|  |  |  |
| --- | --- | --- |
| 浙江大学信息与电子工程学院 | **集成电路原理与设计** | 2023年4月 |
|  |

Table 7.1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Typical Parameter Value | |  |
| Parameter Symbol | Parameter Description | n-Channel | p-Channel | Units |
| VT0 | Threshold voltage(VBS=0) | 0.7 | -0.8 | V |
| K | Transconductance parameter(in saturation) | 134 | 50 | μA/V2 |
| γ | Bulk threshold parameter | 0.45 | 0.4 | V1/2 |
| λ | Channel length modulation parameter | 0.1 | 0.2 | V-1 |
| 2|ϕF| | Surface potential at strong inversion | 0.9 | 0.8 | V |

1. Assume that W/L ratios of Figure 7.1 are (W/L)1 = 2μm/1μm and (W/L)2 = (W/L)3 = (W/L)4 =1μm/1μm. Find the dc value of vIN that will give a dc current in M1 of 110μA. Calculate the small signal voltage gain and output resistance using the parameters of Table 7.1. Assume λ=γ=0.



Figure 7.1

Answer:

1. Suppose the common-source stage of Fig 7.2 is to provide an output swing from 1V to 2.5V. Assume that (W/L)1 = 50/0.5, RD = 2kΩ, VDD = 3V and λ = 0. Use model parameters in Table 7.1.
   1. Calculate the input voltages that yield Vout = 1V and Vout = 2.5V.
   2. Calculate the drain current and the transconductance of M1 for both cases.
   3. How much does the small-signal gain, gmRD, vary as the output goes from 1V to 2.5V?



Figure 7.2

Answer:

a), b):

Vout=1V时：

S

Vout=2.5V时：

S

c)：

1. Consider the circuit of Fig 7.3 with (W/L)1 = 50/0.5 and (W/L)2 = 10/0.5. Assume that λ = γ = 0, VDD = 3V.
2. At what input voltage is M1 at the edge of the triode region? What is the small-signal gain under this condition?
3. When Vout is 0.66 V, what is the small-signal gain under this condition?



Figure 7.3

Answer:

a)

M1 at the edge of the triode region：

，

b)

Vout=0.66V＜0.71V， M1 is working in the triode region

1. In the circuit of Fig 7.4, (W/L)1 = 20/0.5, I1 = 1mA, and IS = 0.75mA. Assuming λ = 0, VDD = 3V, calculate (W/L)2 such that M1 is at the edge of triode region. What is the small-signal voltage gain under this condition? Use model parameters in Table 7.1.

题中如果没说为0.注意考虑二级效应



Figure 7.4

Answer:

M1 at the edge of the triode region：

，

1. Consider the circuit of Fig 7.5 with (W/L)1 = 50/0.5, RD = 2kΩ, and RS = 200Ω, VDD = 3V. Use model parameters in Table 7.1.

a) Calculatethe small-signal voltage gain if ID = 0.5mA.

b) Assuming that λ = γ = 0, calculate the input voltage that places M1 at the edge of the triode region. What is the gain under this condition?



Figure 7.5

Answer:

a)：lamda是否要变化？

b):

M1 at the edge of the triode region

（VGS＜VTH，eliminate），