



SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



Overview of Adders and Subtractors

E.Divya.,AP/ECE /19EC306-Digital Circuits/ unit-2





OVERVIEW



- **Binary Addition**
- **Half & Full Adders**
- **Binary Subtraction**
- **Half & Full Subtractors**
- **Parallel Adders and Subtractors**
- **Using Adders for Subtraction**
- **Binary Multiplication**
- **Binary Multipliers**
- **Half & Full Adders**
- **2s Complement**



BINARY ADDITION



- Conceptually similar to decimal addition
- *Example:* Add the binary numbers 1010 and 11

$$\begin{array}{r} \text{(carry)} \\ 1 \\ 1010 \\ + \quad 11 \\ \hline 1101 \end{array}$$

The diagram illustrates the binary addition of 1010 and 11. The numbers are aligned by their least significant bits. A red arrow labeled '(carry) 1' points from the third bit position (from the right) to the fourth bit position, indicating the carry-over of 1 from the 1+1 operation at that position. The result of the addition is 1101.



TEST



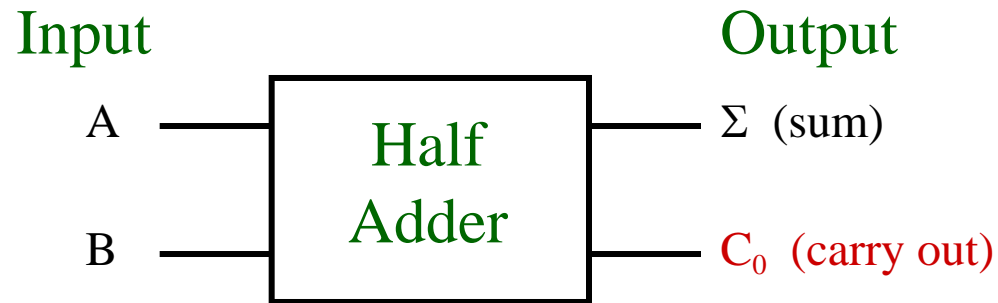
Add the Binary numbers 11010 and 1100

$$\begin{array}{r} \text{(carry)} \quad \text{(carry)} \\ 1 \quad 1 \\ 1 \ 1 \ 0 \ 1 \ 0 \\ + \ 1 \ 1 \ 0 \ 0 \\ \hline 1 \ 0 \ 0 \ 1 \ 1 \ 0 \end{array}$$

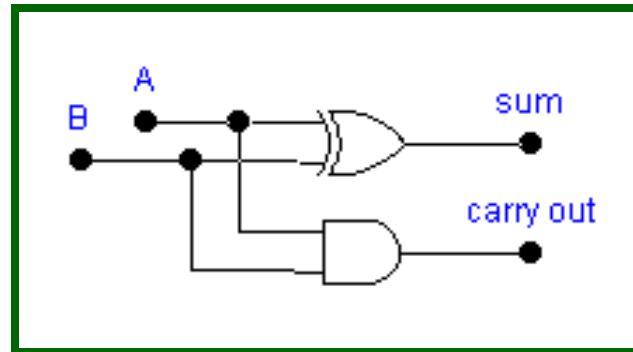
HALF ADDER

- Logic device that adds two binary numbers
- Only adds Least Significant Digit (LSD) column (1s column) in binary addition

Logic
Symbol:



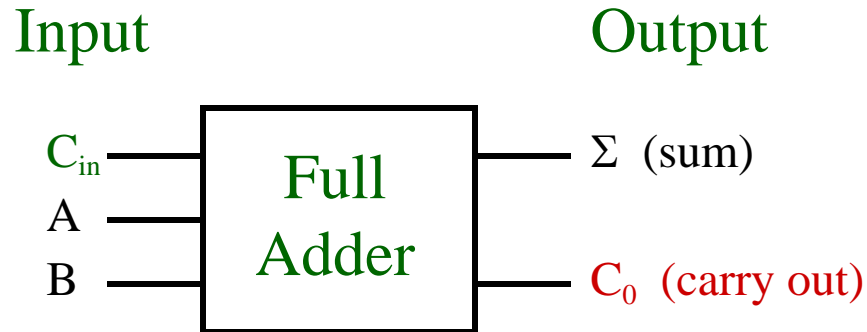
Logic
Diagram:



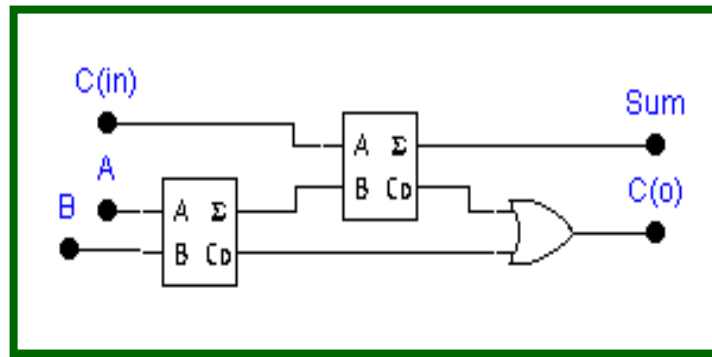
FULL ADDER

Used for adding binary place values other than the 1s place

Logic
Symbol:



Logic
Diagram:





BINARY SUBTRACTION



Example: Subtract binary number 101 from 1011

(borrow)

$$\begin{array}{r} 0 \\ 1011 \\ - 101 \\ \hline 0110 \end{array}$$



TEST



Subtract binary number 11 from 1010

$$\begin{array}{r} 1010 \\ - 11 \\ \hline 0111 \end{array}$$

The diagram illustrates the binary subtraction of 11 from 1010. The minuend (1010) and subtrahend (11) are aligned. Red diagonal lines indicate borrowing from the 2nd, 3rd, and 4th bits of the minuend to the 1st bit of the subtrahend. The resulting difference is 0111. The number 01 is written above the 1st bit of the subtrahend, and the number 10 is written above the 2nd bit of the subtrahend, both with red diagonal lines through them, indicating they are not part of the final result.

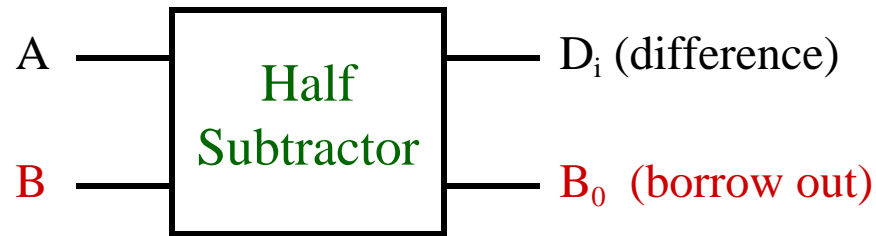
HALF SUBTRACTOR

Subtracts LSD column in binary subtraction

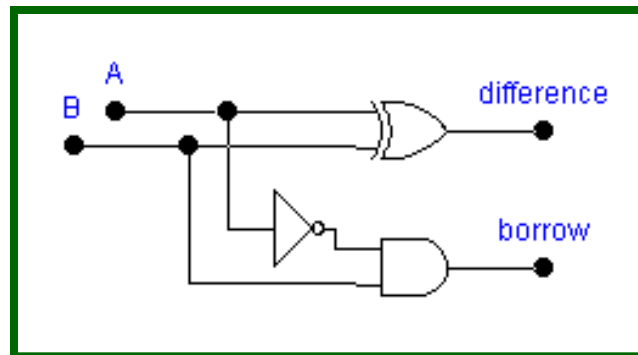
Input

Output

Logic
Symbol:



Logic
Diagram:

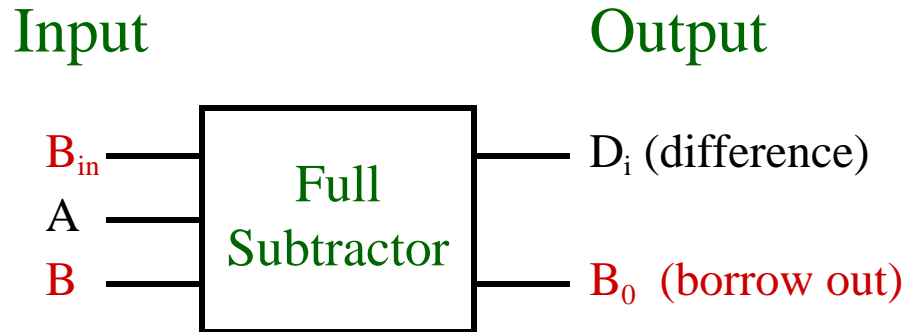




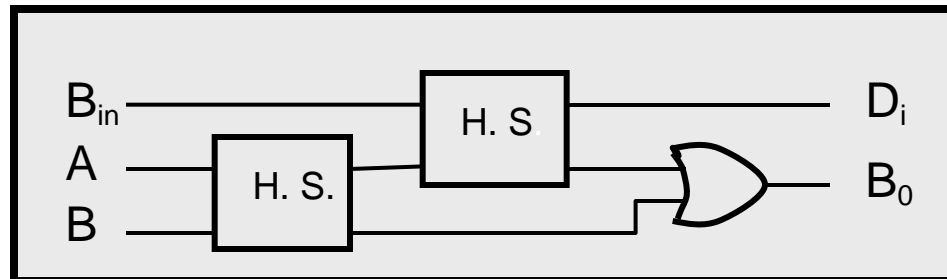
FULL SUBTRACTOR

Used for subtracting binary place values other than the 1s place

Logic Symbol:

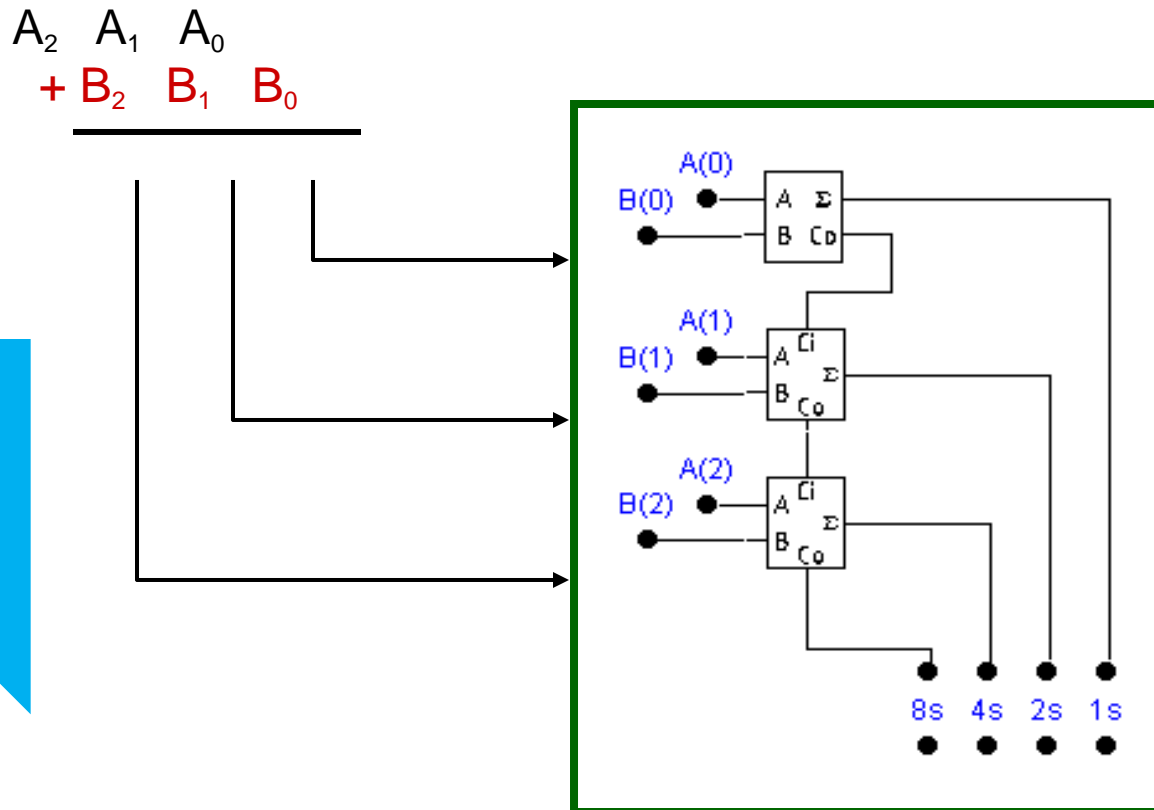


Logic Diagram:



PARALLEL ADDING

- Use half adder for LSD
- Use full adder for other digits



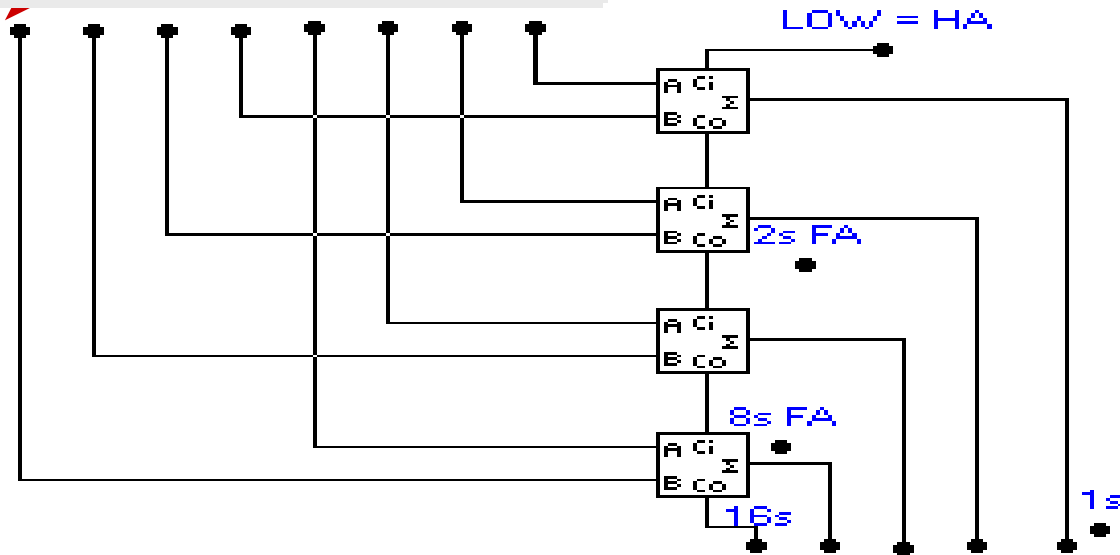


Enter binary numbers
to be added

PARALLEL ADDER



1 1 1 0 + 0 1 1 0



Parallel adders are available in IC form.

1s place uses half-adder

2s, 4s, 8s places use full adders

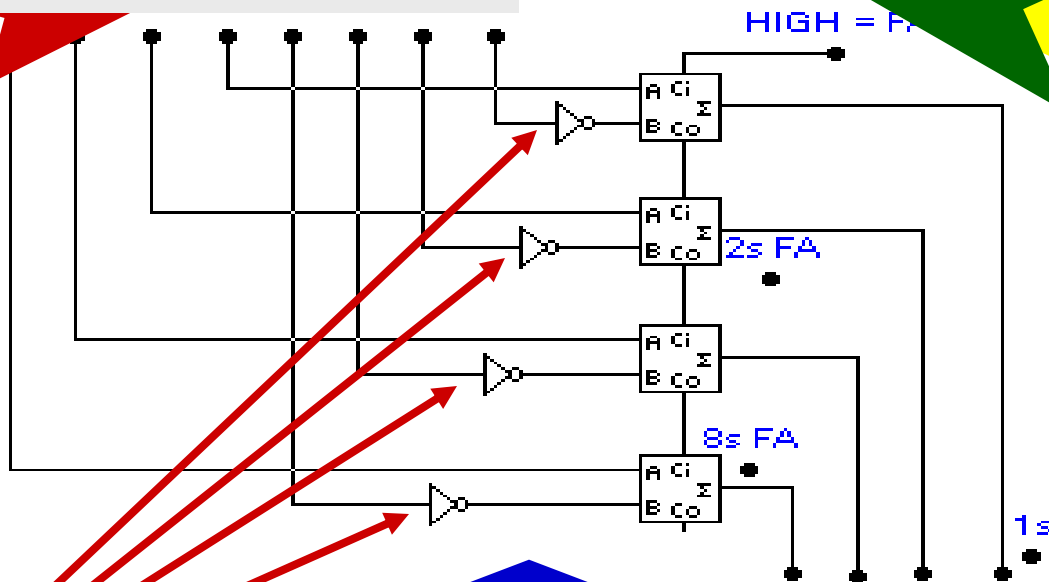


PARALLEL SUBTRACTOR USING FULL ADDERS

Binary numbers to be subtracted are input here

1 0 0 1 - 0 1 1 1

HIGH at Carry in input acts like adding +1 to a 1s C number to form the 2s complement.
1sC is formed by four inverters.



Inverters

0 0 1 0

Note the use of
Also notice the addition of four inverters on the B inputs to the FAs
The result (difference) of the subtraction problem will appear here.



BINARY MULTIPLICATION



Example: Multiply the binary numbers 111 and 101.

$$\begin{array}{r} 111 \\ \times 101 \\ \hline \end{array}$$

Multiplicand

Multiplier

$$\begin{array}{r} 111 \\ 000 \\ 111 \\ \hline 100011 \end{array}$$

1st partial product

$$000$$

2nd partial product

$$111$$

3rd partial product

$$100011$$

Product

15.09.2020



TEST



Multiply the binary numbers 101 and 100.

$$\begin{array}{r} 101 \\ \times 100 \\ \hline \end{array}$$

$$\begin{array}{r} 000 \\ 000 \\ 101 \\ \hline 10100 \end{array}$$

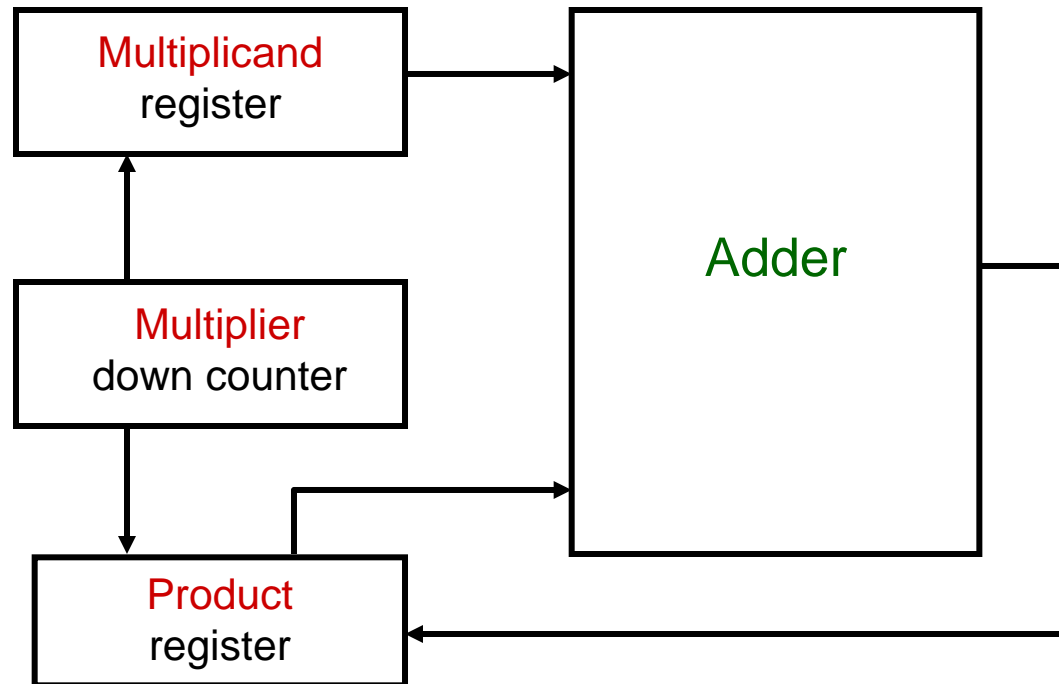


BINARY MULTIPLIERS



Binary multiplier circuits - utilize repeated addition

Block
Diagram:

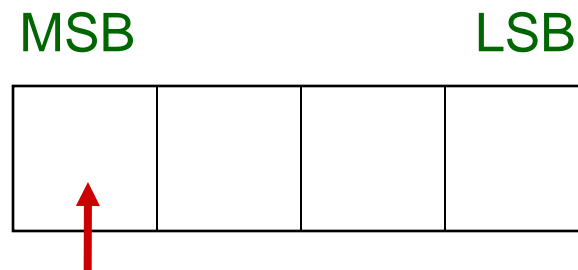




2s COMPLEMENT NOTATION



- 2s complement representation - widely used in microprocessors.
- Represents *sign* and *magnitude*



Sign bit (0 = + ; 1 = -)

Decimal:	+7	+4	+1	0	-1	-4	-7
2s Complement:	0111	0100	0001	0000	1111	1100	1001

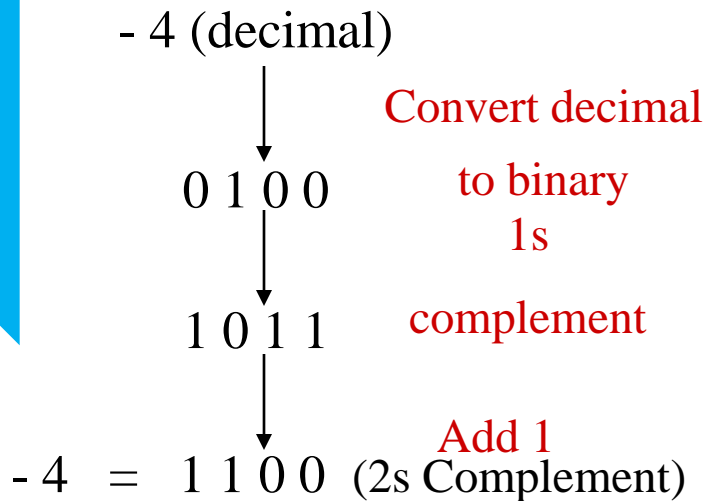


2s COMPLEMENT - CONVERSIONS

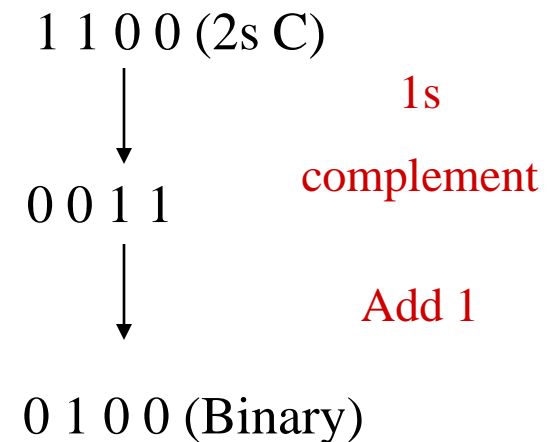


- Converting positive numbers to 2s complement:
 - Same as converting to binary
- Converting negative numbers to 2s complement:

Decimal to 2s Complement



2s Complement to Binary





ADDING/SUBTRACTING IN 2s COMPLEMENT



2s complement notation makes it possible to
add and subtract signed numbers

(Decimal)

2s Complement

(- 1)

1 1 1 1

+ (- 2)

+ 1 1 1 0

(- 3)

1 1 1 0 1

2s complement

Discard

(+1)

0 0 0 1

+ (- 3)

+ 1 1 0 1

(- 2)

1 1 1 0

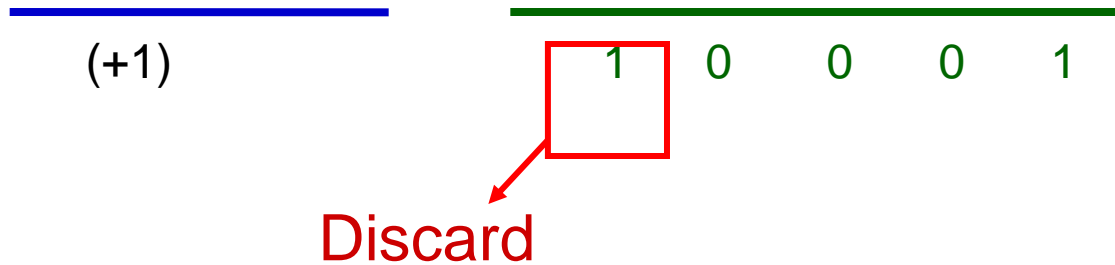


TEST



Add the following 2s complement numbers:

$$\begin{array}{r} (+5) \\ + (-4) \end{array} \quad \begin{array}{r} 0101 \\ + 1100 \end{array}$$

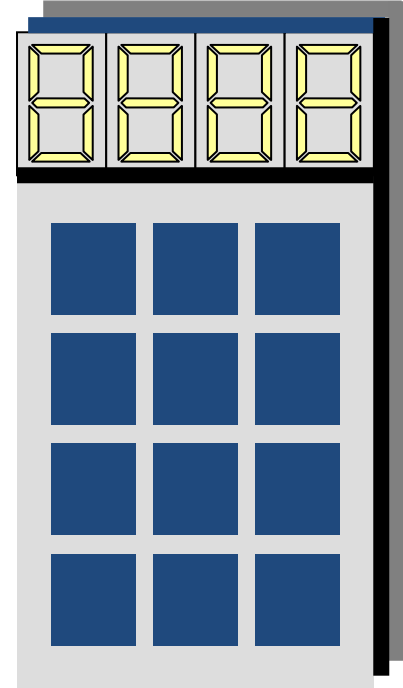




PRACTICAL SUGGESTION FOR BINARY MATH



- Use a scientific calculator.
 - Most scientific calculators have DEC, BIN, OCT, and HEX modes and can either convert between codes or perform arithmetic in different number systems.
 - Most scientific calculators also have other functions that are valuable in digital electronics such as AND, OR, NOT, XOR, and XNOR logic functions.





THANK YOU

