Homework

$$\frac{V_{out}}{V_S} = \frac{\left(\dfrac{x R_{TOT} R_L}{R_L + x R_{TOT}}\right)}{(1-x) R_{TOT} + \left(\dfrac{x R_{TOT} R_L}{R_L + x R_{TOT}}\right)}$$

$$\Rightarrow \frac{\left(\dfrac{x R_{TOT} R_L}{\cancel{R_L + x R_{TOT}}}\right)}{\dfrac{(1-x) R_{TOT} ( R_L + x R_{TOT}) + x R_{TOT} R_L}{\cancel{(R_L + x R_{TOT})}}}$$

$$\Rightarrow \frac{x R_{TOT} R_L}{(R_{TOT} - x R_{TOT})(R_L + x R_{TOT}) + x R_{TOT} R_L}$$

$$\Rightarrow \frac{x R_{TOT} R_L}{R_L R_{TOT} + x R_{TOT}^2 - \cancel{x R_L R_{TOT}} - x^2 R_{TOT}^2 + \cancel{x R_{TOT} R_L}}$$

$$\Rightarrow \frac{x R_{TOT} R_L}{R_L R_{TOT} + x R_{TOT}^2 - x^2 R_{TOT}^2}$$

$$\Rightarrow \frac{x R_{TOT} R_L}{R_L R_{TOT} + R_{TOT}^2 \{x - x^2\}}$$

$\Rightarrow$ divide $R_L R_{TOT}$ to Numerator & denominator

$$\Rightarrow \frac{x}{1 + \dfrac{R_{TOT}^{\cancel{2}}}{R_L \cancel{R_{TOT}}} (x - x^2)} \Rightarrow \boxed{\frac{x}{1 + \dfrac{R_{TOT}}{R_L} (x - x^2)}}$$

# Homework

Goal:- is to find a % error.

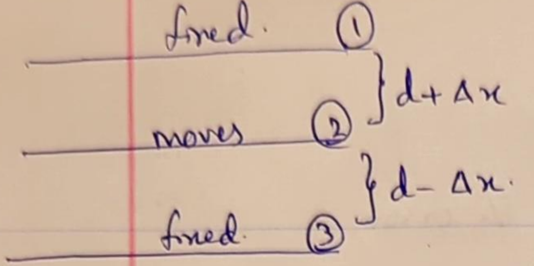
$$\text{Error} = x V_s - \frac{x V_s}{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)}$$

$$\frac{\text{Error in Volts}}{V_s} = x - \frac{x}{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)}$$

$$\Rightarrow \frac{x\left\{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)\right\} - x}{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)}$$

$$\Rightarrow \frac{\cancel{x} + x\frac{R_{TOT}}{R_L}(x - x^2) - \cancel{x}}{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)}$$

$$\frac{\text{Error}}{V_s} \Rightarrow \frac{\frac{R_{TOT}}{R_L}(x^2 - x^3)}{1 + \left(\frac{R_{TOT}}{R_L}\right)(x - x^2)}$$




Sensory Derivation

$$C_{12} = \frac{\varepsilon\varepsilon_0 A}{d+\Delta x} \qquad C_0 = \frac{\varepsilon\varepsilon_0 A}{d}$$

$$C_{12} - C_0 = \Delta C$$

$$\Rightarrow \frac{\varepsilon\varepsilon_0 A}{d+\Delta x} - \frac{\varepsilon\varepsilon_0 A}{d} = \Delta C$$

$$\Rightarrow \frac{\varepsilon\varepsilon_0 A(-\Delta x)}{d+\Delta x} = \Delta C_{12}$$

$$\Rightarrow \frac{\Delta C_{12}}{C_0} = \frac{\dfrac{\cancel{\varepsilon\varepsilon_0 A}(-\Delta x)}{\cancel{d}(d+\Delta x)}}{\dfrac{\cancel{\varepsilon\varepsilon_0 A}}{\cancel{d}}} = \frac{-\Delta x}{d+\Delta x}$$

★★ So $\boxed{\dfrac{\Delta C_{12}}{C_0} = \dfrac{-\Delta x}{d+\Delta x}.}$ (% change in Capacitance)

Now

$$C_{23} = \frac{\varepsilon\varepsilon_0 A}{d-\Delta x} \qquad C_0 = \frac{\varepsilon\varepsilon_0 A}{d}$$

$$C_{23} - C_0 = \Delta C$$

$$\Rightarrow \frac{\varepsilon\varepsilon_0 A}{d-\Delta x} - \frac{\varepsilon\varepsilon_0 A}{d} = \Delta C$$

$$\Rightarrow \Delta C_{23} = \frac{\varepsilon\varepsilon_0 A(\Delta x)}{d(d-\Delta x)}$$

$$\frac{\Delta C_{23}}{C_0} = \frac{\dfrac{\varepsilon \varepsilon_0 \cancel{A} (\Delta x)}{\cancel{d}(d - \Delta x)}}{\dfrac{\cancel{\varepsilon \varepsilon_0 A}}{\cancel{d}}}$$

$$\boxed{\frac{\Delta C_{23}}{C_0} = \frac{\Delta x}{d - \Delta x}}$$ % change in Capacitance.

% change in Capacitance with 2 fixed plates & 1 plate moving.

$$\frac{\Delta C_{23}}{C_0} - \frac{\Delta C_{12}}{C_0} = \frac{\Delta x}{d - \Delta x} - \left[\frac{-\Delta x}{d + \Delta x}\right]$$

$$= \frac{\Delta x}{d - \Delta x} + \frac{\Delta x}{d + \Delta x}$$

$$\Rightarrow \frac{\Delta x\, d + \cancel{\Delta x^2} + \Delta x d - \cancel{\Delta x^2}}{d^2 - \Delta x^2}$$

$$\Rightarrow \frac{2 d \Delta x}{d^2 - \Delta x^2}$$

with MEMS Sensor

$\Delta x$ is very Small.

So, ignore $\Delta x^2$

$$\Rightarrow \frac{2 d \Delta x}{d^2} \text{ (linear).}$$

$$= \frac{2 \Delta x}{d}$$