Test 3

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Electronic Circuits 1
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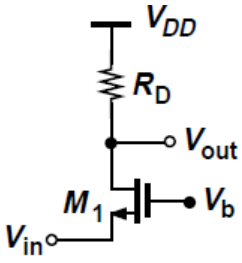
Prob. 1 (40)

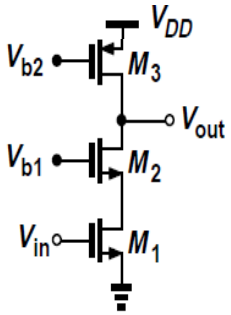
Consider the CG amplifier configuration shown below. Assume the transistor is in saturation with transconductance g_m and its channel length modulation effect can be model with resistance r_0.



(a)(10) Determine the input resistance of the circuit shown above.

(b)(10) Determine the voltage gain of the above CG amplifier.

Now consider a cascaded amplifier shown below. Assume all three transistors are in saturation with transconductance g_{m1}, g_{m2}, g_{m3} and their channel length modulation effects can be model with resistance r_{01}, r_{02}, r_{03}.



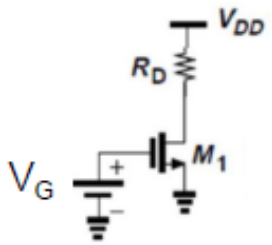
(c)(5) Give the amplifier configurations for M_1 and M_2, and identify the role of M3.

(d)(5) Determine the input resistance for M_2 when looked from its source terminal. You may use the result obtained in (a).

(e)(10) Determine the voltage gain of above cascaded amplifier. You may use the result obtained in (b). What does the voltage gain become if $g_{m1}=g_{m2}=g_{m3}=g_m$, $r_{01}=r_{02}=r_{03}=r_0$ and $g_m r_0 >> 1$?

Prob. 2 (30)

Consider the CS amplifier circuit shown below. V_{DD} = 1.5 V, V_G = 1.5 V, R_D=1KΩ, $\mu_n C_{ox}$ = 200μA/V^2 , W/L = 10, V_{TH} = 0.5V and λ = 0.



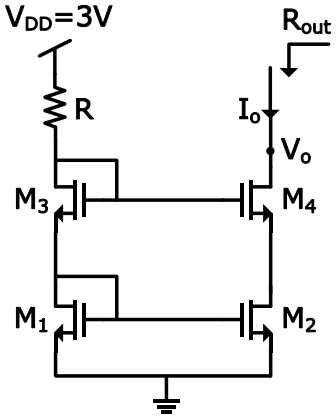
(a)(10) Determine the bias drain current in the above circuit. What mode of operation is M_1 in?

(b)(10) Draw the small-signal model of the above circuit when a small-signal input voltage is applied between V_G and the gate of M_1.

(c)(10) Determine the numerical value for the small-signal voltage gain.

Prob. 3 (30)

We want to realize a current source having a desired current (I_O) and a very large output resistance (R_{out}) with the circuit shown below. Assume all MOS transistors are in saturation, and identical with $\frac{W}{L}$=100, V_{th}=0.7V, and $\mu_n C_{ox}$=200μA/V^2.



(a)(10) Determine the numerical value for R so that I_O =100μA. For this part, ignore the channel length modulation effect. (Hint: All transistors have the same drain current)

(b)(10) What is the smallest value for V_o with which the above circuit can function as a current source? For this part, ignore the channel length modulation effect.

(c)(10) Determine the expression for output resistance, R_{out}. Consider the channel length modulation effect with r_0. Your answer should be an expression of g_m and r_o.