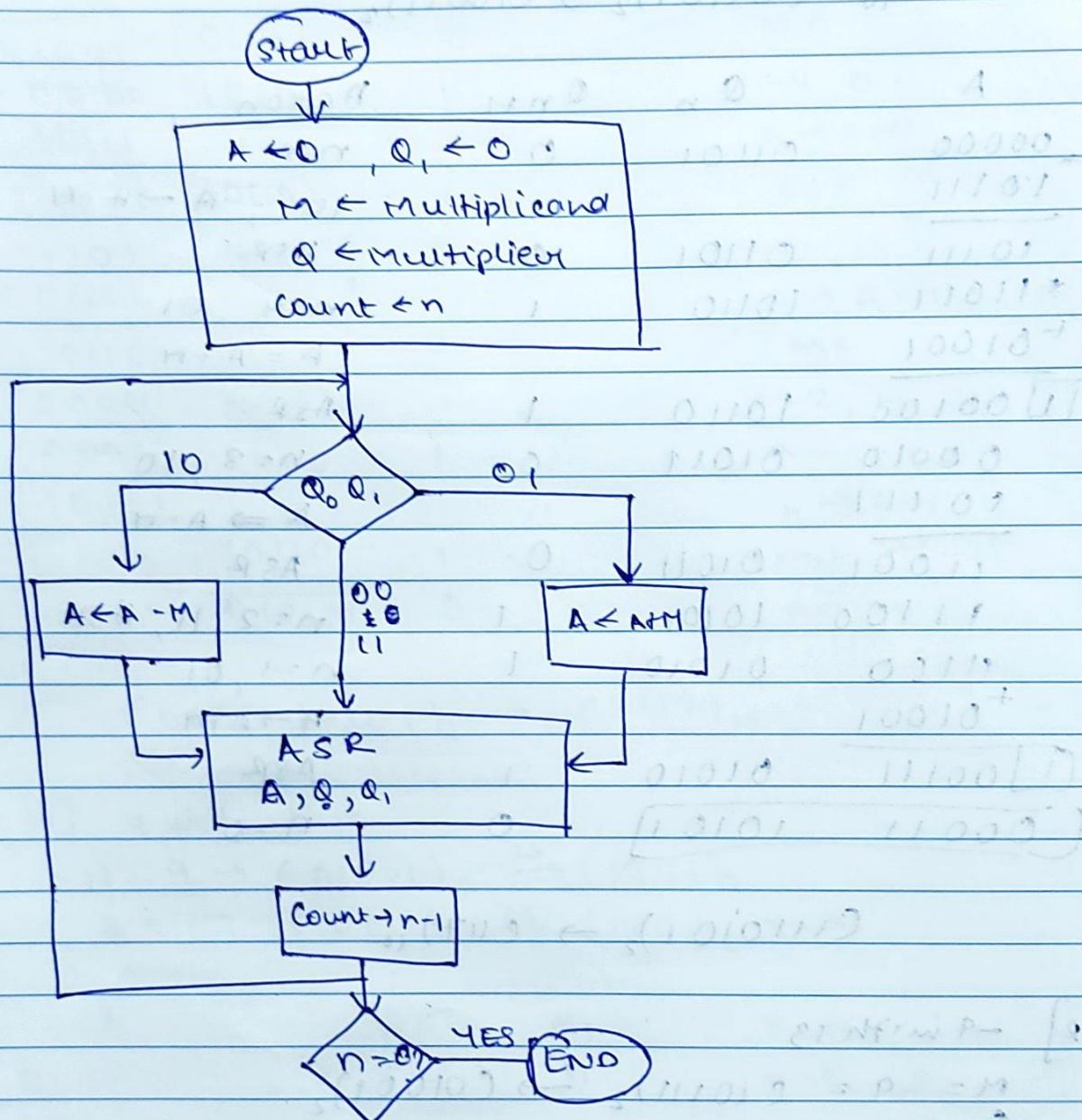


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MPL Written Assignment 2

~~Multibit  
16x16~~

- Q] Draw the flow chart of Booth's Algo. Multiply the following using the same.



1)  $q$  with 13

$$N = 9_{10} = \cancel{010011}_2 \quad (01001)_2 \xrightarrow{2's} (10111)_2$$

$$Q = 13_{10} = (01101)_2 \xrightarrow{2's} (10011)_2$$

A	$Q_n$	$Q_{n+1}$	Action
$+ 00000$	01101	0	$n=2, 1$
10111			$10^-; A \rightarrow A-M$
$\underline{- 10111}$	01101	0	ASR
$* 11011$	10110	1	$n=4, 01$
$+ 01001$			$A = A+M$
$\boxed{1} 00100$	10110	1	ASR
00010	01011	0	$n=3, 10$
$\underline{- 01111}$			$A \Rightarrow A-M$
11001	01011	0	ASR
11100	10101	1	$n=2, 11, ASR$
01100	01010	1	$n=1, 01$
$+ 01001$			$A \rightarrow A+M$
$\boxed{1} 00111$	01010	1	ASR
$\underline{00011}$	10101	0	$n=0$

$$(1110101)_2 \rightarrow (117)_{10}$$

2]  $-q$  with 13

$$N = -9 = (10111)_2 \xrightarrow{2's} (01001)_2$$

$$Q = 13 \Rightarrow (01101)_2$$

$$A+M \rightarrow A+10111$$

$$A+M \rightarrow A+01001$$

A	Q <sub>n</sub>	Q <sub>n+1</sub>	Action
00000	01101	0	$n=5, 10$ $A \rightarrow A - M$
+ 01001			
<u>01001</u>	01101	0	ASR
+ 00100	10010	1	$n=4, 01$ $A \rightarrow A + M$
<u>10111</u>			
11011	10110		ASR
11101	11011	0	$n=3, 10$ $A \rightarrow A - M$
+ 01001			
<u>100110</u>	11011	0	ASR
00011	01101	1	$n=2, 11, ASR$
+ 00001	10110	1	$n=1, 01$
<u>10111</u>			$A \rightarrow A + M$
11000	10110	1	ASR
<u>11100</u>	01011	0	$n=0$

$$(000111010101)_2 \rightarrow C-117_{10}$$

iii) ~~qwim - # 13~~

$$M: 9 \rightarrow (01001)_3 \xrightarrow{28} (10111)_2$$

$$Q: 8+13 \rightarrow (10011)_2 \xrightarrow{28} (01101)_2$$

A	Q <sub>n</sub>	Q <sub>n+1</sub>	Action
00000	10011	0	$n=5, 10$ $A \rightarrow A - M$
+ 10111			
<u>10111</u>	10011	0	ASR
11011	11001	1	$n=4, 11, ASR$
11101	11100	1	$n=3, 01$
+ 01001			
<u>000110</u>	11100	1	<del>A</del> $\rightarrow A + M$

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00011	01110	P	n=2, 09, ASR
00001	10111	0	n=1, 10
10111		0	A $\rightarrow$ A-M
11000	10111	0	ASR
(1100 01011)		1	n=0

$$(0001110101)_2 \rightarrow (-17)_{10}$$

iv)  $\sim 9$  with  $\sim 13$

$$M: (-9)_{10} \rightarrow (10111)_2 \xrightarrow{2's} (01001)_2$$

$$Q: (-13)_{10} \rightarrow (10011)_2$$

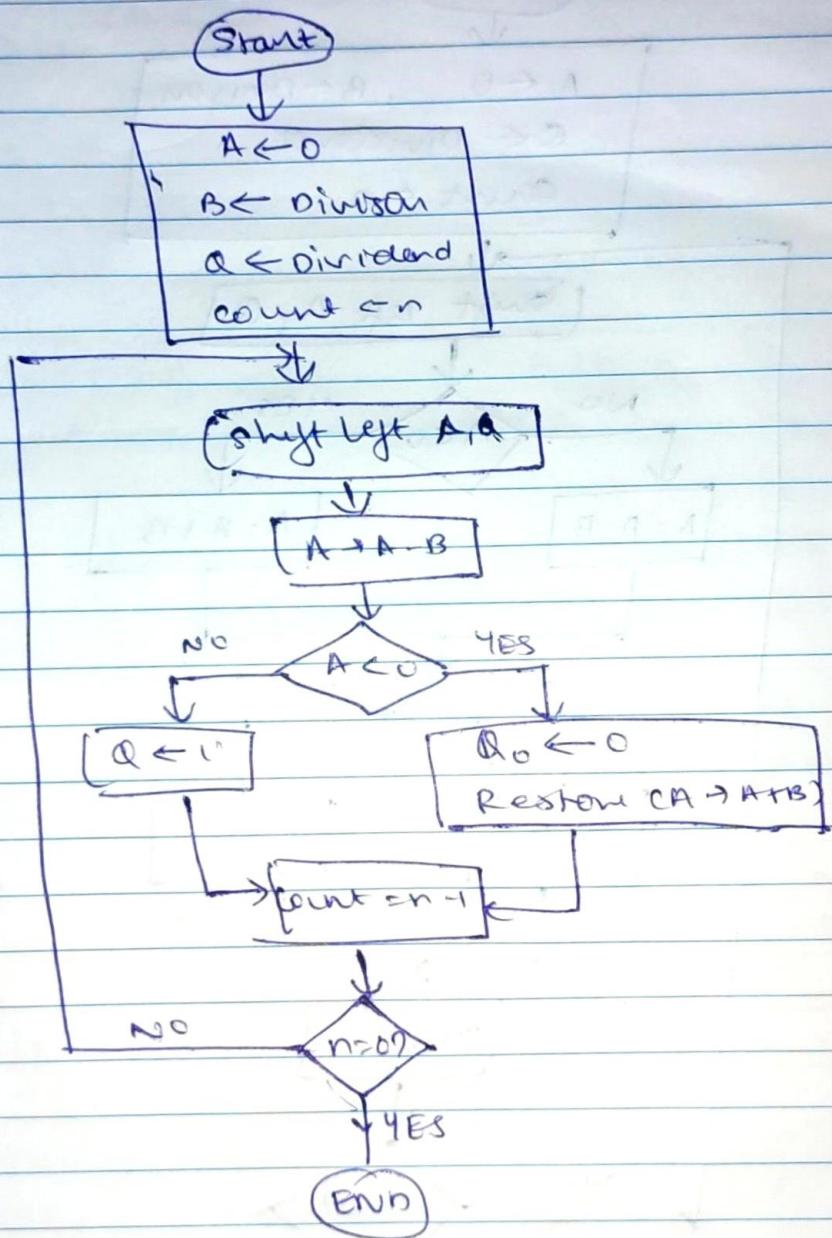
A	Q <sub>a</sub>	Q <sub>b</sub>	Action
00000	10011	0	n=5, 10
01000		0	A $\rightarrow$ A-M
01001	10011	0	ASR
00100	11001	1	n=4, 11, ASR
00010	01100	1	n=3, 01
10111			A $\rightarrow$ A-M
11001	01100	1	ASR
11100	10110	0	n=2, 00, ASR
11110	01011	0	n=1, 10
01001			A $\rightarrow$ A-M
(100111 01011)		0	ASR
(000111 10101)		1	n=0

$$(-17)_{10}$$

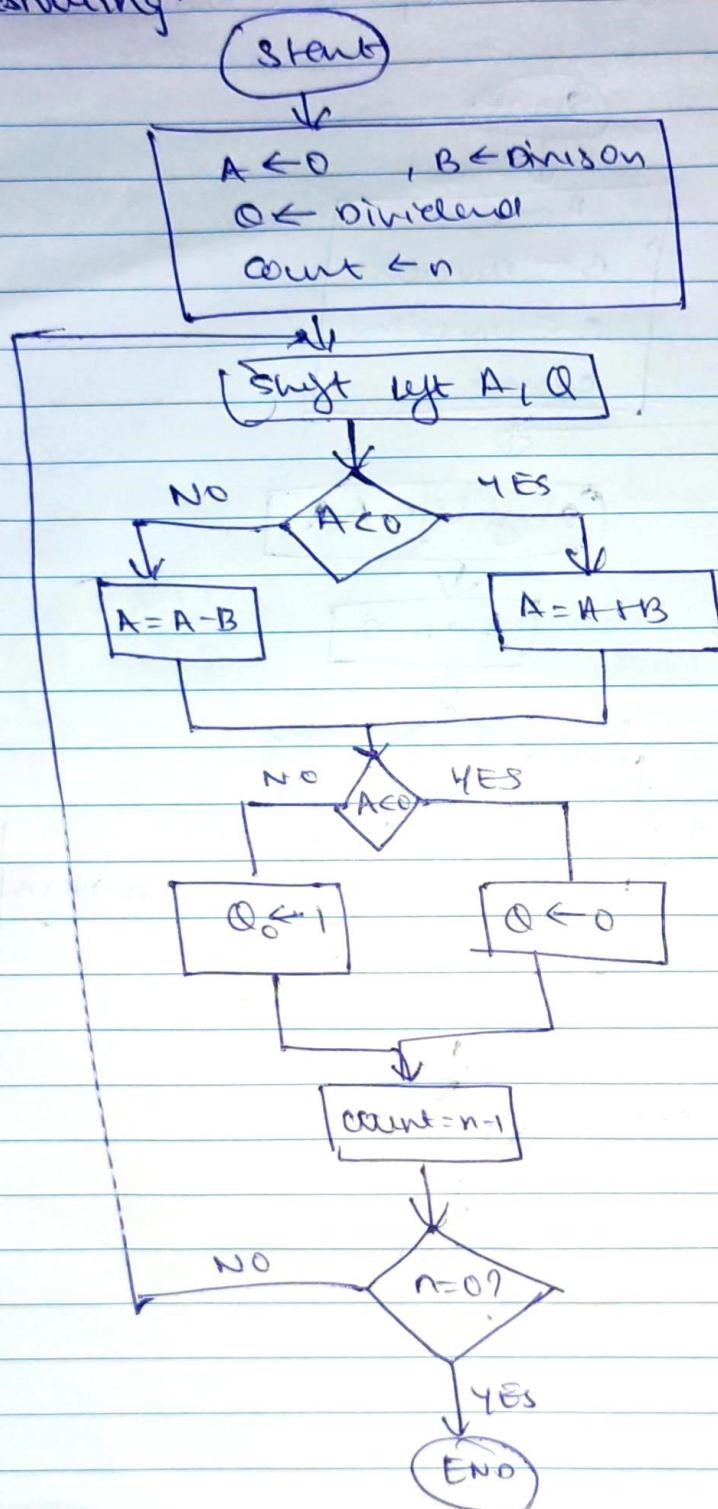
S23-127

Q] Draw flowchart of Restoring and non-restoring

Restoring



Non Restoring.



i) 13 divided by 9

$$M = (01001)_2$$

$$Q = (1101)_2$$

$$n=4$$

A      Q

$$\begin{array}{r} 00000 \\ \underline{-} 11000 \end{array}$$

$$\begin{array}{r} 00001 \\ \underline{-} 101 \end{array}$$

$$\begin{array}{r} 10111 \\ \underline{-} 11000 \end{array}$$

$$\begin{array}{r} 10001 \\ \underline{-} 1010 \end{array}$$

$$\begin{array}{r} 01001 \\ \underline{-} 11010 \end{array}$$

$$\begin{array}{r} 10100 \\ \underline{-} 100 \\ + 01001 \\ \hline 11101 \end{array}$$

$$\begin{array}{r} 11101 \\ \underline{-} 1000 \\ 11011 \\ \underline{-} 000 \\ + 01001 \\ \hline \boxed{1} \quad 00100 \end{array}$$

remainder  
 $(100)_2 = (4)_10$

$$\text{Quotient} = (01)_2 \rightarrow (1)_10$$

$$n=4, 15$$

$$AC = AC - M$$

$$A < 0, Q_0 = 0, n = 3$$

$$A < 0, A = AHM$$

$$A = 0, Q_0 = 0, n = 2, 15$$

$$A < 0, A = AHM$$

$$A < 0, Q_0 = 0, n = 1, 15$$

$$A < 0, A = AHM$$

$$A > 0, Q_0 = 1, n = 0$$

(ii) 13 divided by -9

$$Q = (1101)_2 = (3)_10$$

$$M = (10111)_2 \xleftarrow{2^8} (01001)_2 \leftarrow (9)_10$$

$$AHM = A + H0011$$

$$A - M = A + 01001$$

A	Q	Action
00000	1101	$n=4, LS$
00001	101-	$A \geq 0, A = A - M$
<u>01001</u>		
01010	1011	$A \geq 0, Q_0 = 1$
10101		$n=3, LS$
+ 10111		$A < 0, A = A + M$
<u>10110</u>	0111	$A \geq 0, Q_0 = 1$
11000	111-	$n=2, LS$
<u>10111</u>		$A < 0, A = A + M$
<u>1</u> 01111	1111	$A \geq 0, Q_0 = 1$
11111	111-	<del><math>n=1, LS</math></del>
+ 10111		$A = A + M$
<u>1</u> 10110	1110	$A < 0, Q_0 = 0$

iii)  $\sim 13$  divided by 9

$$Q = (0011)_2$$

$$M = (01001)_2$$

A	Q	Action
00000	0111	$n=4, LS$
00000	011-	$A \geq 0, A = A - M$
<u>10111</u>		
100111	0110	$A < 0, Q_0 = 0$
01110	110-	$n=3, LS$
+ 10111		$A \geq 0, A = A - M$
<u>1</u> 00101	1101	$A \geq 0, Q_0 = 1$
01011	101-	$n=2, LS$
10111		$A \geq 0, A = A - M$
<u>1</u> 00010	1011	$A \geq 0, Q_0 = 1$

$$\begin{array}{r}
00101 \\
10111 \\
\hline
\underline{11100}
\end{array}
\quad
\begin{array}{r}
011 - \\
0110
\end{array}$$

$$\begin{aligned}
n &= 1, LS \\
A \geq 0, A &= A - M \\
A < 0, Q_0 &= 0 \\
n &= 0
\end{aligned}$$

iv) - 13 divided by -9

$$Q = (0011)_2$$

$$M = (10011) \xrightarrow{\text{2s}} (0130+1)_2$$

A	Q	Action
00000	0011	$n=4, LS$
00000	011 -	$A \geq 0, A = A - M$
<u>011101</u>	<u>00111</u>	$A \geq 0, Q_0 = 1$
<del>011010</del>	<del>0111-</del>	$\cancel{n=3, LS}$
10011	<u>1111</u>	$A = A + M$
<u>101101</u>	<u>111-</u>	$A \geq 0, Q_0 = 1$
11011	<u>111-</u>	$n=2, LS$
10011	<u>1111</u>	$A < 0, A = A + M$
<u>101110</u>	<u>1111</u>	$A \geq 0, Q_0 = 1$
11101	<u>111-</u>	$n=1, LS$
+ 10011	<u>111-</u>	$A = A + M$
<u>10000</u>	<u>1110</u>	$A < 0, Q_0 = 0$
		$n = 0$

S23-127

(i)

$$123 \cdot 125$$

$$1111011 \cdot 001$$

$$1 \cdot 111011001 \times 2^6$$

$$(1 \cdot N) 2^{E-127} = (1 \cdot 111011001) \times 2^6$$

$$E-127 = 6$$

$$E = 133$$

$$(133)_0 = (10000101)_2$$

1	10000101	111011001...00
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$$- 123 \cdot 125$$

0	10000101	111011001...00
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$$123 \cdot 125$$

$$(1 \cdot N) 2^{E-1023} = (1.111011001) \times 2^6$$

$$E-1023 = (100000000101)_2$$

0	100000000101	111011001...00
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$$+ 123 \cdot 125$$

1	100000000101	111011001...00
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$$- 123 \cdot 125$$

(ii) 0.125 and -0.125

$$0.125 = (0.001)_2 = 1 \cdot 0 \times 2^{-3}$$

$$1N \times 2^{E-127} = 1.0 \times 2^{-3}$$

$$E-127 = 3$$

$$E = 124$$

$$= (1111011)_2$$

011	01111011	0...00
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S23-127

$$8\text{-bit } 1 \cdot N \times 2^{E-1023} = 10 \times 2^{-3}$$

$$E = 1020$$

$$= 011111100_2$$

011	011111100	0.....000
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(iii) 111.22 and -111.22

$$0110111.001$$

32 bit

$$1 \cdot 1011001 \times 2^6$$

$$1 \cdot N \times 2^{E-1024}$$

$$E = 132$$

$$= 100000100$$

011	100000100	1011001...00
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64 bit

$$E = 1028$$

$$= 10000000000000$$

011	1000000000000	1011001...00
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(iv) 1289.125

$$010011101011.001$$

32 bit

$$E = 127 + 10 = 137$$

011	10001001	001110111...00
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S23-127

E = 1033

011	1000000	1001	0011101011..00
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