

1. Given a NMOS transistor with  $V_t = 2V$  which conducts a current  $i_D = 1mA$  when  $v_{GS} = 3V, v_{DS} = 2V$ . What is the value of  $i_D$  for  $v_{DS} = 4V$  (ignore channel modulation effect)? Calculate the value of the drain-to-source resistance for small  $v_{DS}$ , e.g.  $0.5V$ , and  $v_{GS} = 4V$ .
2. Given an NMOS transistor with  $L=0.2\mu m, W=2\mu m, t_{ox}=6nm, \mu_n=400cm^2/V.s, V_t=0.5V$ , and  $\epsilon_{ox}=34.5 pF/m$ . Assume  $\lambda=0$ . (Include units in all yours answers)
  - (a) Find  $C_{ox}$  and  $k'_n$ .
  - (b) Given  $i_D=0.8mA$ , calculate the values of  $v_{OV}$  and  $v_{DSmin}$  needed to operate the transistor in the saturation region
  - (c) Suppose the transistor is to be used as a  $600\Omega$  resistor for very small  $v_{DS}$ . Find the required values of  $v_{OV}$  and  $v_{GS}$
3. An n-channel MOS device is fabricated in a  $0.4\text{-}\mu m$  process having  $k'_n = 150\mu A/V^2$  and  $V'_A = 40V/\mu m$  of channel length. If  $L = 0.8\mu m$  and  $W = 16\mu m$ , find  $V_A$  and  $\lambda$ . If the device is operated with an overdrive voltage of  $1V$  and  $V_{DS} = 2V$ , what is the value of  $I_D$ ? Find the value of  $r_0$  at this operating point. If  $V_{DS}$  is increased by  $2V$ , what is the corresponding change in  $I_D$ ?
4. A particular n-channel MOSFET is operated in the triode region with  $v_{DS} = 50mV$ . The drain current is found to be  $45\mu A$  for  $v_{GS} = 2V$  and  $140\mu A$  for  $v_{GS} = 4V$ . Find the transistor threshold voltage  $V_t$ . If  $k'_n = 100\mu A/V^2$ , what is the device  $\frac{W}{L}$  ratio? For  $v_{GS} = 3V$  and  $v_{DS} = 0.2mV$ , what is the value of the drain current? If the transistor is operated at  $v_{GS} = 4V$ , at what value of  $v_{DS}$  will the drain end of the MOSFET channel just reach the pinch off, and what is the corresponding drain current?

5. Find the voltage  $V_1$  given that  $V_t=1V$ ,  $k_n = 2mA/V^2$  and  $\lambda=0$

