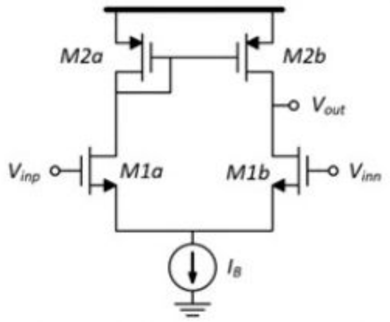
Consider the shown 5T OTA, and assume all devices are biased in weak inversion (WI) (Hint: In WI, the gm/ID almost saturates, and can be assumed constant). If the designer halved the bias current (IB) (multiplied it by 0.5) and kept the sizing fixed, then:

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 .....

Thursday Analog Quiz



This is not like Episode #3!

as we are in WI, g_m will change linearly with I_D so

$$g_m = \frac{2I_D}{V^{\phi}}$$

$$g_m \times \frac{1}{2}$$

1) A_V:

$$r_o = \frac{1}{\lambda I_D^{\times\frac{1}{2}}} \Rightarrow r_o \times 2$$

$$A_V = G_m R_{out}$$

and $G_m = g_m$, $R_{out} = r_{o1} \parallel r_{o2}$

$$A_V \times 1$$

2) Bandwidth:

$$BW = \frac{1}{2\pi R_{out}^{\times 2} C_{out}} \Rightarrow BW \times \frac{1}{2}$$

3) Unity Gain frequency:

$$UGF = GBW = A_V^{\times 1} \cdot BW^{\times\frac{1}{2}} \Rightarrow UGF \times \frac{1}{2}$$

4) Input-referred noise density $\overline{V_n^2}$:

$$\overline{V_n^2} \propto \frac{1}{g_m} \Rightarrow \overline{V_n^2} \times 2$$

Comparison btw SI and WI :

when halving the bias current : (when fixing sizing)

	WI	SI	comments
g_m	linear with I_D $\times 0{,}5$	degrade less $\times 0{,}707$	SI
g_m/I_D	constant as $\left(\frac{g_m}{I_D}\right)_{WI} = \frac{1}{nV_T}$	$\times 1{,}414$	
A_V	constant	$\times 1{,}414$	in SI we get gain boost
UGF	$\times 0{,}5$	$\times 0{,}707$	in WI we get slower
BW	$\times 0{,}5$	$\times 0{,}5$	
$\overline{V_n^2}$	$\times 2$	$\times 1{,}414$	In WI we get harsher in noise