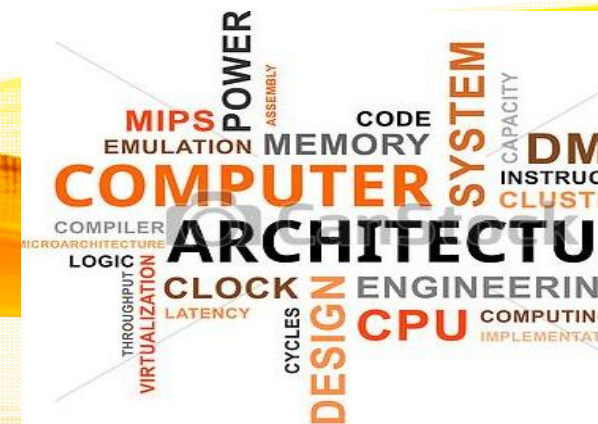# UNIT II
ARITHMETIC OPERATIONS

Addition and subtraction of signed numbers – Design of fast adders –

Multiplication of positive numbers - Signed operand multiplication- fast

multiplication – Integer division – Floating point numbers and operations
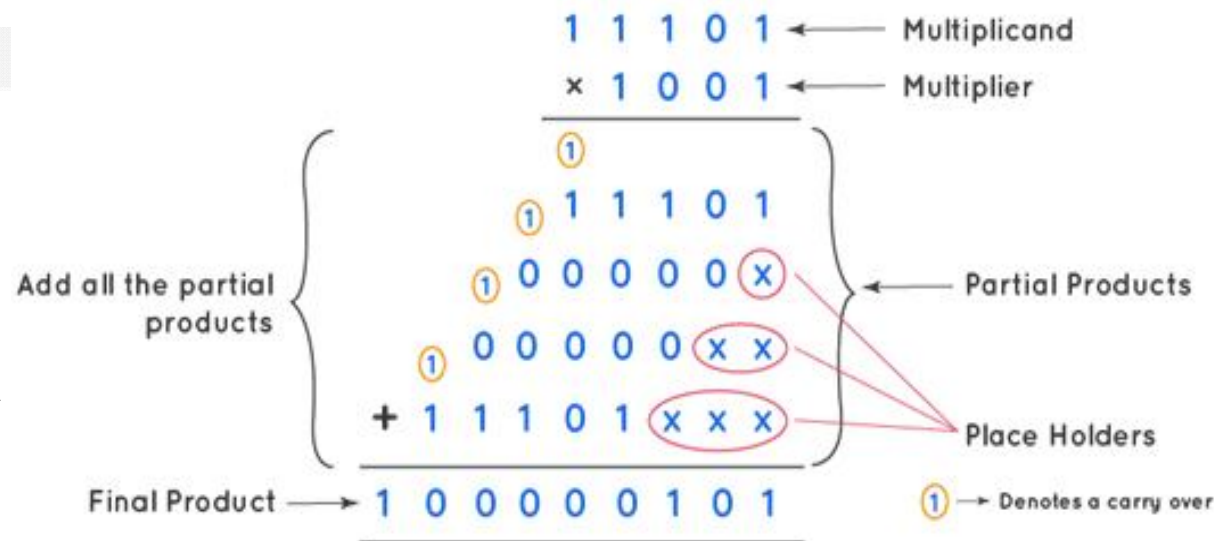
Recap the previous Class

BINARY MULTIPLICATION

$$1101 \quad (13)$$
$$x \quad 1011 \quad (11)$$
$$1011$$
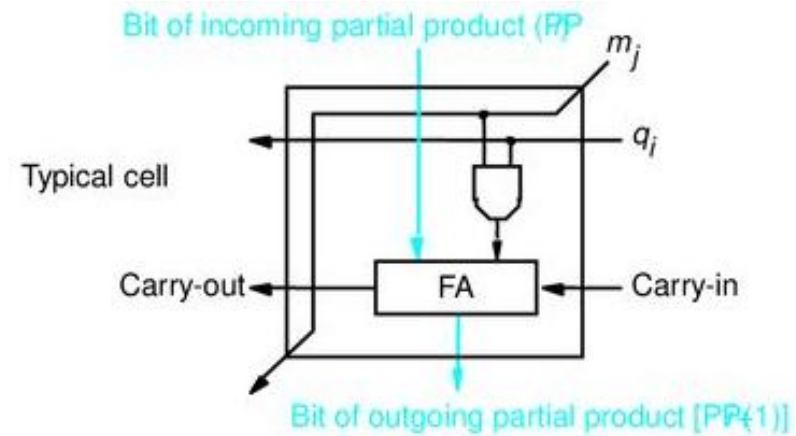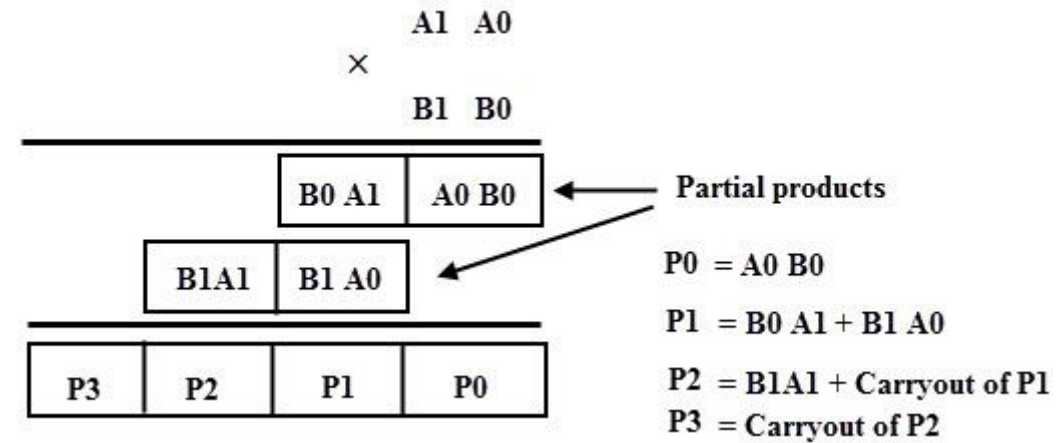$$0000$$
$$+ \quad 1011$$
$$\underline{1011}$$
$$10001111 \quad (143)$$

Binary multiplication is even easier than decimal, because we have either multiplication by 1 or by 0 in the intermediate sums.

1 1 1 0 1 ← Multiplicand
× 1 0 0 1 ← Multiplier

①

① 1 1 1 0 1

Add all the partial products ① 0 0 0 0 0 X ← Partial Products

① 0 0 0 0 X X

+ 1 1 1 0 1 X X X ← Place Holders

Final Product → 1 0 0 0 0 0 1 0 1

① → Denotes a carry over

Rules of Binary Multiplication
$0 \times 0 = 0, 0 \times 1 = 0, 1 \times 0 = 0, 1 \times 1 = 1$

Rules of Binary Addition
$0 + 0 = 0, 0 + 1 = 1, 1 + 1 = 10, 1 + 1 + 1 = 11$

Array Multiplication of Positive Binary Operands
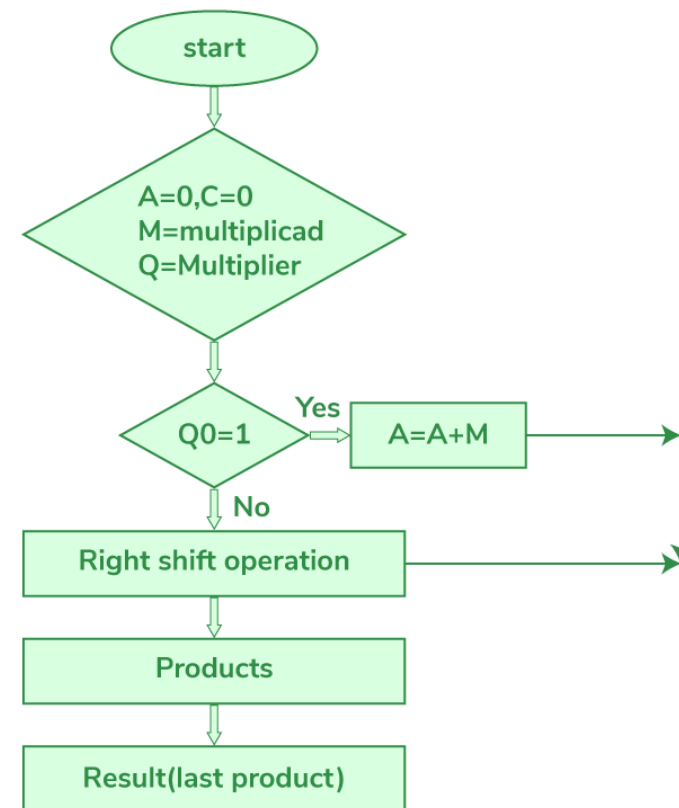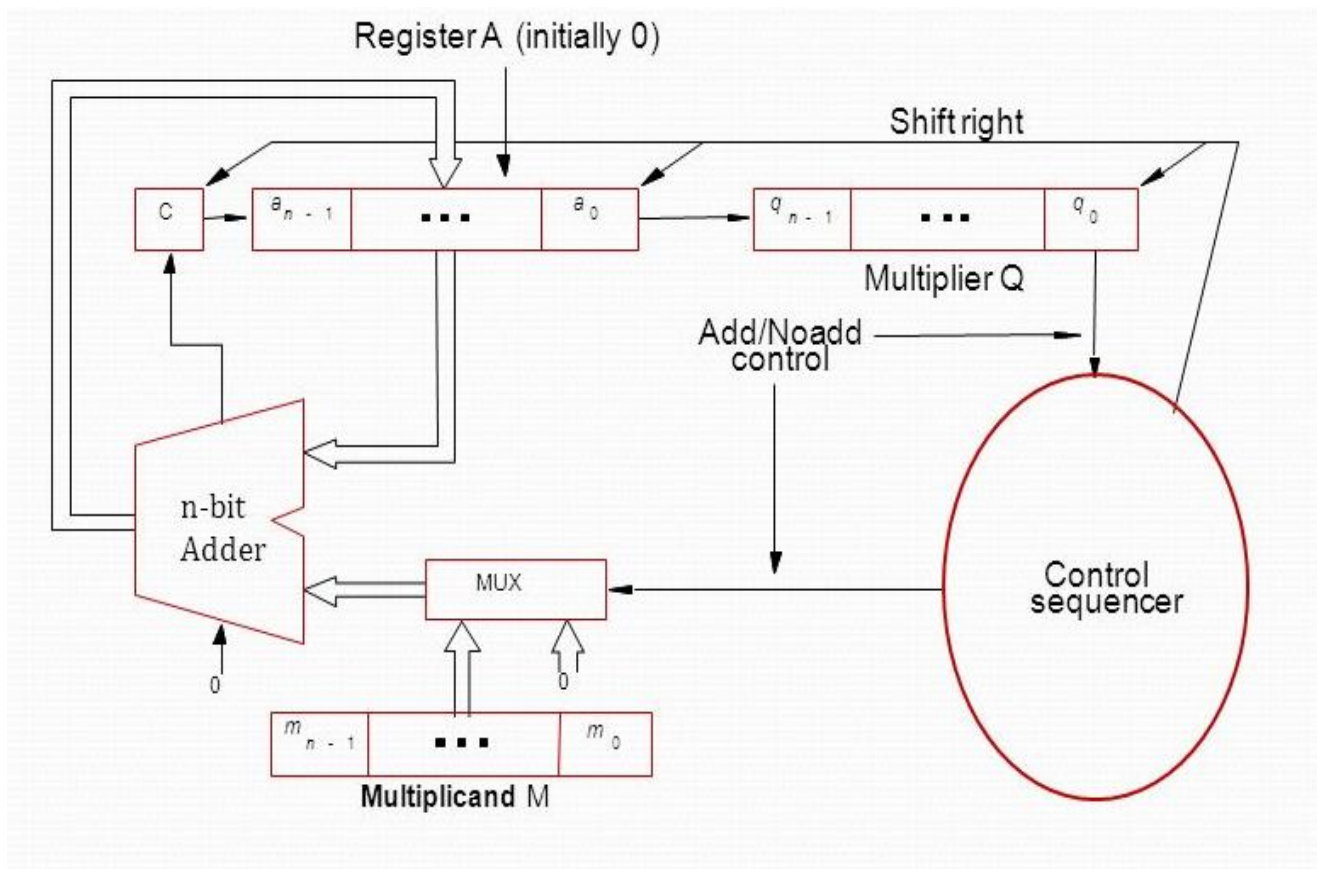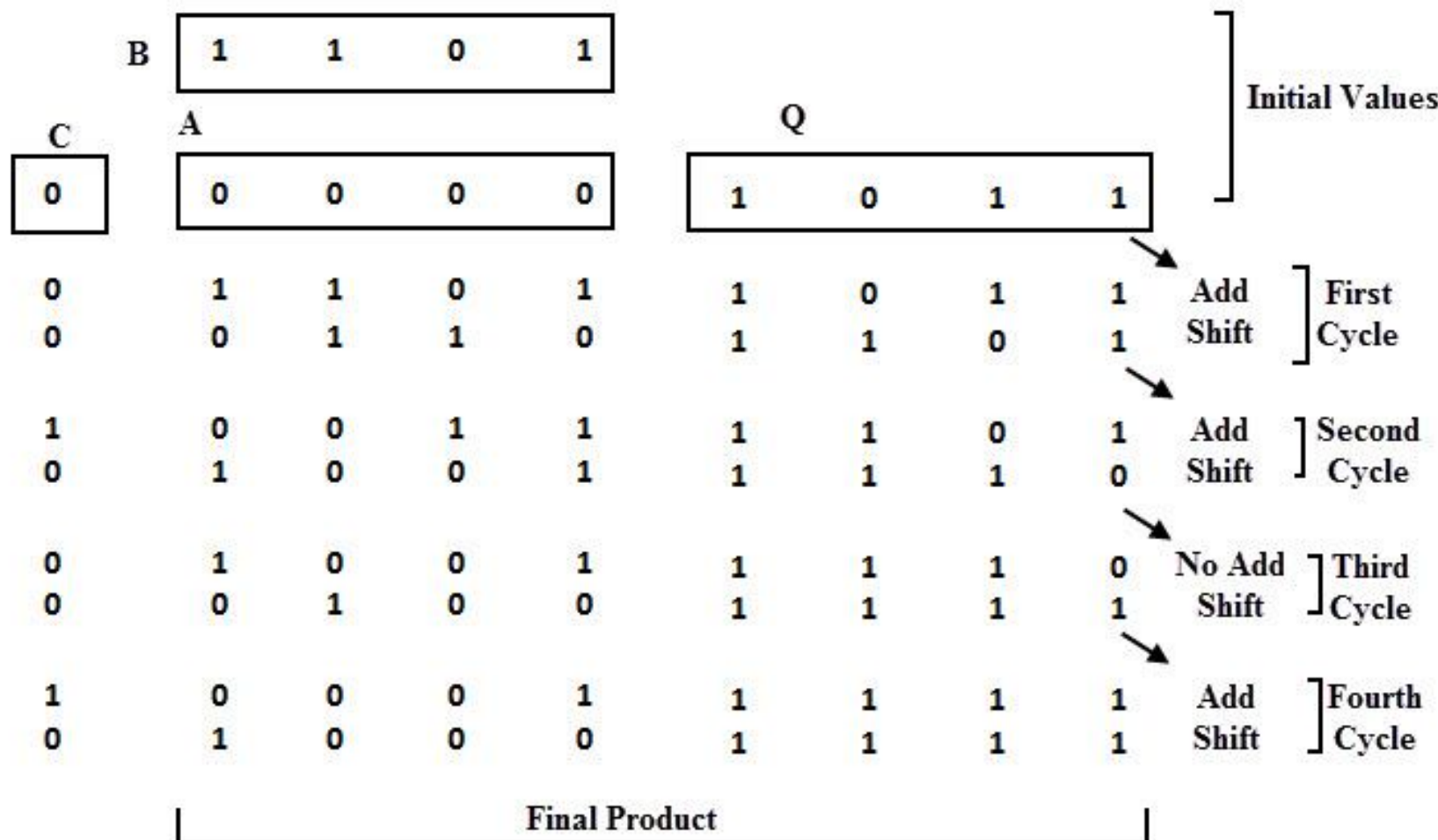
Register Configuration

start

A=0,C=0
M=multiplicad
Q=Multiplier

Q0=1 — Yes → A=A+M

No

Right shift operation

Products

Result(last product)
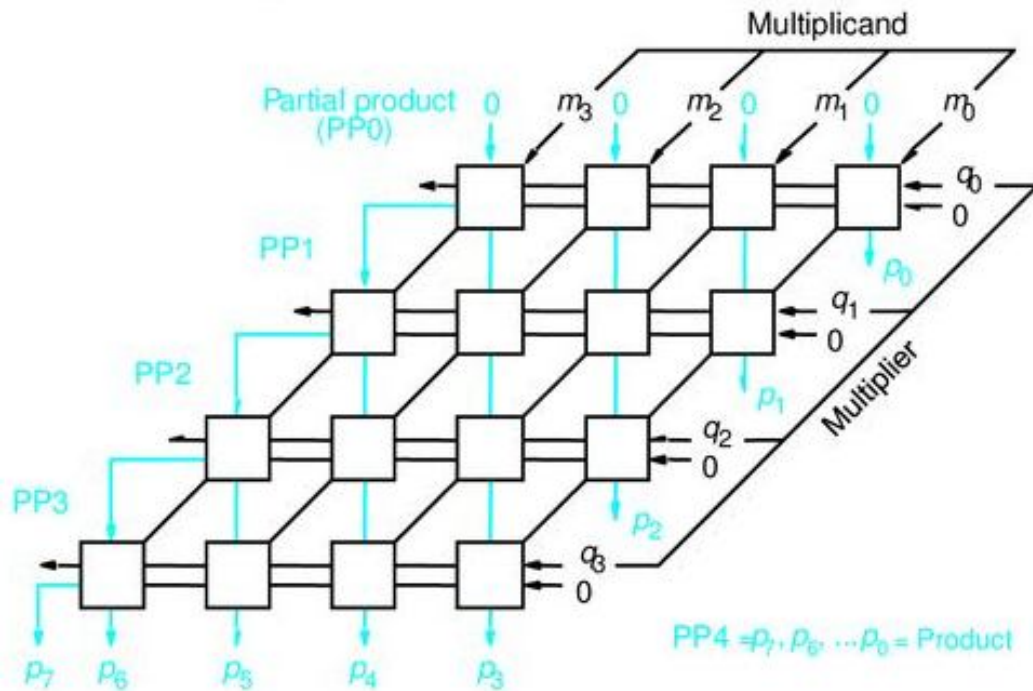
Sequential Circuit Binary Multiplier

13 X 11
7 X 3

Multiplication Example

C		A					Q				
	B	1	1	0	1							
0		0	0	0	0		1	0	1	1		Initial Values
0		1	1	0	1		1	0	1	1	Add	First
0		0	1	1	0		1	1	0	1	Shift	Cycle
1		0	0	1	1		1	1	0	1	Add	Second
0		1	0	0	1		1	1	1	0	Shift	Cycle
0		1	0	0	1		1	1	1	0	No Add	Third
0		0	1	0	0		1	1	1	1	Shift	Cycle
1		0	0	0	1		1	1	1	1	Add	Fourth
0		1	0	0	0		1	1	1	1	Shift	Cycle

Final Product

TEXT BOOK

Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", McGraw-Hill, 6th Edition 2012.

REFERENCES

1. David A. Patterson and John L. Hennessey, "Computer organization and design", MorganKauffman ,Elsevier, 5th edition, 2014.

2. William Stallings, "Computer Organization and Architecture designing for Performance", Pearson Education 8th Edition, 2010

3. John P.Hayes, "Computer Architecture and Organization", McGraw Hill, 3rd Edition, 2002

4. M. Morris R. Mano "Computer System Architecture" 3rd Edition 2007

5. David A. Patterson "Computer Architecture: A Quantitative Approach", Morgan Kaufmann; 5th edition 2011

THANK YOU