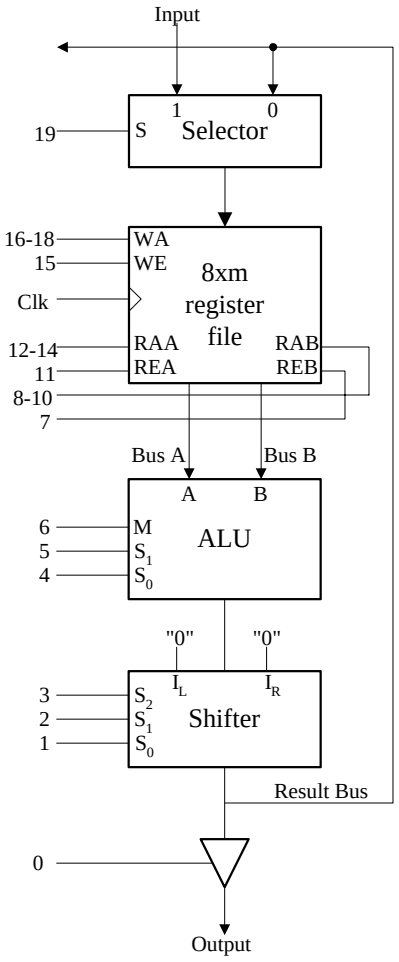
CS120B – Homework #2

Given November 2, 2001. Due November 8, 2001

1. Construct a FSM that realizes the following algorithm based on the datapath below.

   Input two numbers.
   Output the product of the two numbers.



M	S_1	S_0	ALU operstions
0	0	0	Complement A
0	0	1	AND
0	1	0	XOR
0	1	1	OR
1	0	0	Decrement A
1	0	1	Add
1	1	0	Subtract
1	1	1	Increment A

ALU operations

S_2	S_1	S_0	Shift operstions
0	0	0	Pass
0	0	1	Pass
0	1	0	Not used
0	1	1	Not used
1	0	0	Shift left
1	0	1	Rotate left
1	1	0	Shift right
1	1	1	Rotate right

Shift operations

Answer

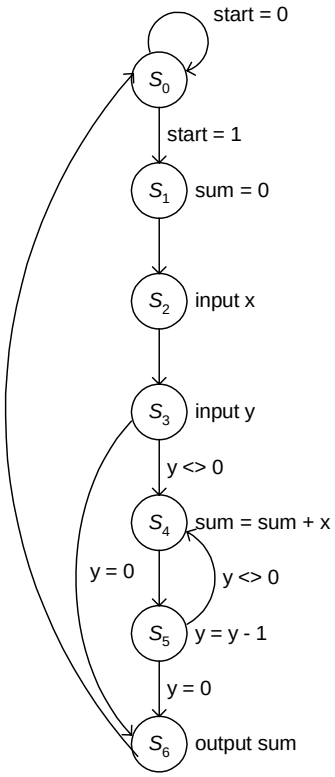
Algorithm

```
1   sum = 0
2   input x
3   input y
    while y <> 0
    4   sum = sum + x
    5   y = y - 1
6   output sum
```

Control words

	19	18-15	14-11	10-7	6-4	3-1	0	
Control words	IE	Write	Read A	Read B	ALU operation	Shifter operation	OE	Comment
1	0	010 1	000 1	000 1	010	000	0	*x* xor *x* = 0
2	1	001 1	×××× 0	×××× 0	×××	×××	0	input *x*
3	1	000 1	×××× 0	×××× 0	×××	×××	0	input *y*
4	0	010 1	010 1	001 1	101	000	0	sum+= *x*
5	0	000 1	000 1	××××	100	000	0	decrement A
6	0	×××× 0	010 1	010 1	001	000	1	sum and sum <=> pass

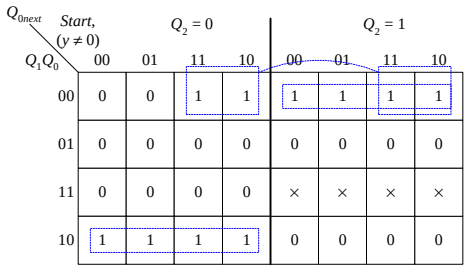
State diagram



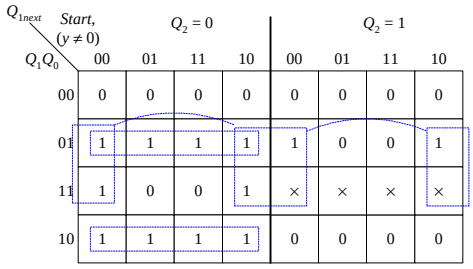
Next-state table:

Current State		Next State			
Sym bol	$Q_2\ Q_1\ Q_0$	Start, (y <>0)			
		00	01	10	11
s_0	0 0 0	0 0 0	0 0 0	0 0 1	0 0 1
s_1	0 0 1	0 1 0	0 1 0	0 1 0	0 1 0
s_2	0 1 0	0 1 1	0 1 1	0 1 1	0 1 1
s_3	0 1 1	1 1 0	1 0 0	1 1 0	1 0 0
s_4	1 0 0	1 0 1	1 0 1	1 0 1	1 0 1
s_5	1 0 1	1 1 0	1 0 0	1 1 0	1 0 0
s_6	1 1 0	0 0 0	0 0 0	0 0 0	0 0 0

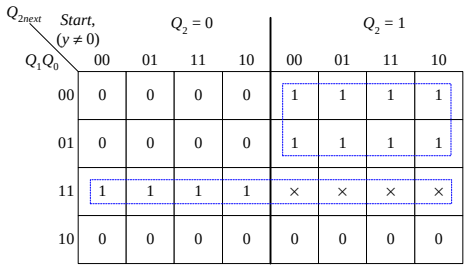
Next-state equations:



$$Q_{0next} = Q_2'Q_1Q_0' + Q_2Q_1'Q_0' + Q_1'Q_0'Start$$



$$Q_{1next} = Q_2'Q_1Q_0' + Q_2'Q_1'Q_0 + Q_0(y{\neq}0)'$$



$$Q_{2next} = Q_1Q_0 + Q_2Q_0'$$

Output equations:

$IE = Q_2'Q_1Q_0' + Q_2'Q_1Q_0$
$WA_2 = 0$
$WA_1 = Q_2'Q_1'Q_0 + Q_2Q_1'Q_0'$
$WA_0(Q_2,Q_1,Q_0) = \Sigma(2)$

$WE(Q_2,Q_1,Q_0) = \Sigma(1,2,3,4,5)$
$RAA_2 = 0$
$RAA_1 = Q_2Q_1'Q_0'$
$RAA_0 = 0$
$RAE(Q_2,Q_1,Q_0) = \Sigma(1,4,5,6)$
etc…

FSM Schematic