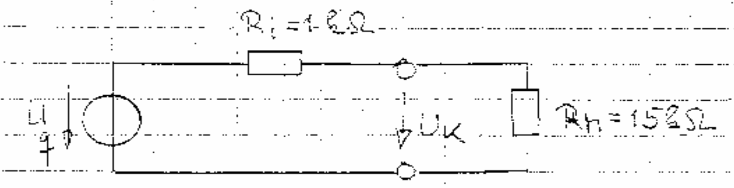
Messtechnik für Informatiker SS2003

Musterlösung zur 4. Übung

4.1 Spannungsmessung



a) $\underline{\underline{U_K}} = U_q \frac{R_M}{R_i + R_M} = U_q \frac{1}{1 + R_i/R_M}$

$\underline{\underline{U_q = U_K (1 + R_i/R_M)}}$

$\underline{\underline{U_q = 10{,}67V}}$

b) $F_{rel} = \frac{U_{K\,ist}}{U_{K\,soll}} - 1 = \frac{U_K(R_M)}{U_K(R_M \to \infty)} - 1$

$F_{rel} = \frac{1}{1 + R_i/R_M} - 1 \approx -R_i/R_M \rightsquigarrow \underline{\underline{R_M}} \geq \frac{R_i}{F_{rel}} = \underline{\underline{100k\Omega}}$

4.2 Strommessung mit Kompensationsschaltung

a) $P = U \cdot I \rightsquigarrow \underline{\underline{I \overset{!}{=} 0}}$; $\underline{\underline{R_M = 0\Omega}}$

b) Nullinstrument wird stromlos d.h. $I_G = 0 \rightsquigarrow \Delta U = U_G = 0$

c) $K\ I_x + I_N - I_h = 0$

$\rightsquigarrow$ mit $U_g = 0$ $U_{R_V} = U_{R_N}$ $\Big\}$ $I_x R_V = (I_h - I_x) R_N$

$\underline{\underline{I_x = I_h \frac{R_N}{R_N + R_V}}}$

d) $\Delta I_x = \frac{\partial I_x}{\partial R_N} \Delta R_N + \frac{\partial I_x}{\partial R_V} \Delta R_V + \frac{\partial I_x}{\partial I_h} \Delta I_h$

$= \cancelto{\ll}{\frac{R_V}{(R_V + R_N)^2} \cdot 0{,}01\% R_N} + \cancelto{\ll}{\frac{-R_N}{(R_V + R_N)^2} \cdot 0{,}01\% R_V} + \underline{\underline{\frac{R_N}{R_N + R_V} \cdot 0{,}2\% I_h}}$

4.4 Messbereichserweiterung

a) $\underline{\text{Klemme A}}$: $\underline{1mA; 100mV}$ $\quad$ $\underline{\text{Klemme B}: 1V}$

b) Spgs-Teiler $\underline{R_V} = \frac{100mV - I_0 R_M}{I_0 R_M} = \underline{\underline{3 R_M = 150\Omega}}$

Strom-Teiler $I_0 = I_{R_M} = 0{,}5mA \rightsquigarrow \underline{\underline{R_1 = R_V + R_M = 200\Omega}}$

Spgs-Teiler $U_{R_2} = 9{,}9V \rightsquigarrow \underline{\underline{R_2 = 99 \cdot 100\Omega = 9{,}9k\Omega}}$

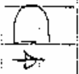
4.5

a) $U_M \equiv \overline{u} = \frac{1}{T}\int_0^T u\,dt = \underline{\underline{0V}}$; $U_G = \overline{|u|} = \frac{1}{T}\int_0^T |u|\,dt = \frac{2}{\pi}\hat{U} = 0{,}637\hat{u}$

$\underline{\underline{U_{eff}}} = \sqrt{\frac{1}{T}\int_0^T u^2\,dt} = \frac{\hat{u}}{\sqrt{2}} = \underline{\underline{0{,}707\hat{U}}}$

230V-Netz: $\underline{\underline{U_{eff}}} = 230V$ $\underline{\underline{\hat{u}}} = \sqrt{2}\cdot 230V = 325{,}3V$; $\underline{\underline{U_G}} = 207{,}2V$

b) $\underline{\underline{k}} = U_{eff} / U_G = 1{,}11$

4.6  mit idealen Gleichrichter zeigt primär Gleichrichtwert an

- Anzeige $U_D = k_\sim \overline{|u|} = 1{,}11\,\overline{|u|}$

a) Formfaktor $k = \frac{U_{eff}}{\overline{|u|}}$ für beliebige Kurvenformen

$$\rightsquigarrow \underline{\underline{U_D = \frac{1{,}11}{k} U_{eff}}}$$

b) ① $U_{eff}^2 = \frac{4}{T}\int_0^{T/4}\left(\frac{U\cdot t}{T/4}\right)^2 dt = \frac{U^2}{3} \rightsquigarrow \underline{U_{eff} = \frac{U}{\sqrt{3}}} = 0{,}577U$

$\overline{|u|} = \frac{4}{T}\int_0^{T/4}\frac{Ut}{T/4}\,dt = \frac{U}{2} \rightsquigarrow \underline{\underline{U_{D①} = \frac{1{,}11}{2}U}} = 0{,}555U$

~~② wie ①~~

③ $\underline{\underline{U_{eff} = U}}$ $\overline{|u|} = U$ $\rightsquigarrow$ $\underline{\underline{U_D = 1{,}11U}}$

④ wie ③ falls symmetrisch zur t/T-Achse

i. allg. U_{eff}, $\overline{|u|}$ von τ/T abhängig.