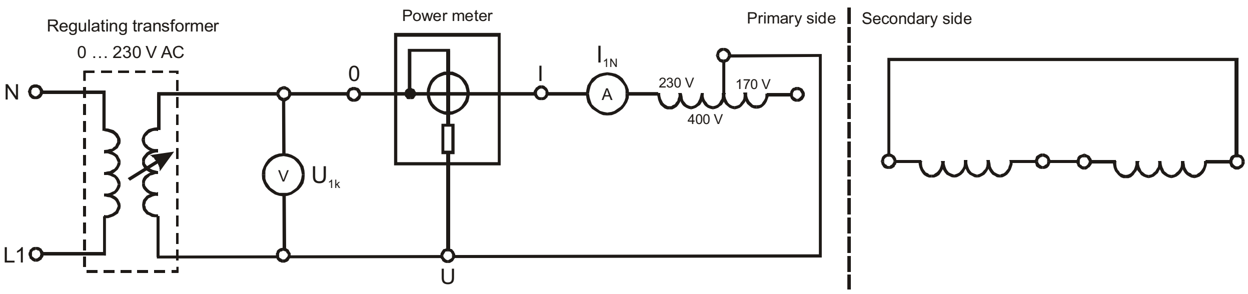


Figure 2.7.1 Measuring circuit

- Measure the applied voltage U_{1k} which leads to rated current and the recorded short-circuit power P_k.

  $U_{1k} = \ldots\ldots\ldots\ldots V$

  $P_k = \ldots\ldots\ldots\ldots W$

- Calculate the short-circuit power factor cos φ_k.

  $$\cos\varphi_k = \frac{P_k}{I_{1N} \cdot U_{1k}} = \ldots\ldots\ldots\ldots$$

- Calculate the partial voltages U_R and U_σ from the measured variables. The equivalent circuit diagram opposite applies (figure 2.7.2). The short-circuit experiment supplies the partial voltages of the Kapp delta.

  $U_R = U_{1k} \cdot \cos\varphi_k = \ldots\ldots\ldots\ldots V$

  $U_\sigma = U_{1k} \cdot \sin\varphi_k = \ldots\ldots\ldots\ldots V$

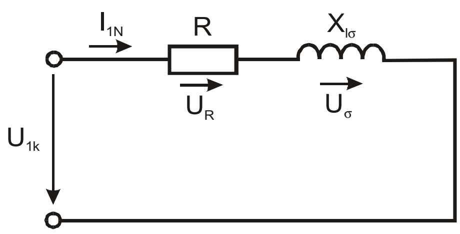


Figure 2.7.2 Simplified equivalent circuit diagram

- The relative short circuit voltage of the transformer which is also specified on the power rating plate can be calculated from these variables. Calculate this voltage. The rated voltage is U_{1N} = 400 V AC.

  $$u_k = \frac{U_{1k}}{U_{1N}} \cdot 100\,\% = \ldots\ldots\ldots\ldots\%$$

- Determine the resistances of the simplified equivalent circuit diagram according to figure 2.7.2.

$$R = \frac{U_{1k} \cdot \cos \varphi_k}{I_{1N}} = \ldots\ldots\ldots\ldots\ldots\ldots \Omega$$

$$X_{L\sigma} = \frac{U_{1k} \cdot \sin \varphi_k}{I_{1N}} = \ldots\ldots\ldots\ldots\ldots \Omega$$

- Calculate the variables for the full equivalent circuit diagram with these resistance values.

$$R_1 \approx R_2' \approx \frac{R}{2} = \ldots\ldots\ldots\ldots\ldots\ldots \Omega$$

$$X_{L\sigma 1} \approx X_{L\sigma 2}' \approx \frac{X_{L\sigma}}{2} = \ldots\ldots\ldots\ldots\ldots \Omega$$

- Then calculate the real variables of the complete equivalent circuit diagram. To do this we use the already determined transformation ratio ü = 0.89 and the mains frequency f = 50 Hz.

$$X_{L\sigma 2} = \frac{X_{L\sigma 2}'}{ü^2} = \ldots\ldots\ldots\ldots\ldots \Omega$$

$$L_{\sigma 2} = \frac{X_{L\sigma 2}}{2 \cdot \pi \cdot f} = \ldots\ldots\ldots\ldots\ldots mH$$

$$L_{\sigma 1} = \frac{X_{L\sigma 1}}{2 \cdot \pi \cdot f} = \ldots\ldots\ldots\ldots\ldots mH$$