QUIZ NO. 13 - SOLUTION

(Average score = 7.1/10 of those who took the quiz)

1.) The amplifier in the feedback circuit shown has a transfer function of

\[ A(s) = \frac{100}{s + \frac{1}{10^5}} + 1 \]

What value of \( \beta \) will increase the upper -3db frequency by a factor of 10 for the closed loop gain? What is the closed loop, low frequency gain?

**Solution**

\[ A_F = \frac{A}{1 + \beta A} = \frac{1}{1 + \beta} = \frac{1}{s/10^5 + 1 + \beta} = \frac{100}{s/10^5 + 1 + 100\beta} = \frac{100}{s/10^5(1+100\beta) + 1} \]

\[ 10^5(1+100\beta) = 10^6 \rightarrow 1+100\beta = 10 \rightarrow \beta = \frac{9}{100} = 0.09 \]

The closed-loop, low frequency gain is,

\[ A_F(0) = \frac{100}{1+100\beta} = \frac{100}{1+9} = 10 \rightarrow A_F(0) = 10 \]

2.) Find the loop gain of the amplifier shown. Assume that \( g_m = 1 \text{mS} \) and \( r_{ds} = \infty \) for all MOSFETs and that \( R = 10 \text{k}\Omega \) and \( C = 100 \text{nF} \).

**Solution**

Use the model shown to find the loop gain.

This circuit consists of three identical stages with each transfer function given as

\[ A(s) = \frac{-g_m R}{sRC + 1} \]

Therefore,

\[ T(s) = -\frac{v_r}{v_x} = \left(\frac{-g_m R}{sRC + 1}\right)^3 = \left(\frac{-10}{s/10^3 + 1}\right)^3 = \left(\frac{s}{10^3 + 1}\right)^3 \rightarrow T(s) = \frac{1000}{s/10^3 + 1}^3 \]