EE 330

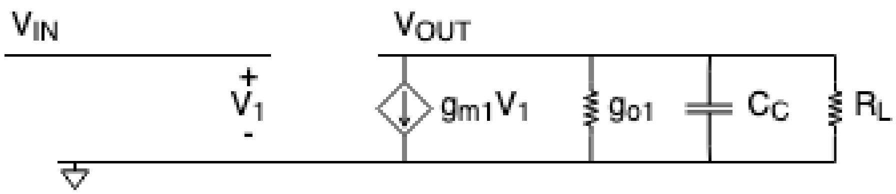
Homework 12

Fall 2020

Due Wednesday October 30

Solution 1

It can be useful to draw the two-port model of this circuit.



Solving KVL, we can find V_{OUT} in terms of V_{IN}:

$$V_{OUT}[g_{o1} + sC_C] = -g_{m1}V_{IN}$$

Then, solving for $\frac{V_{OUT}}{V_{IN}}$:

$$\frac{V_{OUT}}{V_{IN}} = -\frac{g_{m1}}{g_{o1} + sC_C}$$

Solution 2

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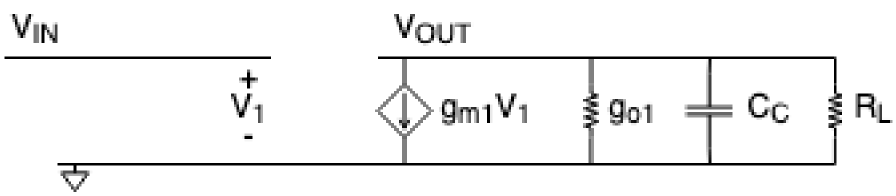

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Using our assumed values, this can be written as:

$$A_V = \frac{1m}{10\mu + s * 1nF}$$

We now need to find the magnitude of this transfer function:

$$|A_V| = \frac{1m}{\sqrt{(10\mu)^2 + (1nF * \omega)^2}}$$

We can now find the gain at each of the specified frequencies:

$$|A_V|@0Hz = \frac{1m}{\sqrt{(10\mu)^2 + (1nF * 0 * 2\pi)^2}} = 100$$

$$|A_V|@1kHz = \frac{1m}{\sqrt{(10\mu)^2 + (1nF * 1k * 2\pi)^2}} = 84.67$$

$$|A_V|@1MHz: \frac{1m}{\sqrt{(10\mu)^2 + (1nF * 1M * 2\pi)^2}} = 0.1592$$

Solution 3

Note that the two NMOS devices form a current mirror. We can then say that the current through the right-branch is equal to the left branch multiplied by 3 ($\frac{15}{5} = 3$). Thus, the right branch has $150\mu A$ flowing through it. V_{OUT} is then equal to $8 - 25k\Omega * 150\mu A = 4.25V$.

Solution 4

Per the lecture content, the gain of this structure is $A_v = \frac{\left(-\frac{g_{m1}}{g_{o1}}\right)\beta}{2}$. We can calculate g_{m1} and g_o as follows:

$$g_{m1} = \frac{I_{cq}}{V_t}$$

$$g_o = \frac{I_{cq}}{V_{AF}}$$

Thus:

$$A_V = -\frac{\frac{V_{AF}}{V_t}\beta}{2} = -\frac{100}{26m} * 50 = 192.3k$$

Solution 5

This is a cascode configuration with $Av = -\frac{gm_1}{g_{01}} = -\frac{\frac{I_{Cq}}{V_t}}{\frac{I_{Cq}}{V_{AF}}} = -\frac{100}{0.026} = -3846$

Solution 6

The difference between the two is that on assumes an ideal current source while the other one is a current source made from a BJT. The difference this presents is that the ideal source has 0 output resistance while the non ideal one in non-zero. What this does is it effectively changed the output level (as seen in previous chapters by cascading amplifiers). Specifically, since both BJTs have the same output resistance, we are doubling the output conductance which means we are halving the gain:

$$A_V = \frac{-g_{m1}}{g_{01} + g_{02}} \cong \frac{-g_{m1}}{2g_{01}}$$