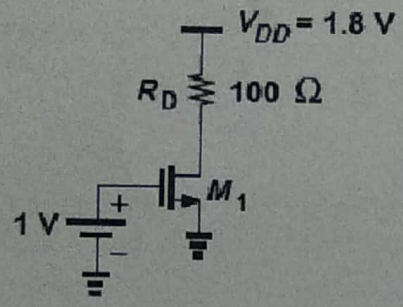
CMOS Analog Circuit Design

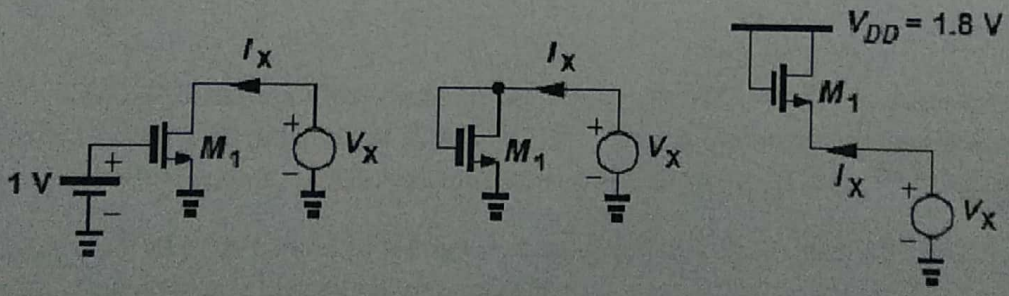
Assignment – 1 (PART -1)

Q.1 In the circuit shown below Determine , V_{DS}, g_m and r_o . Assume VTH = 0.4 V and $\mu_n C_{ox} = \frac{200\mu A}{V^2}$, $\lambda = 0.1V^{-1}$, $W/L = 20/0.18$.

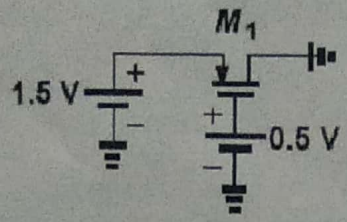


Q.2 Determine how the transconductance of a MOSFET(operating in saturation) changes If,(a) W/L is doubled but ID remains constant. (b) $VGS - VTH$ is doubled but ID remains constant. (c) ID is doubled but W/L remains constant.(d) ID is doubled but $VGS - VTH$ remains constant.

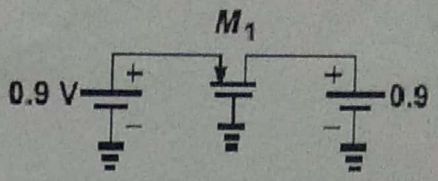
Q.3 Sketch IX as a function of VX for the circuits shown below. Assume VX goes from 0 to VDD = 1.8 V. Also, $\lambda = 0$. Determine at what value of VX the device changes its region of operation.



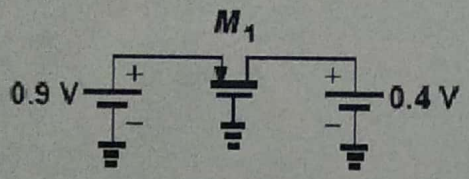
Q.4 Determine the region of operation of $M1$ in each circuit shown below,

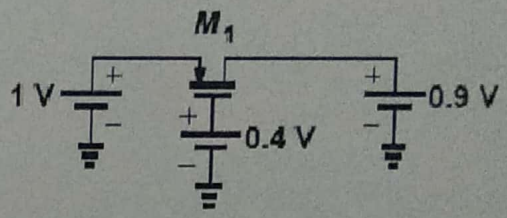


(a)

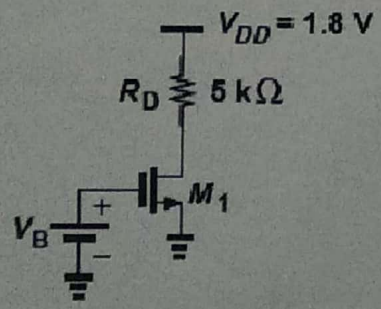


(b)



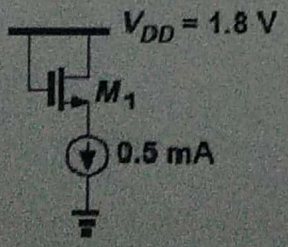


Q.5 Calculate the bias current of $M1$ in Fig. 6.23. Assume $\mu nCox$ = 100 $\mu A/V2$ and VTH = 0.4 V, V_B =1V and W/L = 2/0.18 If the gate voltage increases by 10 mV, what is the change in the drain voltage?



Q.6 A MOSFET carries a drain current of 1 mA with VDS = 0.5 V in saturation. Determine the change in ID if VDS rises to 1 V and $\lambda = 0.1V^{-1}$. What is the device output resistance? Assuming λ is inversely proportional to L, calculate change in ID and r_o, if both W and L are doubled.

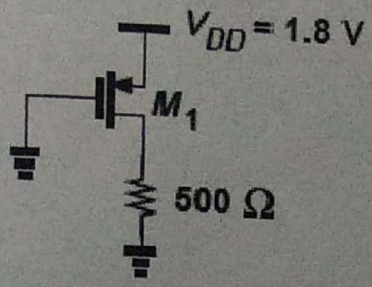
Q.7 If a MOSFET is biased at a drain current of 0.5 mA. If $\mu nCox$ = 100 $\mu A/V2$, W/L =10 and λ = $0.1V^{-1}$. Calculate its small signal parameters.



Q.8 If λ = 0.1V−1 and W/L = 20/0.18, construct the small-signal model of the circuit shown below anddetermine all the small signal parameters.

Q.9 An NMOS device with $\lambda = 0.2\ V^{-1}$ must provide a $g_m r_o$ of 20 with $VDS = 1.5V$. Determine the required value of W/L if $ID = 0.5$ mA.

Q.10 If $W/L = 10/0.18$ and $\lambda = 0$, determine the Vsd and ID of $M1$ in circuit shown below. Assume $\mu pCox = 100\ \mu A/V2$, $VTH = -0.4$ V



Note: If required / Not specified in problem, Assume $\mu nCox = \frac{200\mu A}{V^2}$ (for NMOS), $\mu pCox = \frac{100\mu A}{V^2}$ (for PMOS) and $VTH = 0.4$ V for NMOS devices and −0.4 V for PMOS devices.