

# Homework 1

ECE3544 CRN:82989

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**Problem 1:** Using 2's complement arithmetic, add the following decimal numbers, showing all work. i.e. perform  $17 + 19$ . Use the smallest number of bits possible to represent each number and the sum without overflow.

$$\begin{aligned}
 17 + 19 &= 010001 + 010011 \\
 &= 010010 + 010010 \\
 &= 010100 + 010000 \\
 &= 100100 \\
 &= 36
 \end{aligned}$$

**Problem 2:** For the addition in problem 1, use one less bit to represent the numbers and show how the overflow can be detected.

$$\begin{aligned}
 17 + 19 &= 10001 + 10011 \\
 &= 10010 + 10010 \\
 &= 10100 + 10000 \\
 &= 00100 \\
 &= 4
 \end{aligned}$$

Overflow can be detected during addition for unsigned integers when the most significant bit changes from 1 to 0.

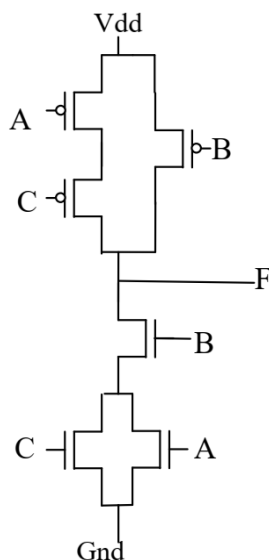
**Problem 3:** Using the same guidelines as for problem 1, subtract decimal 87 from 37, i.e. perform  $37 - 87$ .

$$\begin{aligned}
 37 - 87 &= 00100101 - 01010111 \\
 &= 00100101 + 10101001 \\
 &= 00100110 + 10101000 \\
 &= 01001110 + 10000000 \\
 &= 11001110 \\
 &= -00110010 \\
 &= -50
 \end{aligned}$$

**Problem 4:** Give the hexadecimal representation of the answer to problem 3.

$$\begin{aligned}
 37 - 87 &= -50 \\
 &= 11001110 \\
 &= CE_{16}
 \end{aligned}$$

**Problem 5:** Write the truth table and Boolean function implemented by the CMOS gate below.

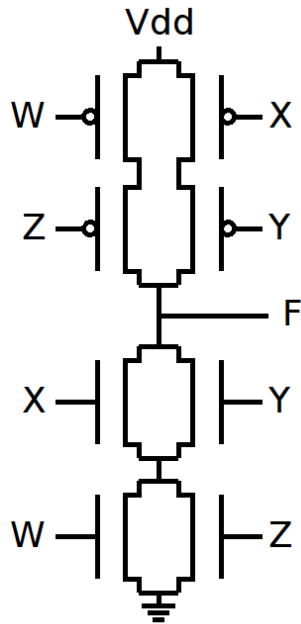


A	B	C	F
0	0	0	1
0	0	1	1
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0
1	1	0	0
1	1	1	0

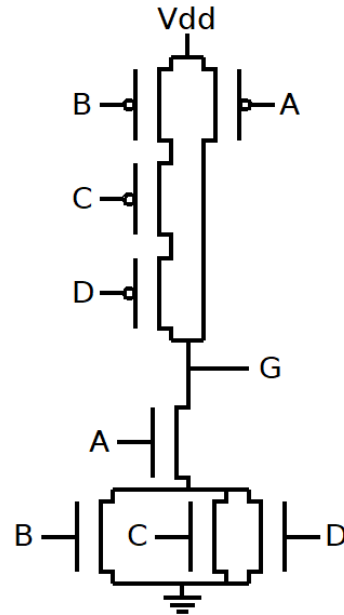
$$F = \overline{B \cdot (A + C)}$$

**Problem 6:** Draw transistor schematics of a CMOS gate for each of the following Boolean functions:

$$F = \overline{(W + Z) \cdot (Y + X)}$$



$$G = \overline{(B + C + D) \cdot A}$$



**Problem 7:** Which would you expect to have a bigger effect on the power consumed by a CMOS circuit, a 5% increase in the power supply voltage ( $V_{dd}$ ) or a 10% increase in total capacitance? Briefly explain your answer.

$$P = CV^2f \implies \Delta P = \Delta C \times (\Delta V)^2 \times \Delta f$$

$$\Delta C = 110\% \text{ and } (\Delta V)^2 = (105\%)^2 = 110.25\%$$

The voltage increase will have a slightly larger effect.