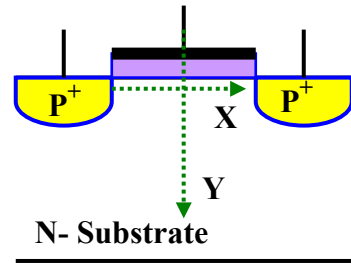


COE 360 – 2nd Assignment – Dr. Muhammad Elrabaa

Q1) An MOS device with a metal gate has a N-type substrate doping of  $10^{16} \text{ cm}^{-3}$ . Assume that the oxide trapped charge is zero,  $t_{ox}=20 \text{ nm}$ ,  $\epsilon_{rox}=4$ ,  $\epsilon_{rSi}=12$ ,  $\epsilon_0=8.85E-14 \text{ F/cm}$ , silicon's bandgap =1.1 eV, its electron affinity = 4.15 eV, and its intrinsic electron concentration= $10^{10} \text{ cm}^{-3}$ .

1. Assuming that the work function of the gate's metal is 6.5 eV, draw the energy band diagrams along the x and y directions for zero bias and calculate the threshold voltage. What is the type of this MOS device?
2. Calculate the required channel (i.e. substrate) doping to make the threshold equal to -0.5V. What would the type of MOS be in this case?
3. Show by using energy band diagrams the conditions for Linear and saturation operation of this MOS transistor.



Q2) For the following circuit, assuming  $t_{ox}=20 \text{ nm}$  and  $V_{tn}=0.8V$ :

- a. Calculate the value of  $V_o$  for  $V_{in}=5V$ .
- b. Calculate the value of  $V_{in}$  that will yield a  $V_o$  value of 2.5V.
- c. If  $V_{in}=0$ , what would be the value of  $V_o$ .

