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Практична робота 1

Вивести формули похибок вимірюваних та параметрів, які розраховуються у 1 лабораторній роботі.

Загальна формула для похибки:

$$\Delta_y^2 = \sum_{i=1}^{m} \left(\frac{\partial y}{\partial x_i} \cdot \Delta x_i \right)^2$$

Знайдемо формули похибок наступних вимірюваних та параметрів, використовуючи зазначену формулу:

1. $U_d = U_\Sigma - U_R$

$$\Delta_{U_d}^2 = \left(\frac{\partial U_d}{\partial U_\Sigma} \Delta U_\Sigma \right)^2 + \left(\frac{\partial U_d}{\partial U_R} \cdot \Delta U_R \right)^2 = \underline{\Delta_{U_\Sigma}^2 + \Delta_{U_R}^2}$$

2. $i_d = \frac{U_R}{R}$

$$\Delta_{i_d}^2 = \left(\frac{\partial i_d}{\partial U_R} \Delta U_R \right)^2 + \left(\frac{\partial i_d}{\partial R} \Delta_R \right)^2 = \left(\frac{1}{R} \Delta U_R \right)^2 + \left(-\frac{U_R}{R^2} \Delta_R \right)^2 =$$

$$= \frac{1}{R^2} \left(\Delta_{U_R}^2 + \frac{U_R^2}{R^2} \Delta_R^2 \right) = \underline{\frac{1}{R^2} \left(R^2 \Delta_{U_R}^2 + U_R^2 \Delta_R^2 \right)}$$

3. $U_{пр} = \varphi_0 - \varphi_T + \gamma_{пр} \cdot \gamma_B$

$$\Delta_{U_{пр}}^2 = \left(\frac{\partial U_{пр}}{\partial \varphi_0} \Delta \varphi_0 \right)^2 + \left(\frac{\partial U_{пр}}{\partial \varphi_T} \Delta \varphi_T \right)^2 + \left(\frac{\partial U_{пр}}{\partial \gamma_{пр}} \Delta \gamma_{пр} \right)^2 + \left(\frac{\partial U_{пр}}{\partial \gamma_B} \cdot \right.$$

$$\left. \cdot \Delta \gamma_B \right)^2 = \underline{\Delta_{\varphi_0}^2 + \Delta_{\varphi_T}^2 + \gamma_B^2 \Delta_{\gamma_{пр}}^2 + \gamma_{пр}^2 \Delta_{\gamma_B}^2}$$

4. $\gamma_B \approx \frac{U_{пр} - \varphi_0}{\gamma_{пр}}$

$$\Delta_{\gamma_B}^2 = \left(\frac{\partial \gamma_B}{\partial U_{пр}} \Delta U_{пр} \right)^2 + \left(\frac{\partial \gamma_B}{\partial \varphi_0} \Delta \varphi_0 \right)^2 + \left(\frac{\partial \gamma_B}{\partial \gamma_{пр}} \Delta \gamma_{пр} \right)^2 =$$

$$= \frac{\Delta_{U_{пр}}^2}{\gamma_{пр}^2} + \frac{\Delta_{\varphi_0}^2}{\gamma_{пр}^2} + \left(\frac{U_{пр} - \varphi_0}{\gamma_{пр}^2} \Delta \gamma_{пр} \right)^2 = \underline{\frac{1}{\gamma_{пр}^2} \left(\Delta_{U_{пр}}^2 + \Delta_{\varphi_0}^2 + \frac{(U_{пр} - \varphi_0)^2}{\gamma_{пр}^2} \cdot \right.}$$

$$\left. \cdot \Delta_{\gamma_{пр}}^2 \right)$$

5. $\gamma_{вих} = \frac{\varphi_T}{\gamma_B}$

$$\Delta_{\gamma_{вих}}^2 = \left(\frac{\partial \gamma_{вих}}{\partial \varphi_T} \Delta \varphi_T \right)^2 + \left(\frac{\partial \gamma_{вих}}{\partial \gamma_B} \Delta \gamma_B \right)^2 = \frac{\Delta_{\varphi_T}^2}{\gamma_B^2} + \left(\frac{\varphi_T}{\gamma_B^2} \Delta \gamma_B \right)^2 =$$

$$= \underline{\frac{1}{\gamma_B^2} \left(\Delta_{\varphi_T}^2 + \frac{\varphi_T}{\gamma_B^2} \Delta_{\gamma_B}^2 \right)}$$

6. $ТЧМ_{пр} = \frac{U_2 - U_1}{T_2 - T_1}$

$$\Delta^2_{ТЧМ} = \left(\frac{\partial ТЧМ}{\partial U_1}\Delta U_1\right)^2 + \left(\frac{\partial ТЧМ}{\partial U_2}\Delta U_2\right)^2 + \left(\frac{\partial ТЧМ}{\partial T_1}\Delta T_1\right)^2 + \left(\frac{\partial ТЧМ}{\partial T_2}\Delta T_2\right)^2 =$$

$$= \frac{\Delta^2 U_2}{(T_2 - T_1)^2} + \frac{\Delta^2 U_2}{(T_2 - T_1)^2} + \left(\frac{U_2 - U_1}{(T_2 - T_1)^2}\Delta T_1\right)^2 + \left(\frac{U_2 - U_1}{(T_2 - T_1)^2}\Delta T_2\right)^2 =$$

$$= \frac{1}{(T_2 - T_1)^2}\left(\Delta^2_{U_1} + \Delta^2_{U_2} + \frac{(U_2 - U_1)^2}{(T_2 - T_1)^2}\Delta^2_{T_1} + \frac{(U_2 - U_1)^2}{(T_2 - T_1)^2}\Delta^2_{T_2}\right)$$

7. $TRJ_{зв} = \frac{y_{зв_{T_2}}}{y_{зв_{T_1}}}$

$$\Delta^2_{TRJ} = \left(\frac{\partial TRJ}{\partial y_{зв_{T_2}}}\cdot\Delta y_{зв_{T_2}}\right)^2 + \left(\frac{\partial TRJ}{\partial y_{зв_{T_1}}}\cdot\Delta y_{зв_{T_1}}\right)^2 = \frac{\Delta^2 y_{зв_{T_2}}}{y^2_{зв_{T_1}}} +$$

$$+ \left(\frac{y_{зв_{T_2}}}{y^2_{зв_{T_1}}}\Delta y_{зв_{T_1}}\right)^2 = \frac{1}{y^2_{зв_{T_1}}}\left(\Delta^2 y_{зв_{T_2}} + \frac{y^2_{зв_{T_2}}}{y^2_{зв_{T_1}}}\Delta^2 y_{зв_{T_1}}\right)$$