Thursday Analog Quiz

Consider the shown 5T OTA, and assume the square-law is valid. If the bias current (IB) is halved (multiplied by 0.5) while sizing is kept fixed, then:
1) The DC voltage gain is multiplied by .....
2) The bandwidth is multiplied by .....
3) The unity-gain frequency (UGF) is multiplied by .....
4) The input-referred noise density (in V^2/Hz) is multiplied by .....

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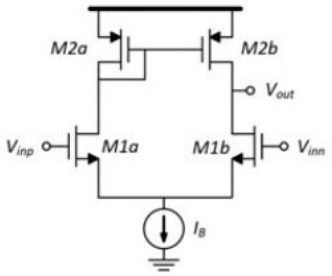

1) Multiplied factor to DC Gain

$$I_D = \frac{1}{2} K_n' \frac{W}{L} V_{OV}^2$$

$$V_{OV} = \sqrt{\frac{I_D}{\frac{1}{2} K_n' \frac{W}{L}}}$$

as $\frac{W}{L}$ constant

$$g_m = \frac{2I_D}{V_{OV}} = \frac{2 I_D \times \frac{1}{2}}{\sqrt{\frac{I_D \times \frac{1}{2}}{\frac{1}{2} K_n' \frac{W}{L}}}}$$

so g_m is multiplied by $\frac{1}{\sqrt{2}}$

for $r_o \Rightarrow$ as $r_o = \frac{1}{\lambda I_D} \Rightarrow$ then $r_o \times 2$

So $$A_V = g_m \times \frac{1}{\sqrt{2}} R_{out} \times 2$$

$\Rightarrow 0,707 \times 2 = 1,414$

$$A_V \times 1,414$$

2) Multiplied factor to Bandwidth and UGF

$$BW = \frac{GBW}{A_{CL}}, \quad GBW = UGF$$

as GBW/UGF scales mainly with g_m than GBW will scale by 0,707

and so Unity-Gain frequency

so $$BW = \frac{GBW \times 0{,}707}{A_{CL} \times 1{,}414}$$

so BW will be scaled by 0,5

and UGF by 0,707

4) input-reffered thermal noise density $\overline{v_n^2}$

as $\overline{v_n^2} \propto \frac{1}{g_m}$ than it will be multiplied by 1,414