Question 1

For a two-stage Miller OTA, assume all transistors are biased in WI and Vstar = 2*n*VT. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the PM is multiplied by

Hint: The PM is determined by the relation between ωu and ωp2.

$\therefore PM \propto \frac{\omega_{p2}}{\omega_u} \rightarrow PM \propto \frac{g_{m6}}{g_{m1}}$

For WI, $\frac{g_m}{I_D}$ saturate $\rightarrow I_D \times \frac{1}{2} \rightarrow g_m \times \frac{1}{2}$

$\therefore \frac{\omega_{p2}}{\omega_u} \times 1 \rightarrow PM \times 1$

Question 2

For a two-stage Miller OTA, assume Cc = CL and all transistors are biased at the same V*. If critical damped response is desired and the tail current source of the first stage is 100 uA, then the bias current of the second stage should be around ____ uA.

For Critical damped response: $\omega_{p2} = 4\omega_u \rightarrow \frac{g_{m6}}{C_C} = 4\frac{g_{m1}}{C_L}$

If $C_C = C_L$ and V^* are the Same: $\frac{g_{m6}}{I_D} = \frac{g_{m1}}{I_D} \rightarrow \frac{g_{m1}}{50\mu} = 4\frac{g_{m1}}{I_{D2}}$

$\therefore I_{D2} = 4 \times 50\mu = 200\,\mu A$

Question 3

For a two-stage Miller OTA, assume all transistors are biased in SI and the long-channel model (square-law) is valid. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the PM is multiplied by ____

Hint: The PM is determined by the relation between ωu and ωp2.

$PM \propto \frac{\omega_{p2}}{\omega_u} \rightarrow PM \propto \frac{g_{m6}}{g_{m1}}$

If Square Law is Valid: $I_D \times \frac{1}{2} \rightarrow g_m \times \sqrt{\frac{1}{2}}$

$\therefore \frac{g_{m6}}{g_{m1}} \times 1 \rightarrow PM \times 1$

Question 4

For a two-stage Miller OTA, increasing ____ always improves the PM.

$\therefore PM \propto \frac{\omega_{p2}}{\omega_u} \rightarrow PM \propto \frac{g_{m6}}{g_{m1}}$

$\therefore g_{m6} \uparrow \rightarrow PM \uparrow$

Gm of second stage

Question 5

For a two-stage Miller OTA, assume all transistors are biased in SI and the long-channel model (square-law) is valid. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the GBW is multiplied by

Note: Write a numerical answer with three significant digits.

$GBW = \frac{g_{m1}}{C_C}$

If Square Law is Valid: $I_D \times \frac{1}{2} \rightarrow g_m \times \sqrt{\frac{1}{2}}$

$\therefore GBW \times$ ٠,٧٠٧

Question 6

For a two stage Miller OTA, a good design practice is to place the feedforward zero at a frequency ____.

> ωp2

Question 7

For a two-stage Miller OTA, assume all transistors are biased in WI and Vstar = 2*n*VT. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the DC gain is multiplied by ____.

$$A_v = G_m R_{out} = A_{v1} \cdot A_{v2}$$

for WI: $\frac{g_m}{I_D}$ Saturate: $I_D \times \frac{1}{2} \rightarrow g_m \times \frac{1}{2} \rightarrow R_{out} \times 2$

$\therefore A_v \times 1$

Question 8

For a two-stage Miller OTA, assume all transistors are biased in WI and Vstar = 2*n*VT. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the GBW is multiplied by ____.

$GBW = \frac{g_{m1}}{2\pi C_C} \rightarrow$ for WI: $I_D \times \frac{1}{2} \rightarrow g_m \times \frac{1}{2}$

$\therefore GBW \times \frac{1}{2}$

Question 9

For a two-stage Miller OTA, assume all transistors are biased in SI and the long-channel model (square-law) is valid. If bias currents are halved (i.e., multiplied by 0.5) without changing the transistor sizing, the DC gain is multiplied by ____.

$A_v = G_m R_{out} \rightarrow$ if Square Law Valid: $I_D \times \frac{1}{2}$

$\therefore g_m \times \sqrt{\frac{1}{2}} \rightarrow R_{out} \times 2$

$\therefore A_{v1} \times 2\sqrt{\frac{1}{2}} \rightarrow A_{v2} \times 2\sqrt{\frac{1}{2}} \rightarrow A_v \times 2$

Question 10

For a two-stage Miller OTA, if CL = 2 pF, then a reasonable value for Cc can be ____.

> 1 pF