VJEŽBA 6

1. Koliko iznose procentualne sigurne granice grešaka serijske, odnosno paralelne veze dva kondenzatora.

$C_1 = 0.1\mu F \pm 1\%$

$C_2 = 2\mu F \pm 1.5\%$

Kapacitet serijske veze je:

$$C_S = \frac{C_1 C_2}{C_1 + C_2}$$

Apsolutni iznos sigurnih granica grešaka računamo:

$$G_C = \pm \sum_{i=1}^{n} \left| \frac{\partial C_s}{\partial C_i} G_i \right|$$

$$G_C = \pm \left[\left| \frac{\partial C_s}{\partial C_1} G_1 \right| + \left| \frac{\partial C_s}{\partial C_2} G_2 \right| \right] \quad \text{pri čemu je } \frac{\partial C_s}{\partial C_1} = \frac{C_2^2}{(C_1 + C_2)^2} \quad \text{i} \quad \frac{\partial C_s}{\partial C_2} = \frac{C_1^2}{(C_1 + C_2)^2}$$

$$G_C = \pm \left[\left| \frac{C_2^2}{(C_1 + C_2)^2} G_1 \right| + \left| \frac{C_1^2}{(C_1 + C_2)^2} G_2 \right| \right]$$

$$G_{1\%} = \frac{G_1}{C_1} 100 \text{ -> } G_1 = \frac{G_{1\%} C_1}{100} \quad \text{i} \quad G_{2\%} = \frac{G_2}{C_2} 100 \text{ -> } G_2 = \frac{G_{2\%} C_2}{100} \text{ pa je}$$

$$G_C = \pm \left[\left| \frac{C_2^2}{(C_1 + C_2)^2} \frac{G_{1\%} C_1}{100} \right| + \left| \frac{C_1^2}{(C_1 + C_2)^2} \frac{G_{2\%} C_2}{100} \right| \right]$$

Procentualna sigurna granica grešaka serijske veze je:

$$G_{C\%} = \frac{G_C}{C_s} 100 = \pm \left[\left| \frac{C_2}{(C_1 + C_2)} G_{1\%} \right| + \left| \frac{C_1}{(C_1 + C_2)} G_{2\%} \right| \right] = \pm 1.024\%$$

Kapacitet paralene veze je:

$$C_p = C_1 + C_2$$

$$G_C = \pm\left[\left|\frac{\partial C_s}{\partial C_1}G_1\right| + \left|\frac{\partial C_s}{\partial C_2}G_2\right|\right] \text{ a } \frac{\partial C_p}{\partial C_1} = 1 \text{ i } \frac{\partial C_p}{\partial C_2} = 1$$

$$G_C = \pm\left[\left|G_1\right| + \left|G_2\right|\right] = \pm\left[\left|\frac{G_{1\%}C_1}{100}\right| + \left|\frac{G_{2\%}C_2}{100}\right|\right]$$

$$G_{C\%} = \frac{G_C}{C_s}100 = \pm\left[\left|\frac{C_1}{(C_1+C_2)}G_{1\%}\right| + \left|\frac{C_2}{(C_1+C_2)^2}G_{2\%}\right|\right] = \pm 1.07\%$$

2. Sa kojom tačnošću je izmjerenja potrošnja električne energije *W* jednosmjerne struje *I* u toku vremena *t* na potrošaču otpora *R* ako je greška mjerenja struje 2%, greška mjerenja otpora 1% i greška mjerenja vremena 0.5%.

   Električna energija potrošača jednosmjerne struje data je relacijom:

$$W = RI^2t$$

$$G = \pm[\left|\frac{\partial W}{\partial I}G_I\right| + \left|\frac{\partial W}{\partial R}G_R\right| + \left|\frac{\partial W}{\partial t}G_t\right|]$$

$$\frac{\partial W}{\partial I} = 2RIt$$
$$\frac{\partial W}{\partial R} = I^2t$$
$$\frac{\partial W}{\partial t} = RI^2$$

$$G = \pm[\left|2RItG_I\right| + \left|I^2tG_R\right| + \left|RI^2G_t\right|]$$
$$G_{\%} = \frac{G}{W}100 = \pm[\left|\frac{2RIt}{W}G_I100\right| + \left|\frac{I^2t}{W}G_R100\right| + \left|\frac{RI^2}{W}G_t100\right|]$$
$$G_{\%} = \frac{G}{W}100 = \pm[\left|\frac{2RIt}{RI^2t}G_I100\right| + \left|\frac{I^2t}{RI^2t}G_R100\right| + \left|\frac{RI^2}{RI^2t}G_t100\right|]$$
$$G_{\%} = \frac{G}{W}100 = \pm[\left|\frac{2}{I}G_I100\right| + \left|\frac{1}{R}G_R100\right| + \left|\frac{1}{t}G_t100\right|]$$
$$G_{\%} = \frac{G}{W}100 = \pm[\left|2G_{I\%}\right| + \left|G_{R\%}\right| + \left|G_{t\%}\right|] = 2*2\% + 1\% + 0.5\% = 5.5\%$$

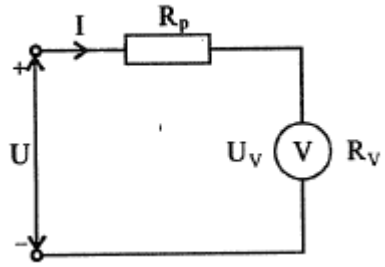
3. Voltvetrom klase tačnosti 0.1 mjernog dometa 1V i unutrašnjeg otpora 5kΩ treba ostvariti mjerno područje 100V. Kojoj klasi tačnosti pripada voltvetar sa proširenim mjernim područjem ako su unutrašnji otpor voltmetra i predotpor sa granicama grešaka $\pm 0.2\%$

U=100V

U_V=1V

R_V=5kΩ

k_t=0.1



$$U - IR_p - U_V = 0$$

$$U - \frac{U_V}{R_V} R_p - U_V = 0 \text{ -> } U = U_V(\frac{R_p}{R_V} + 1)$$

$$\text{-> } R_p = (\frac{U}{U_V} - 1)R_V = 495k\Omega$$

Sigurne granice grešaka iznose: $G = \pm[\left|\frac{\partial U}{\partial U_V} G_{U_V}\right| + \left|\frac{\partial U}{\partial R_V} G_{R_V}\right| + \left|\frac{\partial U}{\partial R_p} G_{Rp}\right|]$

$$G = \pm[\left|(\frac{R_p}{R_V} + 1)G_{U_V}\right| + \left|-U_V \frac{R_p}{R_V{}^2} G_{R_V}\right| + \left|\frac{U_V}{R_V} G_{Rp}\right|]$$

Procentualne granice grešaka iznose:

$$G_{\%} = \pm\frac{G}{U}100 = \pm[\left|G_{U_{V\%}}\right| + \left|\frac{R_p}{R_p + R_V} G_{R_{V\%}}\right| + \left|\frac{R_p}{R_p + R_V} G_{Rp\%}\right|] =$$

$$\pm[0.1\% + 0.99 * 0.2\% + 0.99 * 0.2\%] = \pm 0.496\%$$

4. Koliko iznose sigurne granice grešaka otpora od 89.7Ω realizovanih sa kutijom otpornika sa čepovima (serijska kombinacija otpornika od 50, 20, 10, 10, 5, 2, 1, 1, 0.5, 0.2, 0.1, 0.1, 0.1 Ω) ako su granice grešaka ugrađenih otpornika $\pm 0.05\%$? Zanemariti kontaktne otpore.

Otpor od 89.7 Ω se može realizovati kao 50+20+10+5+2+1+1+0.5+0.2=89.7

Sigurne granice grešaka su:

$$G = \pm[\left|\frac{\partial R}{\partial R_1} G_{R_1}\right| + \left\|\frac{\partial R}{\partial R_2} G_{R_2}\right\| + ... + \left\|\frac{\partial R}{\partial R_9} G_{R_9}\right\|]$$

Obzirom da su svi izvodi u ovom slučaju jednaki i iznose 1, sigurne granice grešaka možemo pisati u obliku:

$$G = \pm[\left|G_{R_1}\right| + \left\|G_{R_2}\right\| + ... + \left\|G_{R_9}\right\|]$$

Sada, procentualne granice grešaka su:

$$G_{\%} = \frac{G}{R}100 = \frac{\pm[|G_{R_1}| + \|G_{R_2}\| + ... + \|G_{R_9}\|]}{R_1 + R_2 + ...R_9}100$$

$$G_{\%} = \frac{G}{R}100 = \frac{\pm[\left|\frac{R_1 G_{R_{1\%}}}{100}\right| + \left\|\frac{R_2 G_{R_{2\%}}}{100}\right\| + ... + \left\|\frac{R_9 G_{R_{9\%}}}{100}\right\|]}{R_1 + R_2 + ...R_9}100$$

Obzirom da je u postavci dato da je $G_{R_{\%}} = G_{R_{1\%}} = G_{R_{2\%}} = G_{R_{3\%}} = ... = G_{R_{9\%}} = \pm 0.05\%$

$$G_{\%} = 9G_{R_{\%}} = \pm 0.45\%$$

Apsolutna vrijednost sigurnih granica grešaka je:

$$G = \frac{G_{\%}}{100} R = 0.4\Omega$$