Uitwerkingen oefenopgaven EE1320 Meettechniek – college 2: Sensoren

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Regtien: opgaven 7.8, 7.11⇒ Zie pdf met uitwerkingen op Blackboard

5.4 $F = M \cdot a = 0.1\ \text{kg} \cdot 1\ \text{m/s}^2 = 0.1\ \text{N}$.
Therefore, the charge displacement $Q = S_q \cdot F = 5 \cdot 10^{-12}\ \text{C/N} \cdot 0.1\ \text{N} = 5 \cdot 10^{-13}\ \text{C}$.
$U_{sensor} = Q / C_s = 5 \cdot 10^{-13}\ \text{C} / 1 \cdot 10^{-9}\ \text{F} = 0.5\ \text{mV}$.

5.5 The cable capacitance C_c and the input capacitance C_i of the amplifier are in parallel with the sensor capacitance, giving a total capacitance
$C_{tot} = C_s + C_c + C_i = 1\ \text{nF} + 40\ \text{pF} + 80\ \text{pF} = 1.12\ \text{nF}$
As a result of this larger capacitance, a charge displacement Q gives an output voltage $U_{sensor}' = Q / C_{tot}$ instead of the (unloaded) output voltage $U_{sensor} = Q / C_s$.
This corresponds to a relative error of
$\varepsilon = (U_{sensor}' - U_{sensor}) / U_{sensor} = C_s / C_{tot} - 1 = 1\ \text{nF} / 1.12\ \text{nF} - 1 = -10\%$.

5.6 The sensitivity of 4 mV/(mm·V) and excitation voltage $U_{exc} = 2\text{V}$ yields $U_o = 8\ \text{mV/mm}$.
A 30 mm displacement results in: $U_o = 30\ \text{mm} \times 8\ \text{mV/mm} = 0.24\ \text{V}$.

5.7 Although amplitude of the induced voltage is the same, the signal is 180^o out-of-phase.

5.9 $U_{oc} = (\alpha_{alumel} - \alpha_{Cu})T_h + (\alpha_{chromel} - \alpha_{alumel})T_1 + (\alpha_{alumel} - \alpha_{chromel})T_2 + (\alpha_{Cu} - \alpha_{alumel})T_h$
$= (\alpha_{alumel} - \alpha_{chromel})(T_2 - T_1)$.
The measurement is independent of T_h, provided that both Cu junctions are at the same temperature, T_h.