Tutorial 5 – Week of Oct. 18th 2021

Questions: 3.6 -3.11, 3.14, 3.16

3.6
Assume 185 and 122 are unsigned 8-bit decimal integers. Calculate 185–122. Is there overflow, underflow, or neither?
Solution:
185 = 1011 1001
122 = 0111 1010
185 – 122 = 63 = 0001 11112
Neither (63)

3.7
Assume 185 and 122 are signed 8-bit decimal integers stored in sign-magnitude format. Calculate 185 +122. Is there overflow, underflow, or neither?
Solution:
185 = 1011 1001 = -57
122 = 0111 1010
-57+122 = 65

3.8
Assume 185 and 122 are signed 8-bit decimal integers stored in sign-magnitude format. Calculate 185 −122. Is there overflow, underflow, or neither?
Solution:
185 = 1011 1001 = - 57
-122 = -179
Overflow, -179 does not fit into 8 bit format

3.9
Assume 151 and 214 are signed 8-bit decimal integers
stored in two's complement format. Calculate 151 +214 using
saturating arithmetic. The result should be written in decimal.
Solution:
151 = 1001 0111 = -128 + 16 + 4 + 2 + 1 = -128 + 23 =-105
214 = 1101 0110 = -42
-105 + (– 42) = -127 (-147)

3.10
Assume 151 and 214 are signed 8-bit decimal integers stored in two's complement format. Calculate 151 −214 using saturating arithmetic. The result should be written in decimal.
Solution:
-105 - (– 42) = -105 + 42 = -63

3.11

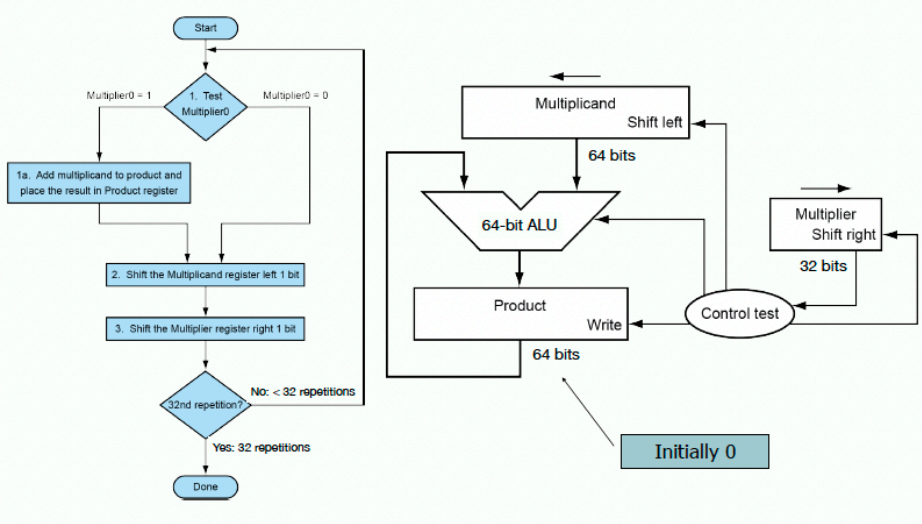
Assume 151 and 214 are unsigned 8-bit integers. Calculate 151+214 using saturating arithmetic. The result should be written in decimal.

Solution:

151+214 = 255 (365)

3.14

Calculate the time necessary to perform a multiply using the approach given in Figure below if an integer is 8 bits wide and each step of the operation takes four time units. Assume that in step 1a an addition is always performed—either the multiplicand will be added, or a zero 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.



Solution:

3.14 For hardware, it takes one cycle to do the add, one cycle to do the shift, and one cycle to decide if we are done. So the loop takes (3 × A) cycles, with each cycle being B time units long.

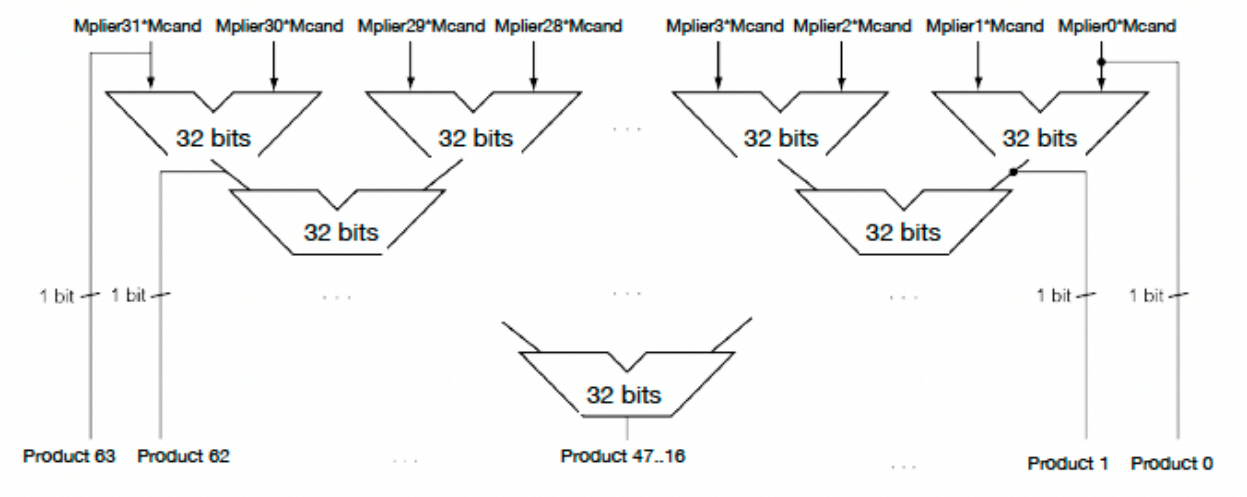
For a software implementation, it takes one cycle to decide what to add, one cycle to do the add, one cycle to do each shift, and one cycle to decide if we are done. So the loop takes (5 × A) cycles, with each cycle being B time units long.

(3 × 8) × 4tu = 96 time units for hardware

(5 × 8) × 4tu = 160 time units for software

3.16

Calculate the time necessary to perform a multiply using the approach given in Figure below if an integer is 8 bits wide and an adder takes four time units.



Solution:

3.16 It takes B time units to get through an adder, and the adders are arranged in a tree structure. It will require log2(A) levels. An 8 bit wide word requires seven adders in three levels. $3 \times 4\text{tu} = 12$ time units.