Name: Email: ID#

UNIVERSITY OF CALIFORNIA
Department of Electrical Engineering and Computer Sciences
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Test #4

1) Consider two NMOSFETs made with identical body doping, gate materials, and gate oxide thickness. MOSFET "A" has a V_T of 0.5V and MOSFET "B" has a V_T of 0.2V.

   a) Which MOSFET most likely has a shorter channel length? How do you know this?

   b) What phenomenon causes the difference in V_T's for the two MOSFETs?

   c) What is the consequence of this reduction in V_T on (give reasons):

      i) On-current (I_{Dsat})

      ii) Off-current (I_D @ $V_{GS} = 0V$, $V_{DS} = V_{DD}$)

   d) Suppose I try to reduce this V_T roll-off effect. Should I increase or decrease the following parameters (give reasons)?

      i) t_{ox}

      ii) r_j

      iii) the doping right near the S/D junctions

   e) What is the disadvantage of reducing r_j? Give your answer in terms of its impact on (give reasons)

      i) On-current

      ii) Switching speed

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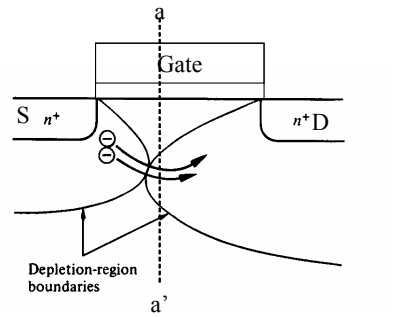
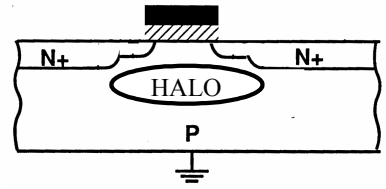
2) Consider a MOSFET that is operating in punchthrough, as shown below.



a) Draw a band diagram for the MOSFET along slice a-a'. Assume the MOSFET is in flatband mode at the surface.

b) We often increase the punchthrough voltage by placing a region of heavy doping (called a "halo" below the channel of the MOSFET, as shown below.



Why do we use a halo and not just dope the entire body more heavily. Answer the question in terms of the effect of heavy doping on:

i) V_T

ii) I_{ON}

iii) Mobility

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3) Consider a MOSCAP with the following specifications:
   - The gate is a metal with a workfunction on 4.5eV
   - Assume silicon has an electron affinity of 4eV
   - The body is doped n-type such that the Fermi level is 0.2eV below the conduction band
   - Assume the oxide is 1.7nm thick, resulting in a C_{ox} of 2uF/cm^2.

   a) Draw an equilibrium band diagram for the above MOSCAP.

   b) What is the V_{FB} for the above MOSCAP?

   c) Now, suppose we add in fixed oxide charge of 2E-7C/cm^2. Redraw the equilibrium band diagram

   d) What is the V_{FB} for the MOSFET now?