CSE141-Fall 1999

Solutions to Homework Number 3

This homework is based on the chapter 4.5-4.8 of the text and focuses primarily on computer arithmetic issues related to multipliers and floating point numbers.

We recommend solving the following problems from the textbook (Patterson and Hennessy, Computer Organization and Design: The hardware software interface, 2nd edition).

Textbook Problems

4.49 and 4.50: A different way of doing adders.

4.49 is a straightforward case of walking through the “bits”.

4.50:
The longest (critical) path is that of starting at the top of the ripple carry adder organization (a0 or b0) and walking through all 7 adders to get an output on s4 or s5. [And there are more than one such long paths!]. The time delay for such a path is 7x2T = 14T.

The longest path for the “carry save” organization is from any of the top inputs (b0, e0, f0, b1, e1 or f1) and passing through 6 adders to get to s4 or s5. The time delay for this solution would be only 6x2T = 12T.

4.55 and 4.56: Problems that describe the use (and value) of guard and round digits.

4.55: Assuming that a rounding mode of “round to nearest” is being used

Without guard and round digits we have

\[ \begin{align*}
 9.51 \times 10^2 \\
 0.64 \times 10^2 \\
\end{align*} \]

Add: \(10.15 \times 10^2\) (note: assumes circuit holds at least one extra digit)

Normalize: \(1.01 \times 10^2\) (note: truncation occurs here)

With guard and round bits we have

\[ \begin{align*}
 9.500 \times 10^2 \text{ (extended with guard and round bits)} \\
 0.6420 \times 10^2 \text{ (shift smaller number to match exponents)} \\
\end{align*} \]

Add: \(10.1520 \times 10^2\) (circuit must hold extra bit)

Normalize: \(1.0152 \times 10^2\)

Round to 3 digits: \(1.02 \times 10^2\)
4.56:
Without guard and round digits we have
\[ 1.47 \times 10^2 \]
\[ + \quad 0.87 \times 10^2 \]
\[ \text{Add:} \quad 2.34 \times 10^2 \] (note: assumes circuit holds at least one extra digit)
\[ \text{Normalize:} \quad 2.34 \times 10^2 \]

With guard and round bits we have
\[ 1.4700 \times 10^2 \] (extended with guard and round bits)
\[ + \quad 0.8760 \times 10^2 \] (shift smaller number to match exponents)
\[ \text{Add:} \quad 2.3460 \times 10^2 \] (circuit must hold extra bit)
\[ \text{Normalize:} \quad 2.3460 \times 10^2 \]
Round to 3 digits: \( 2.35 \times 10^2 \)