University of Maryland Baltimore County
Department of Computer Science and Electrical Engineering

CMSC 411, Computer Architecture

Assignment #2 Due: Monday 10/5/17 in class

Question 1: *(24 Points)*

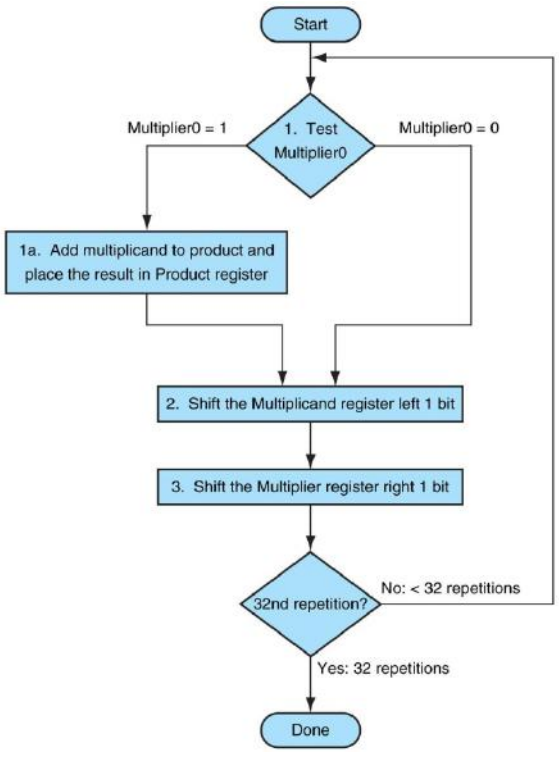
Given the bit pattern: 0010 0100 1001 0010 0100 1001 0010 0100
What does it represent, assuming that it is:

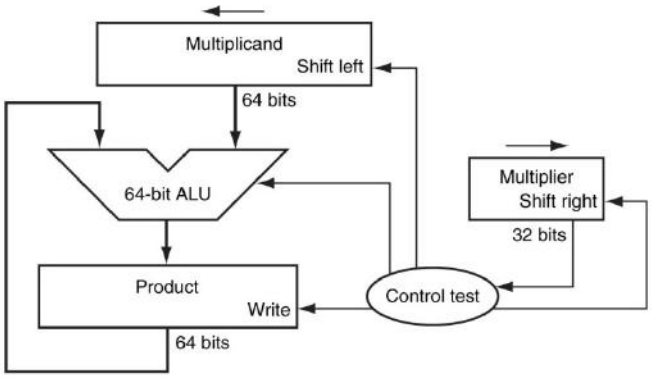
A) a two's complement integer?
B) an unsigned integer?
C) a single precision floating point number?
D) a MIPS instruction?

Question 2: *(36 Points)*

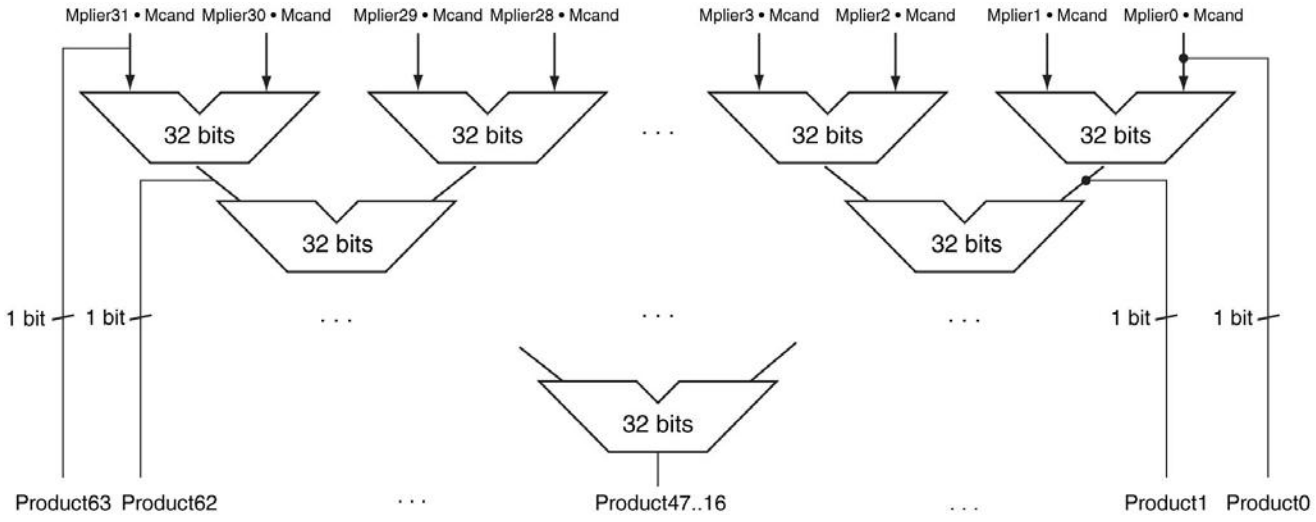
In this question we would like to compare the speed of two multipliers.

A) Calculate the time necessary to perform a multiply using the approach below (and also discussed in class). Assume that it takes *T* time units to perform a step in the multiplication process (block in the flowchart). Assume that in step "1a" an addition is always performed either the multiplicand will be added, or a 0 will be. Also assume that the registers have already been initialized (you are just counting how long it takes to do the multiplication loop itself). If this is being done in hardware, the shifts of the multiplicand and multiplier can be done simultaneously. If this is being done in software, they will have to be done one after the other. Solve for each case.





B) Calculate the time necessary to perform a multiply using the configuration below, if an adder takes *T* time units.



Question 3: *(40 Points)*

The division algorithm discussed in class is called *restoring division*, since each time the result of subtracting the divisor from the dividend is negative you must add the divisor back into the dividend to restore the original value. Recall that shifting left is the same as multiplying by two. Let's look at the value of the left half of the Remainder again, starting with step 3b of the divide algorithm and then going to step 2:

$$(\text{Remainder} + \text{Divisor}) \times 2 - \text{Divisor}$$

The value is created from restoring the Remainder by adding the Divisor, shifting the sum left, and then subtracting the Divisor. Simplifying the result we get

$$\text{Remainder} \times 2 + \text{Divisor} \times 2 - \text{Divisor} = \text{Remainder} \times 2 + \text{Divisor}$$

Based on this observation, write a *non-restoring division* algorithm. Show that your algorithm works by dividing (0000 0111) by (0010)