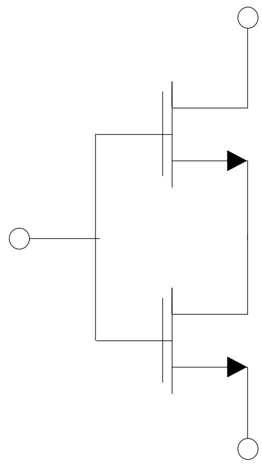
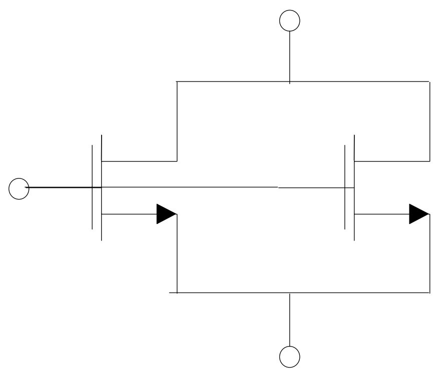
Midterm Exam 2

Exam duration: 1.5 hours, 4 questions

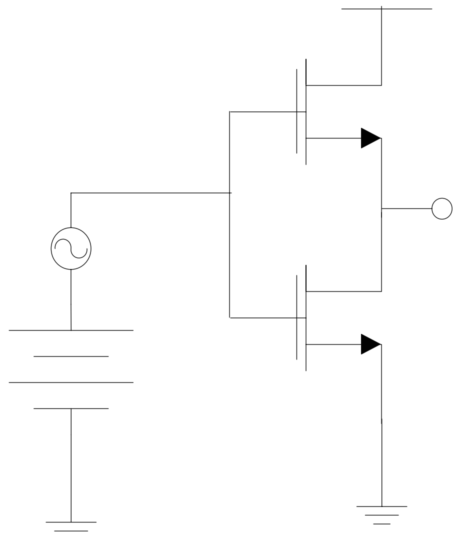
1.
   a. What is the effective width and length of the combination
      i. Asdf



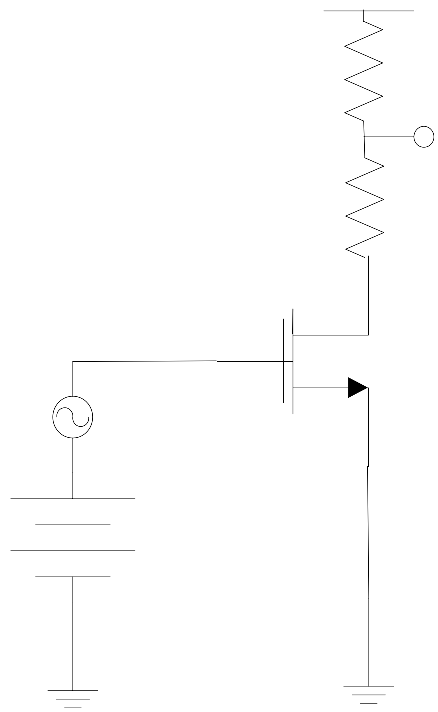
      ii.



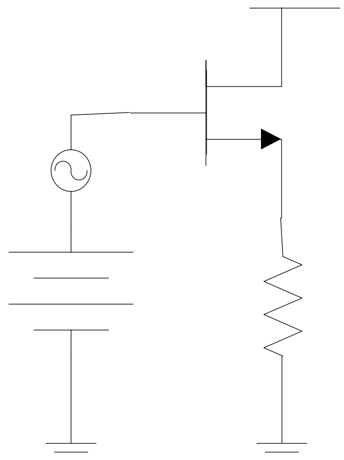
b. What is the small signal low frequency gain Vout/Vin? (Ignore all capacitances. M1 and M2 in saturation. Answer in terms of small signal parameters).



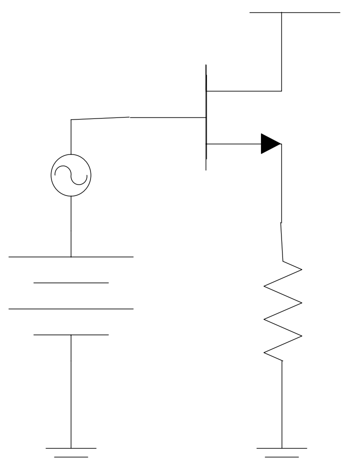
c. Assume M1 in saturation, $\lambda=0$, ignore all capacitances.
   i. Draw the small signal model
   ii. What is the small signal low frequency gain?



d. Assume source and bulk are connected, $\lambda=0$, ignore all capacitances. M1 is a PMOS transistor and is in saturation.
   i. Draw the arrow that indicates the source terminal
   ii. Write an expression for the small signal low frequency gain = Vout/Vin

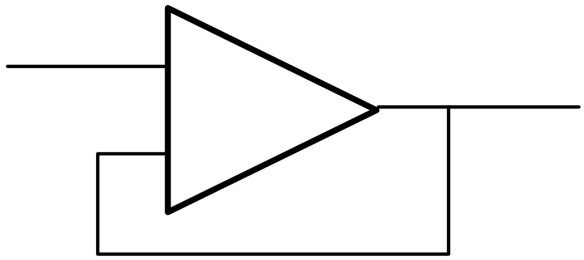


e. Assume source and bulk are connected, λ=0, ignore all capacitances. M2 is an NMOS transistor and is in saturation.
    i. Draw the arrow that indicates the source terminal
    ii. Write an expression for the small signal low frequency gain = Vout/Vin

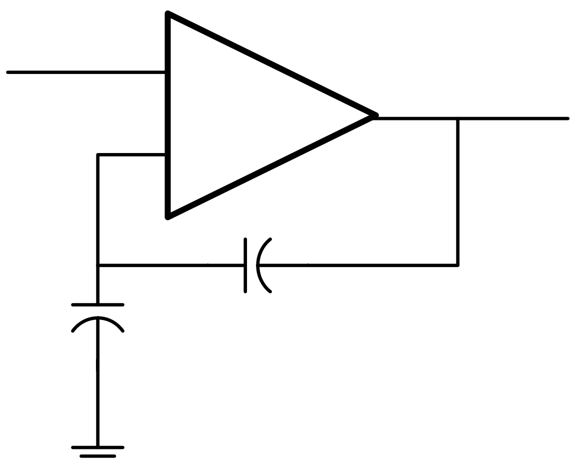


f. What is the feedback factor, β?

i.



ii.



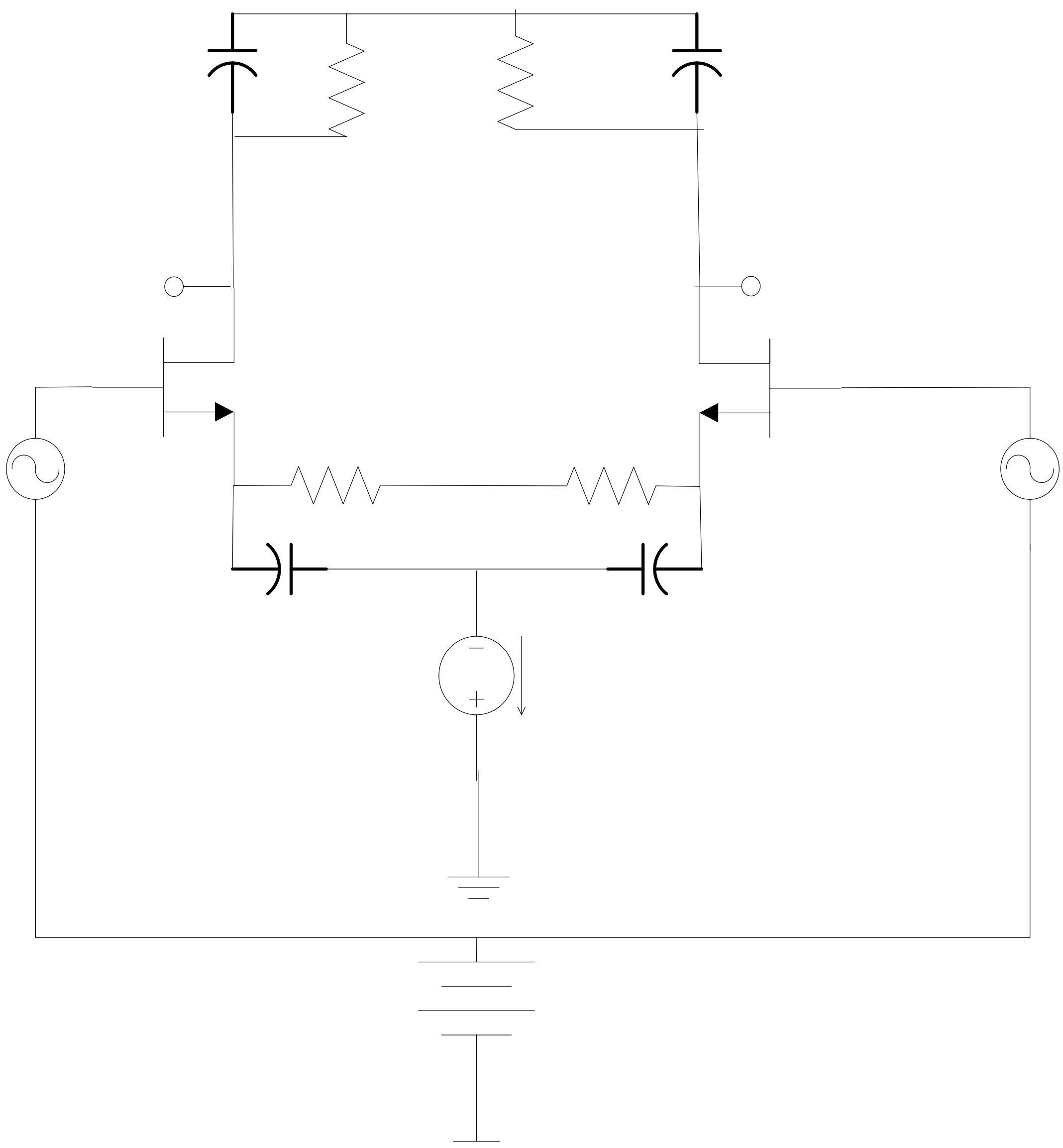
g. An amplifier with a gain of 1000 and an output resistance of 10kΩ is connected in unity gain feedback. What is the output resistance of the overall circuit.

h. If the amplifier from part g. has a single pole at 100kHz, then what is the -3dB frequency of the entire circuit?

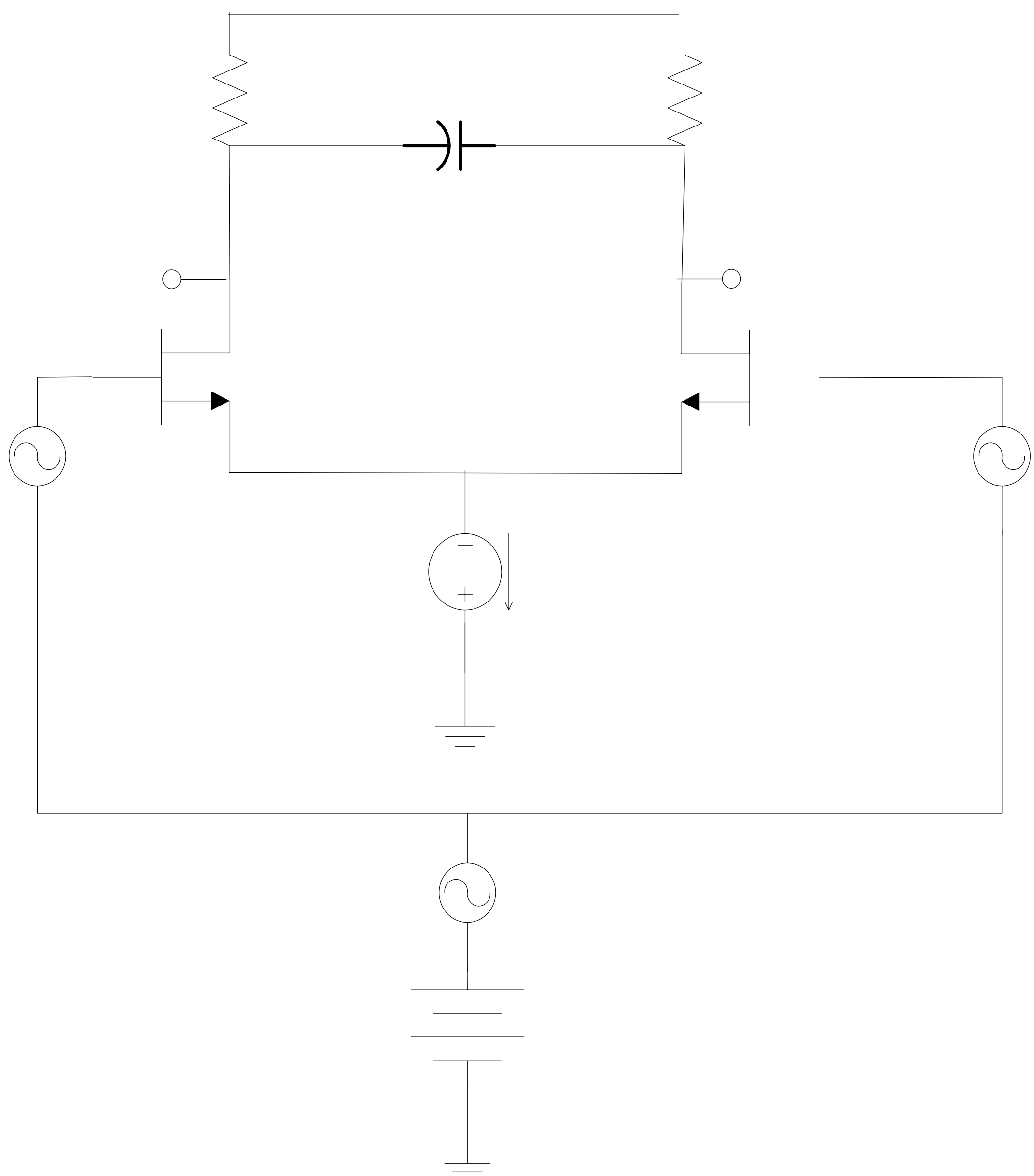
2.

a. An amplifier connected in unity gain feedback has a phase margin of 30 degrees. What is the gain of the overall system at the amplifier's unity gain frequency?
b. The amplifier from a. has two poles, ω_{p1}, ω_{p2} and no zeros. Assume that $|\omega_{p2}|>>|\omega_{p1}|$. What is the relationship between $|\omega_{p2}|$ and the unity gain frequency of the amplifier?
c. Sketch a bode plot showing the gain of the amplifier and the gain of the overall system versus frequency.
d. If the amplifier has only a single pole $|\omega_{p1}|$ and it is much less that the unity gain frequency, then what is the phase margin?

3. Assume that M1=M2 and both are in saturation. Ignore body effect and assume that λ=0. Ignore all capacitances except those shown (C_L and C_S). Vout=Vout+ - Vout-
   a. Using symmetry or otherwise, derive an expression for the small signal low frequency gain Vout/Vin.
   b. Derive an expression for the frequency dependent gain Vout/Vin (s).
   c. Identify the poles and zeros
   d. Sketch the Bode and Phase plots. Assume that $R_SC_S<R_LC_L$
   e. Explain what is happening at the different regions in the Bode plot



4. Assume that M1=M2 and both are in saturation. Ignore body effect and assume that λ=0. Ignore all capacitances except those shown (C_L and C_S). Vout=Vout+ - Vout-
   a. Write an expression for the frequency dependent gain Vout/Vin (s). (i.e A_{DM}).
   b. Write an expression for the common mode gain Vout/Vin (s). (i.e A_{CM}). Recall: Vout+/V_{CM}(s)=Vout-/V_{CM}(s).



R_L

5. Assume that M1=M2 and both are in saturation. Ignore body effect and assume that λ=0. Ignore all capacitances except those shown (C_L and C_S). Vout=Vout+ - Vout-
   a. Write an expression for the frequency dependent differential gain Vout/Vin (s). (i.e A_{DM}(s)).
   b. Write an expression for the frequency dependent common mode gain Vout/Vin (s). (i.e A_{CM}).
   c. Sketch the Bode showing A_{CM}, A_{DM} versus frequency. Assume that $R_S C_S < R_L C_L$