Electronics II * Exam I * March 24, 2011 * 55 minutes * closed books and notes

ID number: ____________ Name: ________________ Signature:____________

40 pts 1) Find the minimum value of *C* in the circuit below such that the low 3 dB cutoff frequency of the amplifier is equal or below 20 Hz.

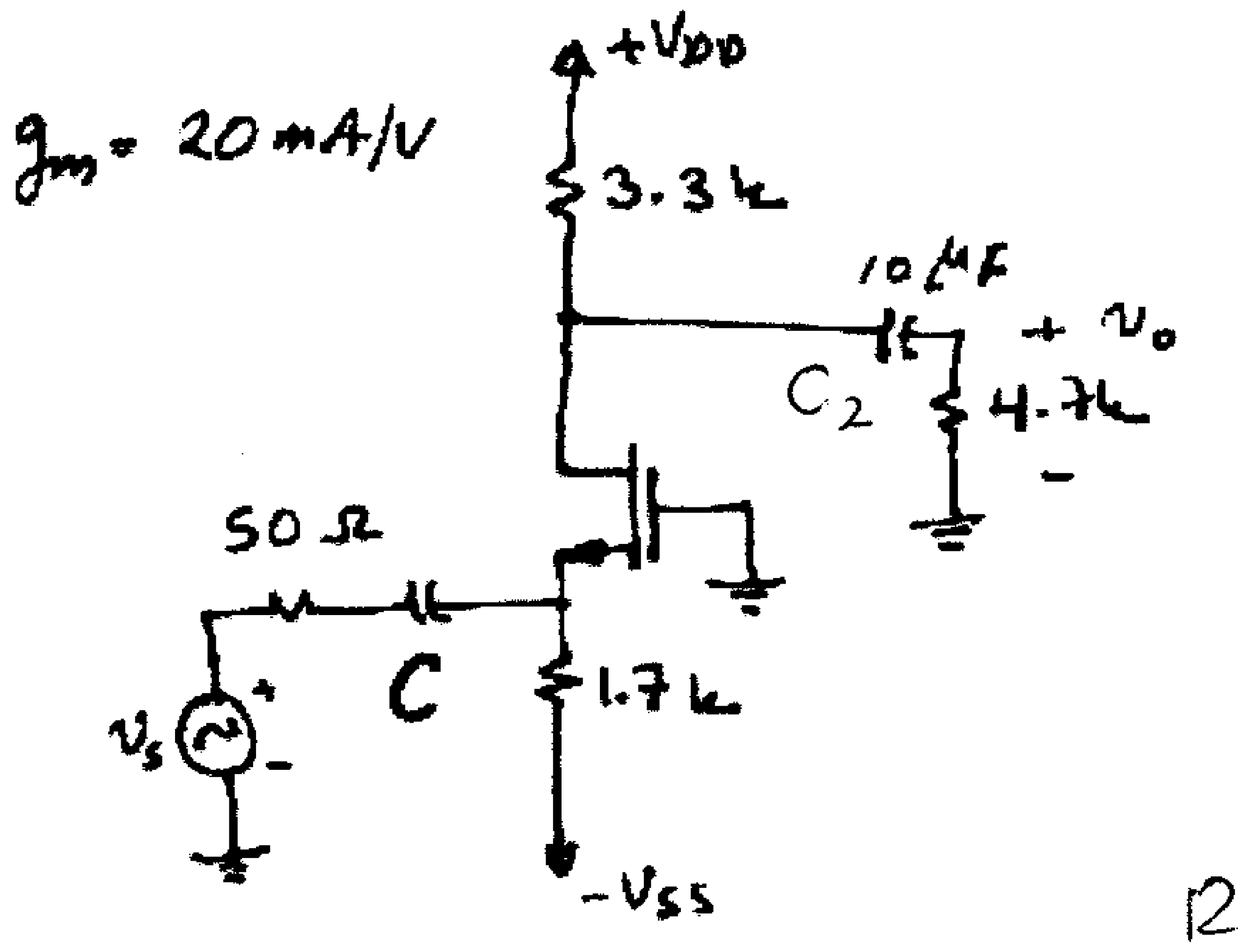
$C =$ ______

5:34

$C = C_1$ pole frequencies

$$f_1 = \frac{1}{2\pi C_1 R_{th_1}} \qquad R_{th_1} = 50\,\Omega + \left(\frac{1}{g_m} \| 1700\,\Omega\right)$$

$$f_2 = \frac{1}{2\pi C_2 R_{th_2}} \qquad R_{th_2} = 3.3k + 4.7k = 8k$$



$$f_L \cong f_1 + f_2 \leq 20\text{ Hz}$$

$$R_{th_1} = 50 + \left(\frac{1}{0.02} \| 1700\right) = 50 + 50 \| 1700 = 98.57\,\Omega$$

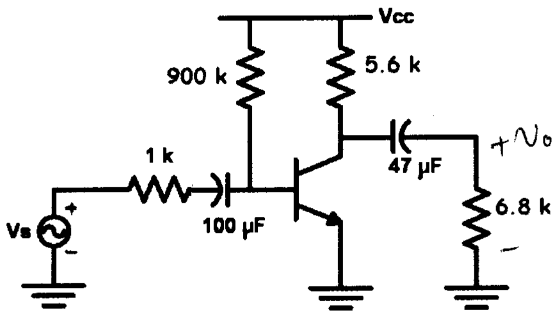
$$f_2 = \frac{1}{2\pi\, 10 \times 10^{-6} \times 8000} = 1.989\text{ Hz} \qquad f_1 \leq 20 - 1.989 \cong 18\text{ Hz}$$

$$C = C_1 \geq \frac{1}{2\pi f_1 R_{th_1}} = \frac{1}{2\pi\, 18 \times 98.57} = 8.96 \times 10^{-5}\text{ F} = 89.6\ \mu\text{F}$$

5:41

40 pts 2) Using Miller's theorem, find the high 3dB cutoff frequency of the amplifier given below.
Assume $\beta = 250$, $I_C = 1.25$ mA, $C_\mu = 1.5$ pF, $f_T = 400$ MHz, $r_x = 100$ ohms, $r_o = 80$ k

5:41



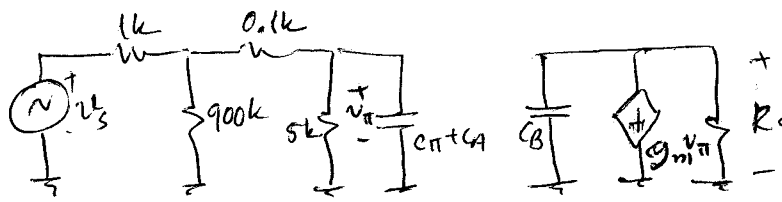
$f_H =$ ________ Hz

$g_m = \frac{1.25}{0.025} = 50$ mA/V

$r_\pi = \frac{\beta}{g_m} = \frac{250}{50} = 5k\Omega$

$C_\pi = \frac{g_m}{2\pi f_T} - C_\mu = \frac{50\times10^{-3}}{2\pi\times400\times10^{6}} - 1.5\times10^{-12} = 18.39\times10^{-12}$ F

HF Small signal eq. ckt – Miller's Theorem applied on C_μ:



$R_{sh} = r_o \| 5.6k \| 6.8k = 2.96k$

$C_A = C_\mu(1 + g_m R_{sh}) = 1.5\times10^{-12}(1 + 50\times2.96) \cong 223\times10^{-12}$ F

$C_B \simeq C_\mu = 1.5$ pF

$f_A = \frac{1}{2\pi(C_A + C_\pi)R_{th_A}}$, $\quad R_{th_A} = 5k \| [0.1k + 1k\|900k] = 0.90k$

$f_A = \frac{1}{2\pi(223 + 18.39)\times10^{-12}\times900} = 732.6$ kHz

$f_B = \frac{1}{2\pi C_B R_{sh}} = \frac{1}{2\pi\times1.5\times10^{-12}\times2960} = 35.8$ MHz

$f_H = \frac{1}{\frac{1}{f_A} + \frac{1}{f_B}} \simeq 730$ kHz

5:52

20 pts 3) What are the effects of negative feedback on an amplifier circuit?

1- Gain stability. Dependence on active device parameters is reduced by neg. feedback

2. S/N ratio is improved by negative fb

3. Bandwidth is increased by a factor of $(1-\beta A)$

4. Input resistance increased by series fb
decreased by shunt fb

5. Output resistance decreased by voltage fb
increased by current fb

6. if $1-\beta A = 1 \rightarrow$ oscillation may occur.

5:56