

ECE 5205 Homework Assignment 7 (turn in by 4-10-2014)

1.HfO₂ Dielectric: Consider a conventional MOSFET with $t_{ox}=250\text{\AA}$, $L=1\text{ }\mu\text{m}$, $W=1\text{ }\mu\text{m}$ $N_A=10^{16}\text{ cm}^{-3}$ and an n⁺poly gate, mobility $\mu=700\text{cm}^2/(\text{Vs})$. You have now replaced the SiO₂ dielectric by HfO₂ dielectric (assume that $\epsilon_{\text{HfO}_2}=25\epsilon_o$) but you have kept the physical thickness of the dielectric constant (250Å). How are the following properties of the HfO₂ transistor relative to the SiO₂ MOSFET changing: a) threshold voltage, b) linear drain current at $V_g=2\text{V}$ and $V_d=0.1\text{V}$, c) I_{dsat} at $V_g=2\text{V}$, d) subthreshold current at $V_g=0\text{V}$ and $V_{ds}=2\text{V}$, e) the subthreshold slope? (8 points)

2.Subthreshold slope: Consider a MOSFET biased in subthreshold region with $V_{ds} \gg kT/q$. What change in gate-to-source voltage produces a factor of 1000 change in drain current if the subthreshold slope of the device is 100mV/dec ? (4 points)

3.Temperature dependence of the subthreshold slope: A given transistor is operated at room temperature and has a subthreshold slope of 80mV/dec. What is the change of the subthreshold change between operating it at -40C and +150C? (Assume that the maximum depletion width does not change much between -40C and +150C.) (4 points)

4.Saturation regime: Does a MOSFET in saturation regime display ohmic behavior? Justify your answer. (2 points)

5.Application of a MOSFET: we wish use a MOSFET transistor as a constant-current source. In which regime would you have to operate the device? What would be the limitation for the operating voltages of a MOSFET as a constant-current source? (2 points)