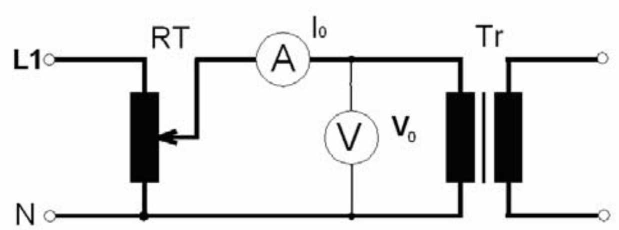
TRANSFORMER MEASUREMENT

I. S_n = 440 VA
V_{1n} = 220 V, I_{1n} = 2 A
V_{2n} = 110 V, I_{2n} = 4 A

II. S_n = 600 VA
V_{1n} = 150 V, I_{1n} = 4 A
V_{2n} = 300 V, I_{2n} = 2 A

1. Voltage – Current Characteristic (Volt – Ampere Ch.)

Task: To measure $I_0 = f\,(V_0)$ dependence – for **NO-loaded** transformer. Plot the graph.



I. V_{1n} = 110 V

V_0 [V]	30	60	90	120	150
I_0 [A]					

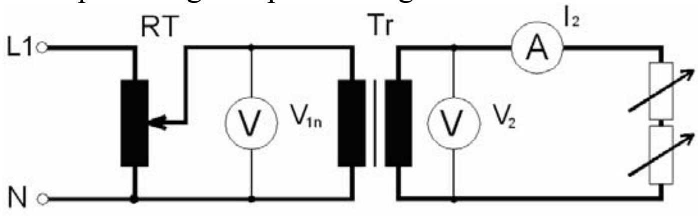
II. V_{1n} = 150 V

V_0 [V]	40	80	120	160	180
I_0 [A]					

2. Loading Characteristic

Task:

a) To measure – the Transformer Loading Characteristic $V_2 = f\,(I_2)$; and plot the graph.
b) To calculate – the percentage drop of voltage Δv for the rated current I_n.



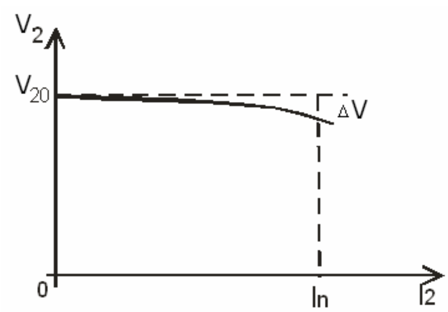
I. V_{1n} = 220 V

I_2 [A]	0	1	2	3	4	5
V_2 [V]						

II. V_{1n} = 150 V

I_2 [A]	0	1	1,5	2	2,5
V_2 [V]					

$$\Delta V = \frac{\Delta V}{V_{20}} 100 \; [\%]$$

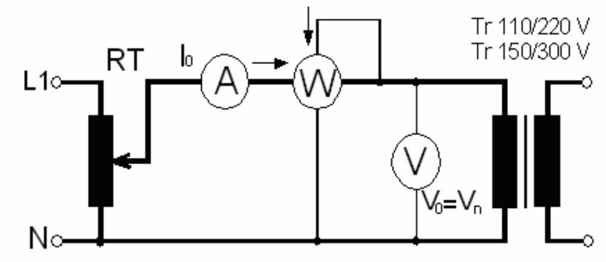


3. As the measurement results – to determine the values for the **Efficiency** η Calculation; and for the **Relative Voltage Drop** ε Calculation - by the specific load.

Task:

a) Using the Ohm's law method – to measure the primary winding Resistor R_1, and the secondary winding Resistor R_2.

b) **Open-circuit Test**

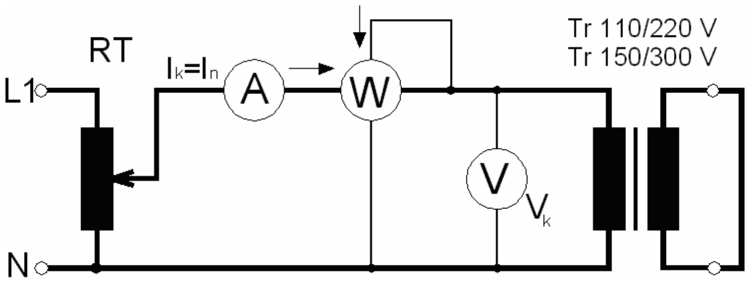


W : wattmetr 1 A; 150 V; $\cos\varphi_W$=0,2

V_0 [V]	I_0 [A]	α [d]	k_W [W/d]	R_W [Ω]	R_V [Ω]	P' [W]	ΔP_0 [W]	$\cos\varphi_0$ [-]
V_n								

$P' = \frac{V_0^2}{R_W} + \frac{V_0^2}{R_V}$ $\Delta P_0 = \alpha . k_W - P'$ $\cos\varphi_0 = \frac{\Delta P_0}{V_0 . I_0}$ $k_W = \frac{r_I . r_v}{d} \cos\varphi_W$

c) **Short-circuit Test**



W : wattmetr 2 A; 75 V; $\cos\varphi_W$=0,2

I_k [A]	V_k [V]	α [d]	k_W [W/d]	ΔP_k [W]	$\cos\varphi_k$ [-]	v_k [%]
I_n						

$\Delta P_k = \alpha . k_W$ $\cos\varphi_k = \frac{\Delta P_k}{V_k . I_k}$ $v_k = 100 \frac{V_k}{V_n}$ $k_W = \frac{r_I . r_V}{d} \cos\varphi_W$

4. Being measured transformer (by open-circuit test; and by short-circuit test) – to calculate: the **Efficiency** η ***[%]*** ; and the **Percentage Drop of Voltage** ε ***[%]*** .
(See textbook – only in Czech - Uhlíř a kol. : Elektrotechnika – laboratorní návody ; (El. Engineering – Labs Manuals) page 90 – 92).

Given parameters: ***cos φ*** … power factor for the load…(e.g.: cos φ = 0,8) ;
$v = I_2/I_{2n}$ … relative load …(e.g.: ν = 1) .

a) **Efficiency Calculus** ***η [%]*** for Transformer (by open-circuit test; and by short-circuit test)

$$\eta = 100 - \frac{1}{\cos\varphi}\left(\frac{\Delta p_0}{\nu} + \nu \Delta p_K\right)$$

$\Delta p_0 = 100 \cdot \frac{\Delta P_0}{S_n}$ ...... percentage loss by open-circuit test

ΔP_0 [W] ...... the loss by open-circuit test for V_{1a}

$\Delta p_K = 100 \cdot \frac{\Delta P_{K75^\circ C}}{S_n}$ ...... percentage loss by short-circuit test

$\Delta P_{K75^\circ C}[W]$ ...... the loss by short-circuit test for I_{1a} and 75˚C

$\Delta P_K = \Delta P_j + \Delta P_d$ $\Delta P_j = R_1 I_{1K}^2 + R_2 I_{2K}^2$

$I_{2K} = p \cdot I_{1K}$ $p = \frac{V_{1n}}{V_{2n}}$

$\Delta P_{K75^\circ C} = \Delta P_{j75^\circ C} + \Delta P_{d75^\circ C}$ $\Delta P_{j75^\circ C} = \Delta P_j \cdot \frac{75 + k}{t_0 + k}$

$\Delta P_{d75^\circ C} = \Delta P_d \cdot \frac{t_0 + k}{75 + k}$ $k = k_{Cu} = 235$ $t_0 = 20^\circ C$

b) **Voltage Drop Calculation** ***ε [%]***

$$\varepsilon = \nu\left(v_{R75^\circ C}\cos\varphi + v_L \sin\varphi\right)$$

$v_R = v_K \cdot \cos\varphi_K$ ··· resistive part of v_K in percentage $v_{R75^\circ C} = v_K \cdot \frac{k + 75}{k + t_0}$

$v_L = v_K \cdot \sin\varphi_K$ ...... reactive part of v_K in percentage

$v_K = 100 \cdot \frac{V_{1K}}{V_{1n}}$ ...... short circuit voltage in percentage