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For the shown differential amplifier, assume gm*ro >> 1 and ignore body effect. Assume M1 has gm/ID = 16 and M2 has gm/ID = 8.

1) The DC voltage gain is equal to .....

2) If the square-law is valid and L1 = L2, then W1/W2 = ...

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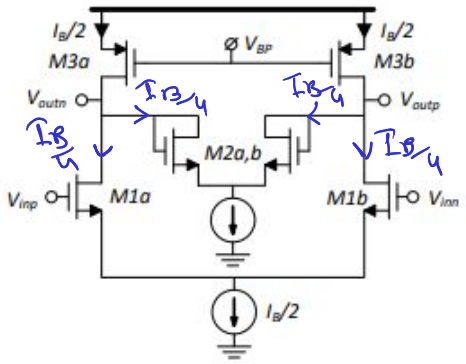
Thursday Analog Quiz



1) DC gain:

first we need r_o and resistance at output node, assuming $r_{o1} = r_{o3} = r_o$

$$R_{out} = r_o \,//\, r_o \,//\, \frac{1}{g_{m2}}$$

$$R_{out} = \frac{r_o}{r_o g_{m2} + 2}$$

as $g_m r_o >> 1$:

$$\boxed{R_{out} = \frac{1}{g_{m2}}}$$

so the gain is:

$$A_V = \frac{g_{m1}}{g_{m2}}$$

as M_1 and M_2 both of them flow a current of $\frac{I_B}{4}$ on them and $\left(\frac{g_m}{I_D}\right)_1 = 16$, $\left(\frac{g_m}{I_D}\right)_2 = 8$

so $\Rightarrow g_{m1} = \frac{64}{I_B}$, $g_{m2} = \frac{32}{I_B}$

resulting in a gain:

$$A_V = \frac{64}{32} = 2$$

2) same $L \Rightarrow$ same r_o ($I_{D1} = I_{D2}$)

using this g_m equation:

$$g_m = \sqrt{2 \mu_n C_{ox} \frac{W}{L} I_D}, \quad L_1 = L_2$$

$$\frac{g_{m1}}{g_{m2}} = \sqrt{\frac{W_1}{W_2}} \Rightarrow \sqrt{\frac{W_1}{W_2}} = 2 \Rightarrow \frac{W_1}{W_2} = 4$$

$\frac{64}{32} \rightarrow \frac{g_{m1}}{g_{m2}}$