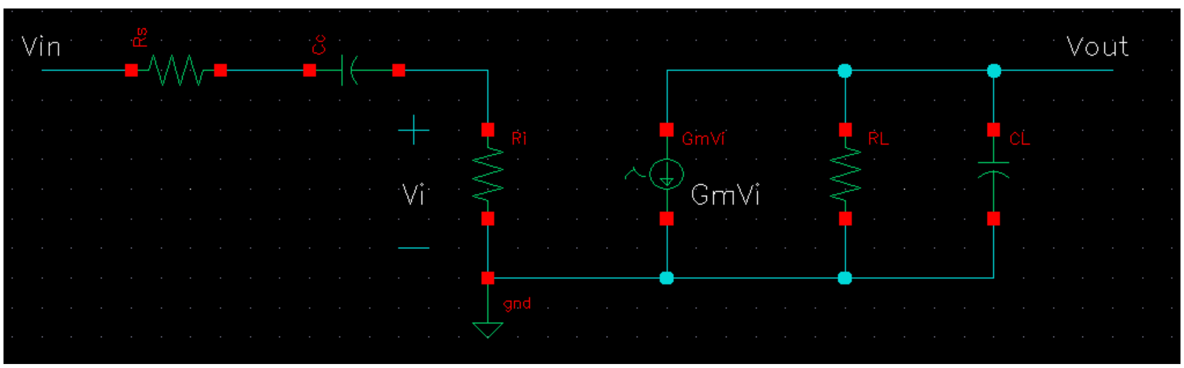
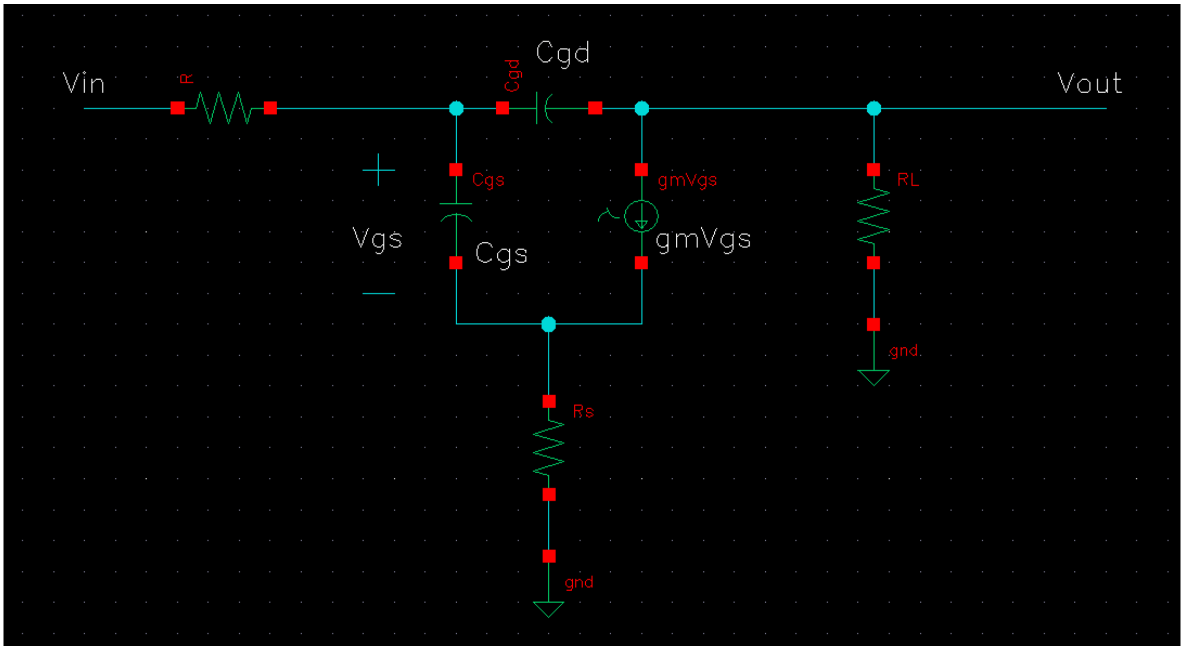
ECE595B HW2

Due: Nov 9, 6:00PM

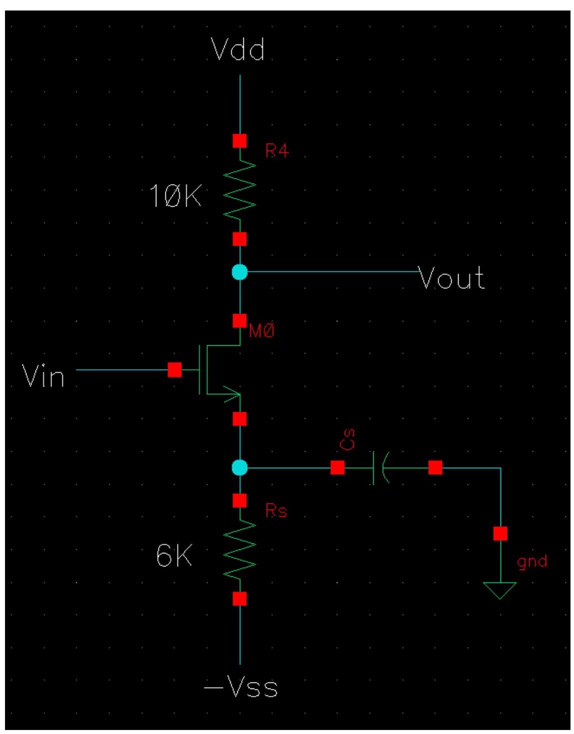
1. The equivalent circuit of an amplifier is shown below. The input signal source is coupled to the amplifier input via coupling capacitor Cc. Capacitor CL represents a parasitic capacitance appearing across the load resistance RL.
   (a) Derive an expression for the amplifier voltage gain A(s) – mid-band gain.
   (b) Noting that Cc is responsible for the frequency dependence of the gain at low frequencies, and the CL causes the gain to fall off at high frequencies, find H(s).
   (c) For Rs=20K, Ri=100K, and RL=10K, find the required value of Gm to obtain a midband gain of 20dB.



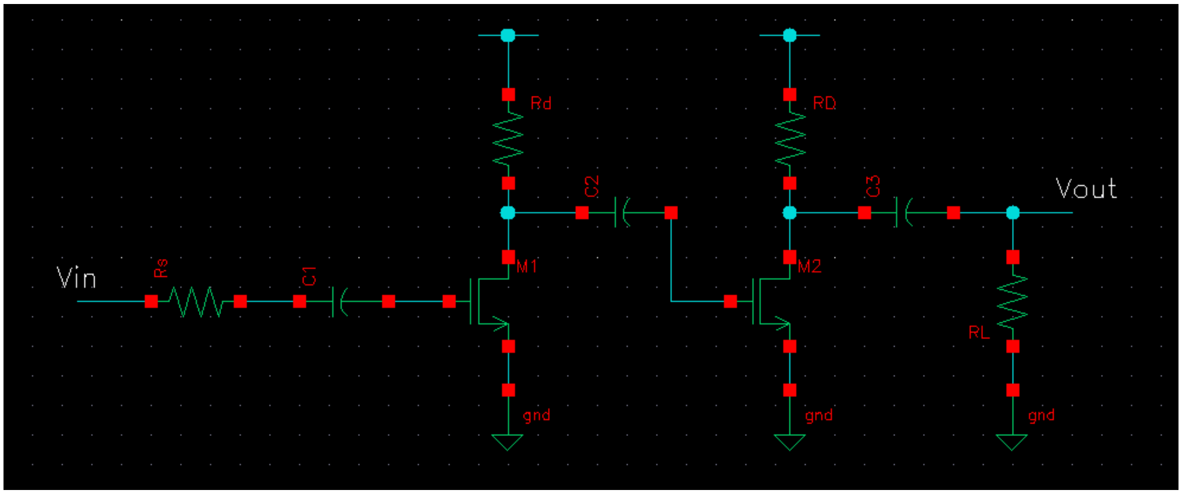
2. The following figure shows the high-frequency equivalent circuit of a FET amplifier with a resistance Rs connected in the source. The purpose of the problem is to show that the value of Rs can be used to control the gain and bandwidth of the amplifier, specifically to allow the designer to trade off gain for increased bandwidth.
   (a) Derive an expression for the low-frequency voltage gain.
   (b) Derive an expression for the transfer function.
   (c) Let R=100K, gm=4mA/V, RL=5K, Cgs=100fF, and Cgd=20fF. Find the low frequency gain and 3-dB frequency for the cases Rs=0, 100 and 250ohm. In each case evaluate also the gain-bandwidth product.



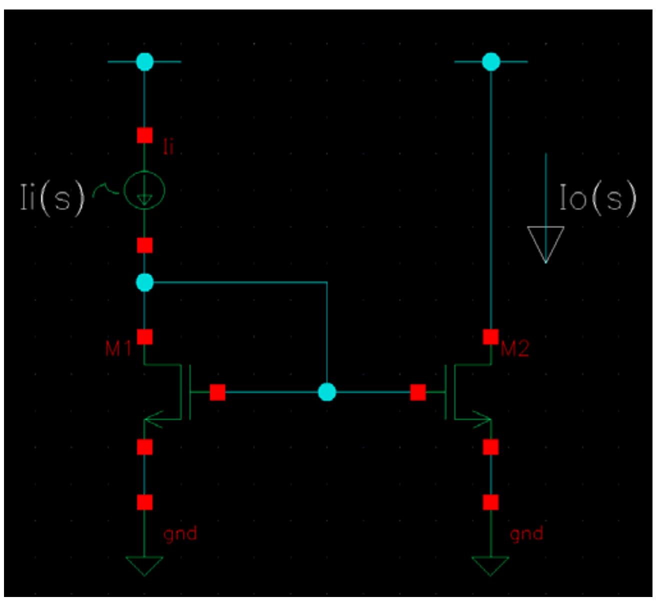
3. The amplifier shown below is biased to operate at Id=1mA and gm=15mA/V. Neglecting ro, find the midband gain. Find the value of Cs that places the corresponding pole at 10Hz. What is the frequency of transfer-function zero introduced by Cs? Give an expression for the gain function.



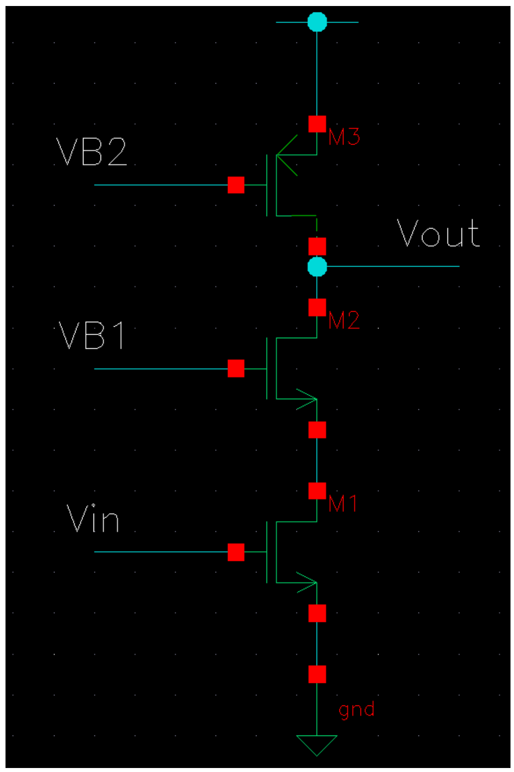
4. The circuit shown below is a basic two-stage capacitor coupled amplifier. Rs=RL=Rd=RD=1K, C1=C2=1uF, and C3=10uF. Find the voltage transfer function. (Hint: use the Miller method and ignore C1, C2, and C3 at high frequencies.)



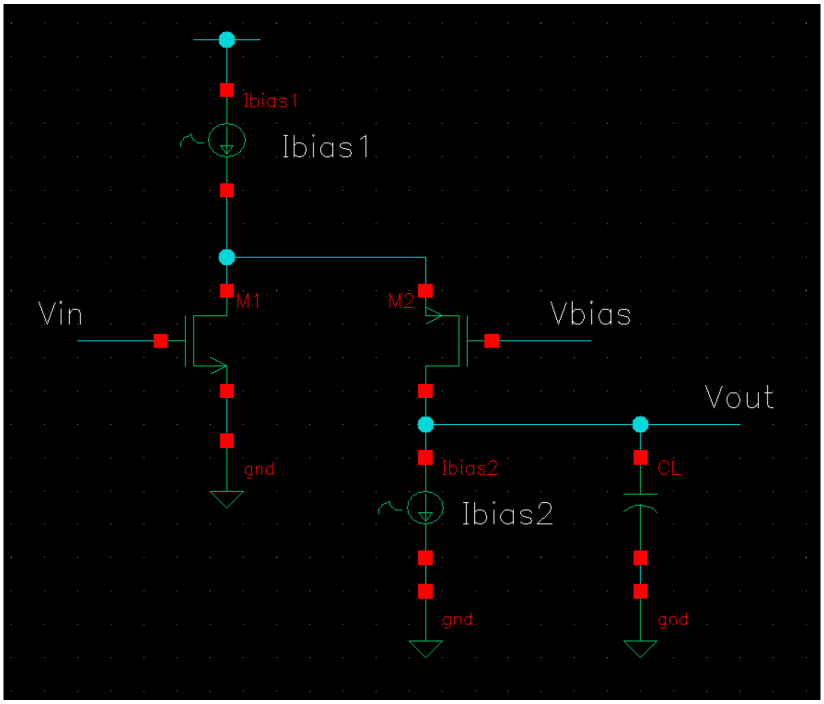
5. For the current mirror shown below, derive an expression for the current transfer function Io(s)/Ii(s) taking into account the MOS internal capacitance and neglecting ro. Assume the MOSFETs to be identical. Observe that a signal ground appears at the drain of M2.



6. The following figure shows a cascode CMOS amplifier using three devices.
   (a) Draw the amplifier small signal equivalent circuit. It should include three capacitors: Cgd1, C1, and C2, where C1 is the total capacitance at the drain of M1, and C2 is the total capacitance at the drain of M2. Since the resistance between the output node and ground is dominated by ro3 you may neglect the effect of ro2 and omit it from the equivalent circuit. Also neglect body effect in M2.
   (b) Derive an expression for the transfer function.



7. The following figure shows the circuit of a folded cascode amplifier. The folded cascode is a cascode circuit in which the cascode transistor M2 is of complementary polarity to M1.
   (a) If the bias current are such that M1 and M2 have equal gm and ro values and assuming the current source Ibias2 is implemented with a cascode and thus has an output resistance equal to that looking back into the drain of M2, show the gain equation.
   (b) The dominant high-frequency pole is usually formed at the output node. Find out the pole frequency.



8. The transistors in the following circuit have gm=10mA/V, ro=30K, Cgs=100fF, and Cgd=20fF. (Note that the bias details are not shown.)
   (a) Find Rin (input resistance) and the low frequency gain.
   (b) Find an estimate of the upper 3dB frequency. Which capacitor dominates? Which one is the second most significant?