

Homework Assignment IV

Reading Assignment: Kuc Chapter 4 and Kerns-Irwin Chapter 13

1. Kerns-Irwin Problem 13.18
2. Use Boolean algebra to prove the following identity

$$ABC + ABC\bar{C} + A\bar{B}\bar{C} + A\bar{B}C = A.$$

Construct a truth table to confirm your algebra.

3. Construct truth tables to prove the following equalities
 - (a) $A(B + C) = AB + AC$
 - (b) $ABC = \overline{\overline{A} + \overline{B} + \overline{C}}$
4. Consider the design of a digital divisible-by-3 circuit which takes in as inputs a 4-bit non-negative binary number $X_3X_2X_1X_0$ and outputs a **1** whenever the decimal equivalence of the binary input is divisible by the decimal number 3. In other words, the circuit yields a **0** output when the input in decimal is not a multiple of 3. Note that zero is considered to be divisible by 3.
 - (a) Construct the truth table for the 4-input ($X_3 X_2 X_1 X_0$) divisible-by-3 circuit.
 - (b) Find the simplified Boolean expression for the output Y in terms of the inputs $\{X_3, X_2, X_1, X_0\}$.
 - (c) Implement the divisible-by-3 circuit using only basic gates: INVERTER, 2-input AND, 2-input OR, and 2-input XOR gates.
 - (d) Re-design your circuit so that it now becomes a divisible-by-6 circuit. Implement your modified design with basic gates.
 - (e) What about a divisible-by-2 circuit (in other words, an even-number detection circuit)?

5. Consider the design of a multiplier which accepts two 2-bit non-negative binary numbers – A_1A_0 and B_1B_0 – as inputs and yields the 4-bit output $Y_3Y_2Y_1Y_0$. Assume that the stock room has an ample supply of basic gates as well as full adders.
- (a) Draw the circuit that performs the partial product of B_0 and A_1A_0 . How about the product of B_1 and A_1A_0 ?
 - (b) Use your result in Part (a) to implement the multiplier. *Hint:* use a cascade of full adders and beware of the shift.
 - (c) Find the logic function for Y_3 , the multiplication overflow bit.

Due date: **October 17** in class