

**ECE 270 (Spring 2022)**

**Homework 13-14**

**Due on 04/18/2022 (Monday) by 11:59 pm on BrightSpace.**

- 1) Draw an iterative circuit that compares three 4-bit numbers and produces output 1 if they are equal. Provide the logic equation of the output(s) of any basic building block used.
- 2) Provide an expression for borrow and difference in the circuit implementation of a half-subtractor. A half-subtractor is a combinational circuit that performs subtraction of 2-bits.
- 3) A majority function circuit is a circuit whose output is equal to 1 if the input variables have more 1's than 0's. The output is 0 otherwise. Explain how an output of a full adder circuit works as the output of a majority function circuit.
- 4) Design a four-bit combinational circuit decrementer (a circuit that subtracts 1 from a four-bit binary number) using full-adders.
- 5) Use a full adder to design a circuit that counts the number of zeros in a 3-bit input.
- 6) A 16-bit ripple carry adder is realized using 16 identical full adders. The carry propagation delay of each full adder is 12 ns and the sum propagation delay of each full adder is 15 ns. What is the worst case delay of this 16 bit ripple adder? The propagation delay depends only on the type of output being produced and is independent of the inputs.
- 7) Design a circuit that adds two 3-bit numbers and if the sum is greater than 7, it subtracts 5 from the sum.
- 8) Design a circuit that uses full subtractors to compare two 3-bit numbers X and Y. The output of the circuit is 1 if X is greater than Y and 0 otherwise.
- 9) How does a carry lookahead adder speed up the addition operation compared to a ripple carry adder? Explain by providing the sum and carry expressions for a 4-bit carry lookahead adder.
- 10) Design a circuit which multiplies a 4-bit input by 3 using a single 4-bit binary adder.