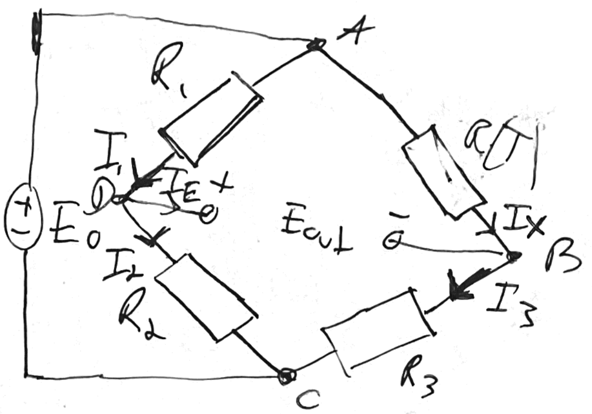
Øving 2 - Karakterisering av sensore

- Wheatstone bru:

$R(T) = R_0 + \alpha \Delta T \qquad \Delta T = T - T_0$

$E_{out} \propto \Delta T$



Spenningsdeling over ADC og ABC

Fra D: $V_D = \frac{R_2}{R_1 + R_2}$

Fra B: $V_B = \frac{R_3}{R_3 + R(T)}$

a) $I_1 = I_2$, $I_3 = I_x$, $V_D = V_B$

$$\frac{V_{DC}}{V_{AD}} = \frac{V_{BC}}{V_{AB}} \Rightarrow \frac{\cancel{I_2} R_2}{\cancel{I_1} R_1} = \frac{\cancel{I_3} R_3}{\cancel{I_x} R(T)}$$

$$\Rightarrow R(T) = R_3 \cdot \frac{R_1}{R_2}$$

$$E_{out} = \left(\frac{R_2}{R_1 + R_2} - \frac{R_3}{R_3 + R(T)} \right) E_0$$

$$E_{out} = E_0 \, \frac{R_2 \cdot R(T) - R_1 R_3}{(R_1 + R_2)(R_3 + R(t))}$$

(v) Se a)

$$F = \frac{R_1}{R_2} = \frac{R_0}{R_3} \quad \text{hvis } \alpha \Delta T << R_0$$

Siden $I_1 = I_2$ $\quad I_3 = I_x$

og at spenningen over branch ADC og ABC er den samme så

må

$$\frac{V_{DC}}{V_{AD}} = \frac{V_{BC}}{V_{AB}} \iff \frac{R_1}{R_2} = \frac{R(T)}{R_3} = \frac{R_0 + \alpha \Delta T}{R_3}$$

$$\alpha \Delta T << R_0 \Rightarrow \frac{R_1}{R_2} = \frac{R_0}{R_3}$$

$$\frac{E_{out}}{E_0} = \frac{R_2}{R_1 + R_2} - \frac{R_3}{R_3 + R(T)} \Rightarrow \frac{\frac{R_1}{F}}{\cancel{R_1} + \frac{R_1}{F}} = \frac{1}{1+F}$$

$$\frac{R_3}{R_3 + R_0 + \alpha \Delta T} = \frac{\frac{R_0}{F}}{\frac{R_0}{F} + R_0 + \alpha \Delta T} = \frac{\frac{1}{F}}{\frac{1}{F} + 1 + \frac{\alpha \Delta T}{R_0}}$$

$$= \frac{1}{1 + F + \frac{\alpha \Delta T}{R_3}}$$

$$\boxed{\frac{1}{1+x} \simeq 1 + X}$$

$$\frac{E_{out}}{E_0} = \frac{1}{1+F} - \frac{1}{1 + F + \frac{\alpha \Delta T}{R_3}}$$

$$E_{out} = \frac{E_0}{1+F}\left[1 - \frac{1}{1 + \frac{\alpha \Delta T}{R_3(1+F)}}\right]$$

$$= \frac{E_0}{1+F}\left[1 - \frac{1}{1 + \frac{\alpha \Delta T}{\frac{R_0}{F}(1+F)}}\right]$$

$$\frac{1}{1+x} \simeq 1 - x$$

$$= \frac{E_0}{1+F}\left[1 - \left(1 - \frac{\alpha \Delta T}{\frac{R_0}{F} + R_0}\right)\right]$$

$$E_{out} = \frac{E_0}{(1+F)} \frac{\alpha \Delta T}{\left(\frac{1}{F}+1\right) R_0}$$

$\underline{E_{out} \propto \Delta T}$

c)

$$E_{out} = \frac{E_0 \alpha \Delta T}{\frac{1}{F}+1+1+F} = \frac{E_0 \alpha \Delta T}{2+\frac{1}{F}+F} = \frac{E_0 \alpha \Delta T\, F}{(1+F)^2}$$

F^2+2F+1

$\Rightarrow$ ~~$u = F^2+2F+1$~~ | $u = \frac{1}{F}+2+F$

~~$du = 2F+2\, dF$~~ | $du = -\frac{1}{F^2}+1$

$u =$ ... $\quad u = 2+F+\frac{1}{F}$

$= \frac{d}{du}\frac{1}{u}\frac{du}{dx} \quad du = 1-F^{-2}\,dx$

$$\frac{dE_{out}}{dF} = E_0 \alpha \Delta T \frac{d}{dF}\left[\frac{1}{2+F+\frac{1}{F}}\right] = \frac{1-F}{(F+1)^3} = 0$$

$F = 1$

d) Større temperatursvinger (ΔT)

- da er ikke $\frac{1}{1+x} \approx 1-x$, men

$$\frac{1}{1+x} = 1 - x - x^2 - x^3 - x^4 - \dots$$

$$E_{out} = \frac{E_0}{1+F} - \frac{1}{1+\frac{\alpha \Delta T}{R_3}}$$

- $E_{out} = A_1\left(\frac{\alpha \Delta T}{R_0}\right) + A_2\left(\frac{\alpha \Delta T}{R_0}\right)^2 + A_3\left(\frac{\alpha \Delta T}{R_0}\right)^3 + \dots$