2) PART 1.

$$g_{ds} = \frac{2I_{DS}}{2V_{DS}}$$

V_{DS} = FIXED VALUE

$V_{DS\text{-}MATCH}$ = IDEAL VALUE BASED ON $V_{DS2} = V_{GS1}$

↑ PERFECT CURRENT MATCH CONDITION.

(IDEAL) FOR MATCHED CURRENTS:

$$I_{DS_1} = \frac{\beta}{2}\frac{W}{L}\left(V_{G_1} - V_{th}\right)^2$$

$$V_{DV_1} = V_{DV_2} = \sqrt{\frac{2I_{REF}}{\beta\frac{W}{L}}} \Rightarrow V_{DS\text{-}MATCH} = V_{th} + \sqrt{\frac{2I_{REF}}{\beta\, W/L}}$$

$$\Delta V_{DS} = V_{DS} - V_{DS\text{-}MATCH} \quad \Leftarrow \text{ASSUMING } V_{DS} > V_{DS\text{-}MATCH}$$

$$\Delta I_{DS} = g_{ds}\Delta V_{DS}$$

$$\boxed{\Delta I_{DS} = g_{ds}\left(V_{DS} - V_{th} - \sqrt{\frac{2I_{REF}}{\beta\, W/L}}\right)}$$

$$I_o = I_{REF} + \Delta I_{DS}$$

$$\boxed{I_o = I_{REF} + g_{ds}\left(V_{DS} - V_{th} - \sqrt{\frac{2I_{REF}}{\beta\, W/L}}\right)}$$

$$\frac{\Delta I}{I} = \frac{\left(I_o - I_{REF}\right)\cdot 100}{I_{REF}} = \frac{g_{ds}}{I_{REF}}\left(V_{DS} - V_{th} - \sqrt{\frac{2I_{REF}}{\beta\frac{W}{L}}}\right)\times 100$$

$$\boxed{\frac{\Delta I}{I} = \frac{100\left(g_{ds}V_{DS} - g_{ds}V_{th}\right)}{I_{REF}} - g_{ds}\sqrt{\frac{20}{\beta\frac{W}{L}I_{REF}}}}$$

* I APPLIED SOME TEST VALUES TO CHECK MY WORK:

$g_{ds} = 6.4\times10^{-7}\,S$
$V_{th} = 0.5V$, $V_{ov} = 0.2V$
$I_{REF} = 16\mu A$, $V_{DS} = 0.75V$
$\frac{W}{L} = 10$, $\beta = 320\,\frac{\mu A}{V^2}$

RESULTS IN $\frac{\Delta I}{I} = 0.98\%$

THIS IS REASONABLE!

* FROM SIMULATION:

$g_{ds} = 5.08\times10^{-6}\,S$
$V_{th} \approx 0.5V$, $V_{ov} \approx 0.2V$
$I_{REF} = 16\mu A$, $V_{DS} = 0.75V$
$\frac{W}{L} = 10$, $\beta = 320\,\frac{\mu A}{V^2}$

RESULTS IN $\boxed{\frac{\Delta I}{I} = 7.83\%}$ FROM MY DERIVED EXPRESSION

SIMULATION RESULTS IN $\boxed{\frac{\Delta I}{I} = 5.56\%}$

RESULTS ARE COMPARABLE.