

EE4803 Analog IC Design Quiz 1

Instructions

1. This is a closed-book examination. But you can bring 1 A4 sheet with formula written on both sides
2. Unless specifically stated, all symbols have their usual meanings.
3. Time allowed: 1 hour.
4. Use the following parameters for MOS transistors taken from a nominal 0.8 μm process

Parameter Symbol	Parameter Description	Typical Parameter Value		Units
		n-Channel	p-Channel	
V_{T0}	Threshold voltage ($V_{BS} = 0$)	0.7 ± 0.15	-0.7 ± 0.15	V
K'	Transconductance parameter (in saturation)	$110.0 \pm 10\%$	$50.0 \pm 10\%$	$\mu\text{A}/\text{V}^2$
γ	Bulk threshold parameter	0.4	0.57	$\text{V}^{1/2}$
λ	Channel length modulation parameter	$0.04 (L = 1 \mu\text{m})$ $0.01 (L = 2 \mu\text{m})$	$0.05 (L = 1 \mu\text{m})$ $0.01 (L = 2 \mu\text{m})$	V^{-1}
$2 \phi_F $	Surface potential at strong inversion	0.7	0.8	V

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1. Figure 1 shows a Common-source amplifier with PMOS diode load. The size of the transistors in μm are given as $(W/L)_1 = 4/1$ and $(W/L)_2 = 1/1$.

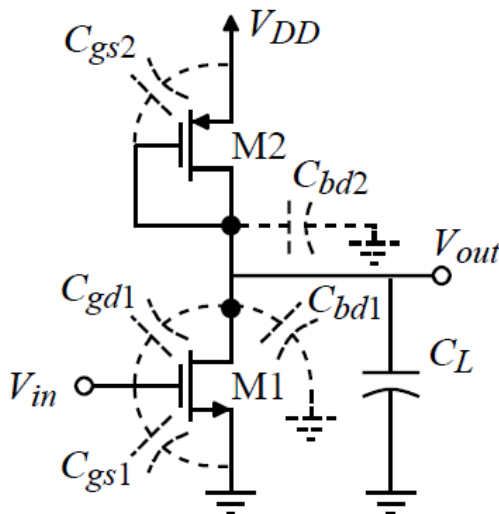


Figure 1

- a) Ignoring all parasitic capacitors and only considering C_L , draw the small-signal model and derive the transfer function V_{out}/V_{in} of this amplifier in terms of g_{m1} , g_{m2} , r_{o1} , r_{o2} and C_L .
- b) What is the magnitude of AC gain of this circuit?
- c) If $C_L = 10$ pF, what is the bandwidth and unity gain frequency? (assume $1 \mu A$ current)
2. If we replace the PMOS diode load with a PMOS current source load with same DC bias current, explain how the gain, bandwidth and unity gain frequency will change?
3. Suppose I want to create a cascode current source as shown in Figure 3 with a desired current of $I_{out} = 10 \mu A$. Suppose size of the transistors in μm are given as $(W/L)_1 = (W/L)_2 = 10/1$.
- (a) What is the minimum output voltage $V_{out, min}$ for this circuit to operate properly with both transistors in saturation?
- (b) Design the values of the bias voltages V_{GG1} and V_{GG2} to achieve this $V_{out, min}$

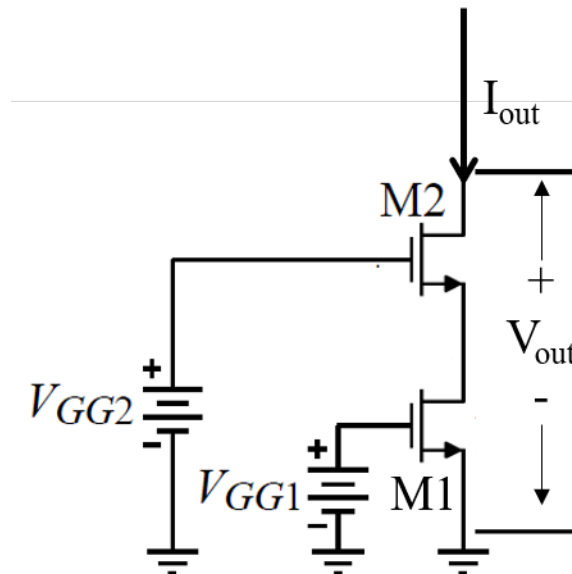


Figure 3