EE 40 Midterm 3

Fall 2002

Problem 1: 10 Points

Fill in the blanks to correctly complete the sentences.

To improve conduction in silicon, atoms from other elements are incorporated into the lattice.

The addition of Group III elements creates _____ - type material.

For example, _____ is a Group III element that might be added to the silicon.

The addition of Group V elements creates _____ - type material.

For example, _____ is a Group V element that might be added to the silicon.

The Group _____ elements need one more electron in the outer shell to complete all four lattice bonds.

This lack of an electron is called a _____.

When the two types of material are joined together, electrons cross the junction between the two materials to complete lattice bonds where needed.

The movement of free electrons from an area of greater concentration to lesser concentration, motivated by the need to complete lattice bonds, is called _____

This creates a layer without free charge carriers, called the _____ layer.

The movement of electrons creates positive charge in the atoms the electrons have left behind, and negative charge in the atoms which the electrons have joined. This creates a potential difference across the junction; the _____ - type material is at a higher potential.

This causes electrons to move across the junction towards the higher electric potential. This movement, due to attraction by positive potential, is called _____.
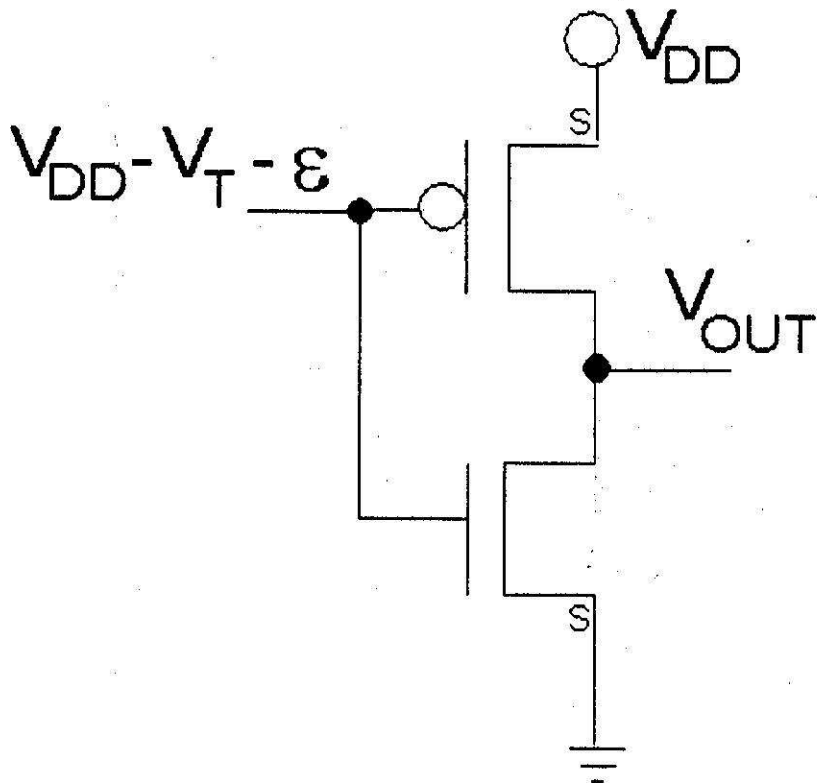
Problem 2: 20 Points

Determine the logical operation performed by the circuit below:
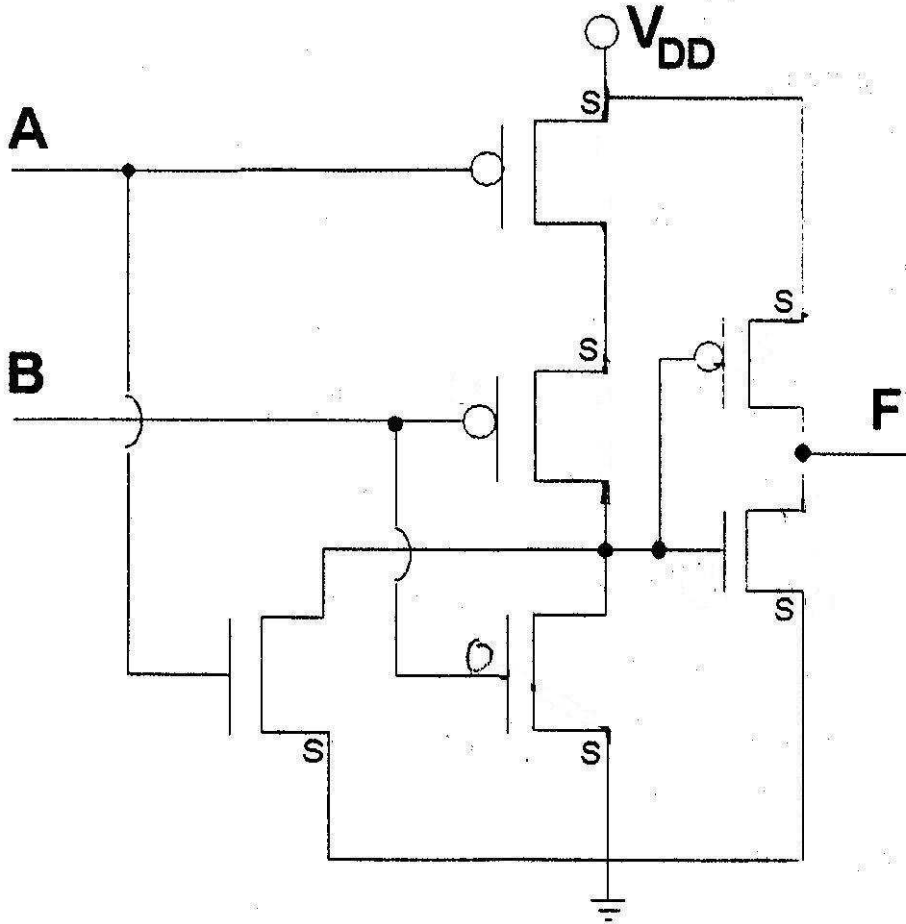
Problem 3: 10 Points

Consider the following circuit, with the input voltage just below $V_{DD}-V_T$. Here, the NMOS threshold voltage is $-V_T$. V_T is positive, and much smaller than V_{DD}. Assume that the transistors have matched I_D/V_{DS} characteristics.

Determine the most likely mode of operation for each transistor.

Problem 4: 20 Points

Consider the following circuit. Find V_{OUT} when V_{IN} is 3.7 V.
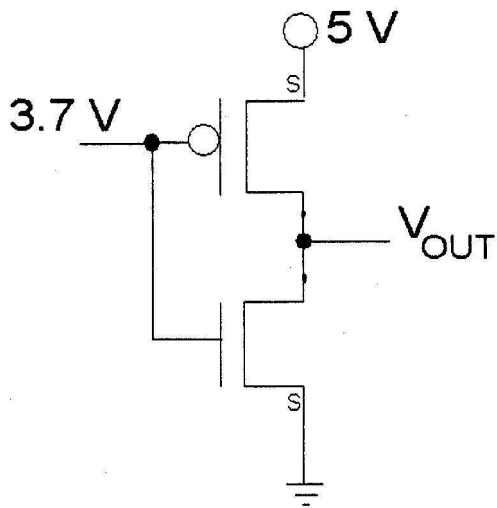
NMOS:
$V_{T(N)} = 1$ V
lambda $= 0$
$I_{DSAT(N)} = 10^{-3}(V_{GS(N)}-V_{T(N)})^2$ A

PMOS:
$V_{T(P)} = -1$ V
lambda $= 0$
$I_{DSAT(P)} = 10^{-3}(V_{GS(P)}-V_{T(P)})^2$ A

Problem 5: 20 Points

Consider the following circuit. Find V_{OUT} when V_{IN} is 3.7 V.

NMOS:
$V_{T(N)} = 1$ V
lambda = 0
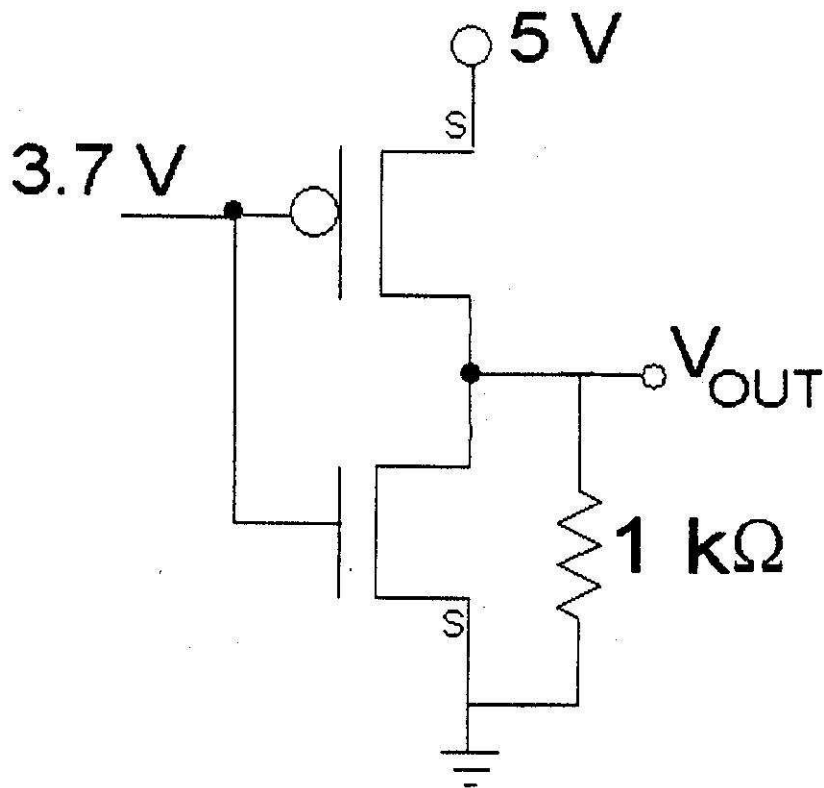$I_{DSAT(N)} = 10^{-3}(V_{GS(N)}-V_{T(N)})^2$ A

PMOS:
$V_{T(P)} = -1$ V
lambda = 0
$I_{DSAT(P)} = 10^{-3}(V_{GS(P)}-V_{T(P)})^2$ A

Problem 6: 20 Points

Sketch V$_{OUT}$(t) for the diode circuit

a) using the ideal model
b) using the large-signal model
c) using the small-signal model.

Provide enough detail to completely indicate the effect created by the circuit.