



**BITS Pilani**

Hyderabad Campus

Department of Electrical Engineering



# **Digital Design**

## **First Semester 2020-21**

### **Tutorial : 13**

# **Binary Multiplication and**

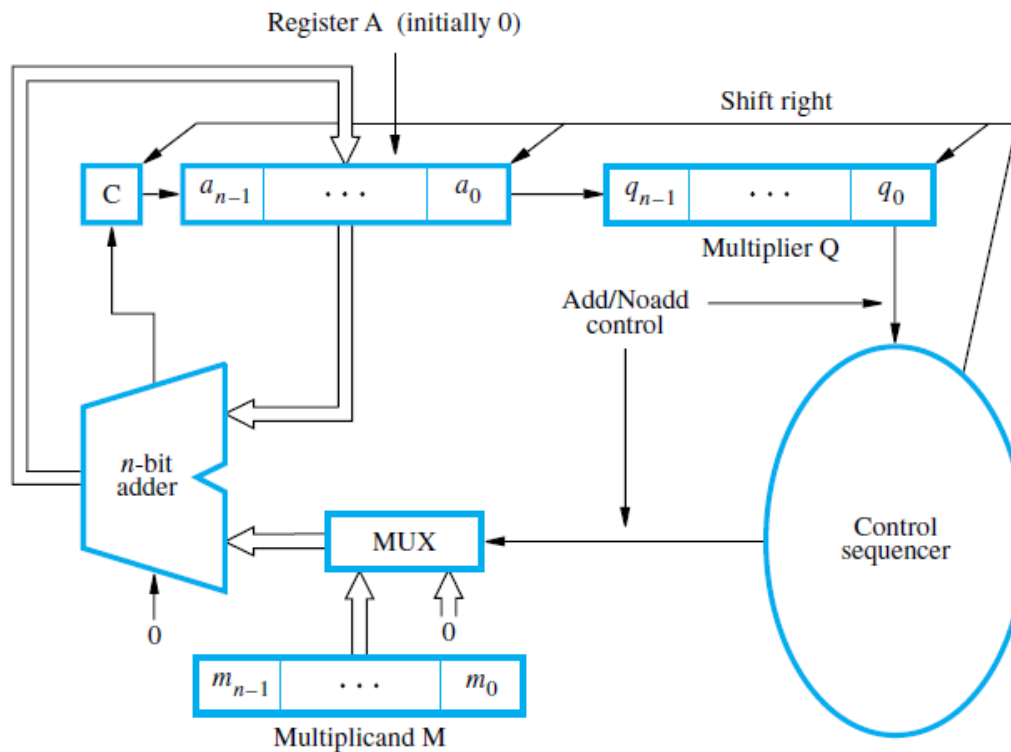
# Problem 1

1. Multiply 4 X 5 using sequential multiplier

$$\begin{array}{r}
 \phantom{0000}1000 \\
 \phantom{000}x\phantom{000}1001 \\
 \hline
 \phantom{0000}1000 \\
 \phantom{000}0000 \\
 \phantom{00}0000 \\
 \phantom{0}1000 \\
 \hline
 1001000
 \end{array}$$

# Problem 1

## 1. Multiply 4 X 5 using sequential multiplier



(a) Register configuration

# Problem 1

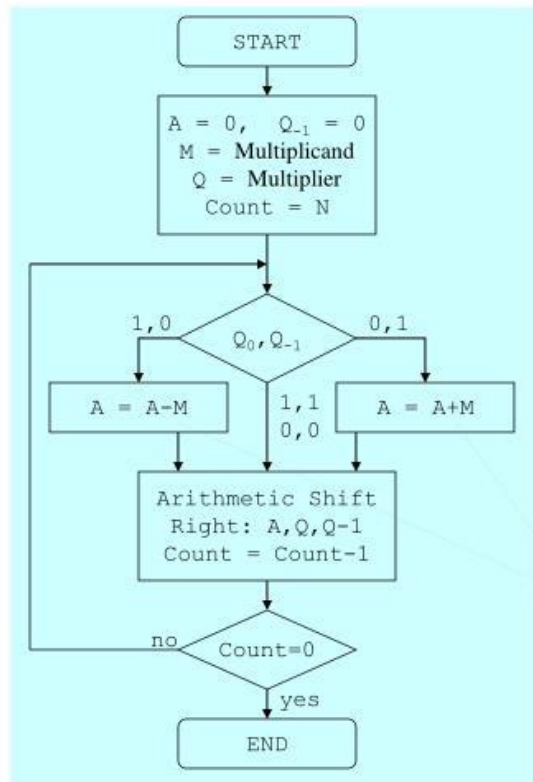
## 1. Multiply 4 X 5 using sequential multiplier

		4x5			
		M	A	Q	
	<b>Initial Condition</b>	<b>0100</b>	<b>00000</b>	<b>0101</b>	
	<b>Load</b>	<b>0100</b>	<b>00100</b>	<b>0101</b>	<b>1</b>
	<b>Shift Right</b>	<b>0100</b>	<b>00010</b>	<b>0010</b>	
	<b>Load</b>	<b>0100</b>	<b>00010</b>	<b>0010</b>	<b>2</b>
	<b>Shift Right</b>	<b>0100</b>	<b>00001</b>	<b>0001</b>	
	<b>Load</b>	<b>0100</b>	<b>00101</b>	<b>0001</b>	<b>3</b>
	<b>Shift Right</b>	<b>0100</b>	<b>00010</b>	<b>1000</b>	
	<b>Load</b>	<b>0100</b>	<b>00010</b>	<b>1000</b>	<b>4</b>
	<b>Shift Right</b>	<b>0100</b>	<b>00001</b>	<b>0100</b>	

# Problem 2

## 2. Multiply -4 X 2 using Booth Algorithm

### Booth's Algorithm for 2's Complement Multiplication



M = 0101    -M = 1011  
Q = 0110  
N = 4

A	Q	Q <sub>-1</sub>	N
0000	0110	0	4
0000	0011	0	3
1011	0011	0	
1101	1001	1	2
1110	1100	1	1
0011	1100	1	
0001	1110	0	0

Answer is in A, Q  
00011110<sub>2</sub> = 30<sub>10</sub>

Two's complement multiplication can be performed using Booth's Algorithm.

To save time, both M and -M can be computed ahead and provided as one of the inputs to the adders for A-M and A+M.

Instead of a loop, the math processor can provide separate hardware for each stage of the multiplication algorithm.

# Problem 2

## 1. Multiply -4 X 2 using Booth Algorithm

<b>-4X2</b>	<b>1100</b>	<b>0010</b>			<b>-M = 0100</b>
	<b>A</b>	<b>Q</b>	<b>Q-1</b>	<b>N</b>	
<b>Initial Condition</b>	<b>0000</b>	<b>0010</b>	<b>0</b>		
<b>Nothing</b>	<b>0000</b>	<b>0010</b>	<b>0</b>	<b>1</b>	
<b>Shift Right</b>	<b>0000</b>	<b>0001</b>	<b>0</b>		
<b>Substract</b>	<b>0100</b>	<b>0001</b>	<b>0</b>	<b>2</b>	
<b>Shift Right</b>	<b>0010</b>	<b>0000</b>	<b>1</b>		
<b>Add</b>	<b>1110</b>	<b>0000</b>	<b>1</b>	<b>3</b>	
<b>Shift Right</b>	<b>1111</b>	<b>0000</b>	<b>0</b>		
<b>Nothing</b>	<b>1111</b>	<b>0000</b>	<b>0</b>	<b>4</b>	
<b>Shift Right</b>	<b>1111</b>	<b>1000</b>	<b>0</b>		