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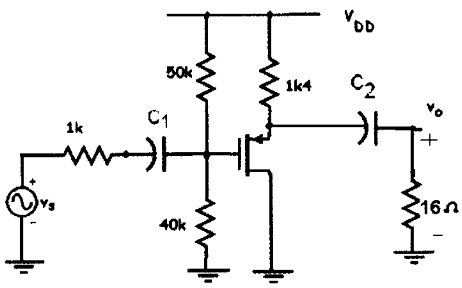
Electronics II * Exam I * ~~July 24,2009~~ * 55 minutes * closed books and notes

ID number: ERKAYA Name: SOLUTIONS Signature:____________

45 pts 1) Select C_1 and C_2 in a way that the low 3 dB cutoff frequency of the amplifier given below is 300 Hz. Assume K=32 mA/V^2, I_D = 2 mA.



$g_m = 2\sqrt{K I_D} = 2\sqrt{32 \times 2} = 16$ mA/V

$\frac{1}{g_m} = \frac{1}{16} = 0.0625$ kΩ

There are two poles f_1 and f_2.

$C_1 = 6.85 \times 10^{-6}$ F

$C_2 = 7 \times 10^{-6}$ F

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$f_L \cong f_1 + f_2$

no unique solution

set $f_2 = 299$ Hz
$f_1 = 1$ Hz

$f_1 = \frac{1}{2\pi C_1 R_{th_1}}$

$f_2 = \frac{1}{2\pi C_2 R_{th_2}}$

$R_{th_1} = 1k + 50k \| 40k = 23.22$ kΩ

$R_{th_2} = 16\Omega + \frac{1}{g_m} \| 1.4k \cong 76\Omega$

$C_1 = \frac{1}{2\pi f_1 R_{th_1}} = \frac{1}{2\pi \times 1 \times 23220} = 6.85 \times 10^{-6}$ F

$C_2 = \frac{1}{2\pi f_2 R_{th_2}} = \frac{1}{2\pi \times 299 \times 76} = 7 \times 10^{-6}$ F

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55 *pts* 2) Using Miller's theorem, find the high 3dB cutoff frequency of the amplifier given below.
Assume $\beta = 240$, $I_C = 1.50$ mA, $C_\mu = 1.7$ pF, $f_T = 450$ MHz, $r_x = 0$ ohms, $r_o = 120$ k

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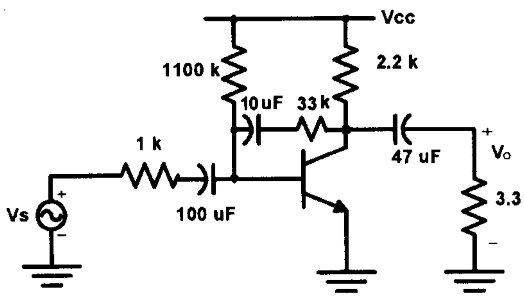
$f_H \simeq$ 3.8 MHz



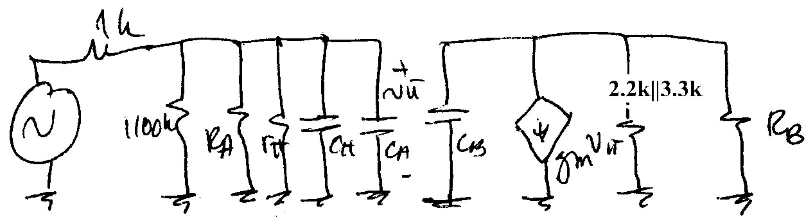
$g_m = \frac{1.5}{0.025} = 60\ mA/V$

$r_\pi = \frac{\beta}{g_m} = \frac{240}{60} = 4k\Omega$

$C_\pi = \frac{g_m}{2\pi f_T} - C_\mu = \frac{60\times10^{-3}}{2\pi\times450\times10^{6}} - 1.7\times10^{-12} = 19.52\ pF$

Apply Millers theorem on 33k and C_μ

$|g_m R_{sh}| \gg 1 \rightarrow R_B \simeq 33k$



$R_{sh} = 2.2k \| 3.3k \| 33k$
$\simeq 1.27k\Omega$

$g_m R_{sh} = 60 \times 1.27 = 76.15$

$C_B \simeq C_\mu = 1.7pF$

$R_A = \frac{33k}{1+g_m R_{sh}} = \frac{33k}{77.15} = 0.427k$

$\omega_A = \frac{1}{R_{thA}(C_A + C_\pi)} =$

$R_{thA} = r_\pi \| R_A \| 1100k \| 1k$
$= 4 \| 0.427 \| 1100k \| 1k = 0.278k$

$\omega_A = \frac{1}{278\times(131.2+19.52)\times10^{-12}} = 23.87\ Mrad/s$

$C_A = C_\mu(1+g_m R_{sh}) = 1.7 \times 77.15 = 131.2\ pF$

$\omega_B = \frac{1}{C_B R_{sh}} = \frac{1}{1.7\times10^{-12}\times1270} = 463\times10^{6}\ rad/s$

$\omega_B \gg \omega_A$ Hence $\omega_H \cong \omega_A \rightarrow f_H = \frac{23.87\times10^{6}}{2\pi} = 3.799\ MHz.$

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