

**ECE 3030: Physical Foundations of Computer Engineering**

Spring 2024

Homework 7—Total points 100

Late submissions will not be accepted for credit.

**Q1 MOSFET Structure:** What are the dimensions  $A$  and  $B$  called (see figure 1)? Circle the correct answer. [20 pts]

$A$  = Channel/Gate length ( $L_G$ ) or Channel Width ( $W$ )

$B$  = Channel/Gate length ( $L_G$ ) or Channel Width ( $W$ )

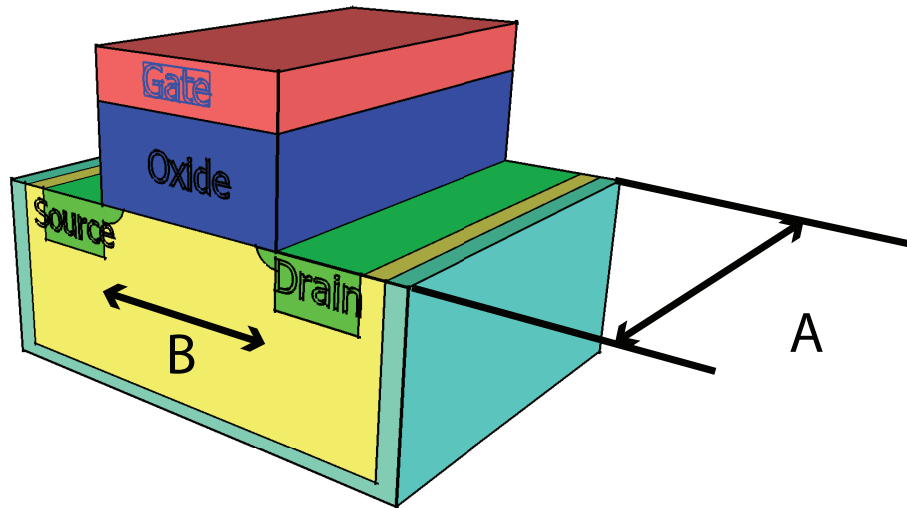


Figure 1: MOSFET structure.

**Q2 Power in a microprocessor:** Consider a microprocessor logic block that can operate at a maximum clock frequency ( $f$ ) of 2 GHz and 2.5 GHz when the power supply voltage ( $V_{DD}$ ) is 1.2 V and 1.5 V, respectively.

Based on simplest possible assumptions, at which clock frequency will the block consume more power: 2 GHz or 2.5 GHz? Briefly explain your answer. [30 pts]

Q3 Consider an inverter operating a power supply voltage  $V_{DD}$ . Make the necessary assumptions to answer the following questions. [50 pts]

[Q3.1] How will the delay and active power per device change as you increase  $V_{DD}$ ? Explain with equations.

[Q3.2] How will the delay and active power per device change as you increase the doping density of both the N- and the P-MOSFET? Explain with equations.

Q4 Discuss the impact of channel length modulation on the performance of MOSFETs in power applications. Explain how changes in channel length affect key parameters such as drain current and output resistance.