ELEC8550:Computer Arithmetic, Fall 2020

Assignment 4

Due: 10pm, Sunday, Dec 6, 2020

1. (20 marks) Build a 18-bit carry-select adder. Decide the number of groups and the size of each group. Estimate the time delay of your design.

2. (20 marks) Build a 18-bit carry-skip adder. Decide the number of groups and the size of a group. Estimate the time delay of your design.

3. (20 marks) Build a carry-save adder that performs $X = A + B + C + D + E$, where each of operands A, B, C, D, and E has 4 bits. Draw a full diagram for the carry-save adder and estimate the complexities using both (3, 2) and (2, 2) counters as building blocks. Explicitly show a critical path.

4. (20 marks) Consider multiplication of a 5-bit multiplicand A and a 4-bit multiplier X. Design a high-speed multiplier realizing this multiplication operation. Assume that (3, 2) and (2, 2) counters are used for carry save addition and carry-propagate addition. Show the steps in dot diagram or draw a block diagram for your design. How many (3, 2) and (2, 2) counters are required? Assume that $\Delta_{(3,2)} = 2\Delta_G$ and $\Delta_{(2,2)} = \Delta_G$. What is time delay of your multiplier?

5. (20 marks) Consider multiplication of a 5-bit multiplicand A and a 4-bit multiplier X. Design an array multiplier realizing this multiplication operation. Assume that FA and HA are used as building cells. Draw a block diagram for your design. How many FAs and HAs are required? Assume that $\Delta_{\text{FA}} = 2\Delta_G$ and $\Delta_{\text{HA}} = \Delta_G$. What is time delay of your design?

6. (no marks) Let a residue number system (RNS) be given by $(m_2, m_1, m_0) = (15, 14, 13)$.

   (a) Solve dynamic range for the RNS.

   (b) Find the RNS representations for $A = 19_{10}$ and $B = 22_{10}$. Perform $C = A \times B$ in the RNS.

   (c) How many bits are required to represent a number with respect to this RNS?