

Example 2.23 :-

Divide 01100100 by 00011001

2's complement of divisor.

11100110

+ 1

11100111

2's complement

Subtract divisor from dividend
using 2's complement addition

'0'1100100

+ 11100111

←1 01001011

1st partial remainder

Add 1 to quotient

$$\Rightarrow 00000000 + 00000001 \\ = 00000001$$

Adding 2's complement to 1st
partial remainder.

'0100'1'0'11

+ 11100111

←1 00110010

2nd partial remainder.

Add 1 to quotient

$$\Rightarrow 00000001 + 00000001 \\ = 00000010$$

Adding 2's complement to 2nd partial remainder.

$$\begin{array}{r} 00110010 \\ + 11100111 \\ \hline \leftarrow 1 00011001 \end{array}$$

3rd partial remainder.

Add 1 to quotient

$$\Rightarrow 00000010 + 00000001 \\ = 00000011$$

Adding 2's complement to 3rd partial remainder.

$$\begin{array}{r} 00111001 \\ + 11100111 \\ \hline \leftarrow 1 00000000 \end{array}$$

Zero
Remainder.

Add 1 to quotient

$$\Rightarrow 00000011 + 00000001 \\ = 00000100 \quad \text{Final quotient}$$

Section : 2.7

31.

Convert each pair of binary numbers to binary and add using the 2's complement form.

a) 33 and 15

$$\begin{array}{r} 33 \\ \hline 2 | 16 - 1 \\ 2 | 8 - 0 \\ 2 | 4 - 0 \\ 2 | 2 - 0 \\ 1 - 0 \end{array}$$

$$33 = 00100001$$

$$\begin{array}{r} 15 \\ \hline 2 | 7 - 1 \\ 2 | 3 - 1 \\ 1 - 1 \end{array}$$

$$15 = 00001111$$

$$\begin{array}{r} & 1 & 1 & 1 \\ 00100001 & + & 00001111 \\ \hline 00110000 \end{array} \text{ Ans.}$$

b) 56 and -27

$$\begin{array}{r} 56 \\ \hline 2 | 28 - 0 \\ 2 | 14 - 0 \\ 2 | 7 - 0 \\ 2 | 3 - 1 \\ \hline 1 - 1 \end{array}$$

$$56 = 00111000$$

$$\begin{array}{r} 27 \\ \hline 2 | 13 - 1 \\ 2 | 6 - 1 \\ 2 | 3 - 0 \\ 1 - 1 \end{array}$$

$$27 = 00011011$$

$$\Rightarrow -27 = \begin{array}{r} 1 \\ 01100100 \\ + 1 \\ \hline 101100101 \end{array}$$

$$\begin{array}{r} 00111000 \\ + 11100101 \\ \hline 1000111101 \end{array}$$

$$\Rightarrow 00011101 \text{ Ans.}$$

c) -46 and 25

$$\begin{array}{r} 2 \mid 46 \\ 2 \mid 23 - 0 \\ 2 \mid 11 - 1 \\ 2 \mid 5 - 1 \\ 2 \mid 2 - 1 \\ 1 - 0 \end{array}$$

$$\begin{array}{r} 2 \mid 25 \\ 2 \mid 12 - 1 \\ 2 \mid 6 - 0 \\ 2 \mid 3 - 0 \\ 1 - 1 \end{array}$$

$$\Rightarrow 46 = 00101110$$

$$25 = 00011001$$

$$\begin{aligned} \Rightarrow -46 &= 11010001 \\ &\quad + 1 \\ &\hline 11010010 \end{aligned}$$

$$\begin{array}{r} 11010010 \\ + 00011001 \\ \hline 11101011 \end{array} \text{ Ans.}$$

d) -110 and -84

$$\begin{array}{r} 110 \\ 2 \overline{)55} \quad 0 \\ 2 \overline{)27} \quad -1 \\ 2 \overline{)13} \quad -1 \\ 2 \overline{)6} \quad -1 \\ 2 \overline{)3} \quad -0 \\ 1 -1 \end{array}$$

$$\begin{array}{r} 84 \\ 2 \overline{)42} \quad -0 \\ 2 \overline{)21} \quad -0 \\ 2 \overline{)10} \quad -1 \\ 2 \overline{)5} \quad -0 \\ 2 \overline{)2} \quad -1 \\ 1 -0 \end{array}$$

$$\Rightarrow 110 = 01101110$$

$$84 = 01010100$$

$$\Rightarrow -110 = 10010001$$

$$\begin{array}{r} +1 \\ \hline 10010010 \end{array}$$

$$\Rightarrow -84 = 10101011$$

$$\begin{array}{r} +1 \\ \hline 10101100 \end{array}$$

$$\begin{array}{r} 10010010 \\ +10101100 \\ \hline \leftarrow 10011110 \end{array}$$

$$\Rightarrow 10011110 \text{ Ans.}$$

32. Perform each addition in the 2's complement form-

a) $00010110 + 00110011$

$$\begin{array}{r} 0'0'01'0'110 \\ + 00110011 \\ \hline 01001001 \end{array} \text{ Ans.}$$

b) $01110000 + 10101111$

$$\begin{array}{r} 0'1110000 \\ + 10101111 \\ \hline 100011111 \end{array} \text{ Ans.}$$

33. Perform each addition in the 2's complement form-

a) $10001100 + 00111001$

$$\begin{array}{r} 10'0'01100 \\ + 00111001 \\ \hline 11000101 \end{array} \text{ Ans.}$$

b) $11011001 + 11100111$

$$\begin{array}{r} 11011001 \\ + 11100111 \\ \hline \leftarrow 11100000 \\ \Rightarrow 11000000 \text{ Ans.} \end{array}$$

34. Perform each subtraction in
the 2's complement form.

a) $00110011 - 00010000$

$$\begin{array}{r} 00110011 \\ - 00010000 \\ \hline \end{array}$$

2's complement of 00010000

$$\begin{array}{r} 11101111 \\ + 1 \\ \hline 11110000 \end{array}$$

Now,

$$\begin{array}{r} 00110011 \\ + 11110000 \\ \hline \leftarrow 00100011 \end{array}$$

$$\Rightarrow 00100011 \text{ Ans.}$$

b) $01100101 - 11101000$

2's complement of 11101000

00010111

$$\begin{array}{r} & +1 \\ \hline 00011000 \end{array}$$

Now,

$$\Rightarrow \begin{array}{r} 01100101 \\ + 00011000 \\ \hline 0111101 \end{array}$$

35. Multiply 01101010 by
11110001 in 2's complement form.

HEXADECIMAL NUMBERS:-

Example 2.24

Convert the following binary numbers to hexadecimal.

a) 1100101001010111

$$\begin{array}{cccc} \underline{1100} & \underline{1010} & \underline{0101} & \underline{0111} \\ C & A & 5 & 7 \end{array}$$

$$\Rightarrow CA57_{16}$$

b) 111111000101101001

$$\begin{array}{ccccc} \underline{0011} & \underline{1111} & \underline{0001} & \underline{0110} & \underline{1001} \\ 3 & F & 1 & 6 & 9 \end{array}$$

$$\Rightarrow 3F169_{16}$$

Example 2.25

Determine binary numbers for the following hexadecimal numbers.

a) $10A4_{16}$

$$\begin{array}{cccc} 1 & 0 & A & 4 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 0001 & 0000 & 1010 & 0100 \end{array}$$

$$\Rightarrow 1000010100100_2 \text{ Ans.}$$

b) CF8E₍₁₆₎

| | | | |
|--------------|--------------|--------------|--------------|
| C | F | 8 | E |
| \downarrow | \downarrow | \downarrow | \downarrow |
| 1100 | 1111 | 1000 | 1110 |

$\Rightarrow 1100111110001110_2$ Ans.

c) 9742₍₁₆₎

| | | | |
|--------------|--------------|--------------|--------------|
| 9 | 7 | 4 | 2 |
| \downarrow | \downarrow | \downarrow | \downarrow |
| 1001 | 0111 | 0100 | 0010 |

$\Rightarrow 1001011101000010_2$

Example 2.26

Convert following hexadecimal numbers to decimal.

a) 1C₍₁₆₎

| | |
|--------------|--------------|
| 1 | C |
| \downarrow | \downarrow |
| 0001 | 1100 |

$\Rightarrow 00011100$

$\Rightarrow (0 \times 2^7) + (0 \times 2^6) + (0 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (0 \times 2^0)$

$\Rightarrow 16 + 8 + 4$

$\Rightarrow 28_{(10)}$ Ans.

b) A85₁₆

A 8 5
↓ ↓ ↓
1010 1000 0101

$$\Rightarrow 1010100000101$$

$$\begin{aligned}\Rightarrow & (1 \times 2^9) + (0 \times 2^8) + (1 \times 2^7) + (0 \times 2^6) + (0 \times 2^5) + \\ & (0 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)\end{aligned}$$

$$\Rightarrow 2048 + 512 + 128 + 4 + 1$$

$$\Rightarrow 2693_{10} \text{ Ans.}$$

Example 2.27

Convert following hexadecimal to decimal :-

a) E5₁₆

$$\Rightarrow (E \times 16^1) + (5 \times 16^0)$$

$$\Rightarrow (14 \times 16) + (5 \times 1)$$

$$\Rightarrow 229_{10} \text{ Ans.}$$

b) B2F8₁₆

$$\Rightarrow (B \times 16^3) + (2 \times 16^2) + (F \times 16^1) + (8 \times 16^0)$$

$$\begin{aligned}\Rightarrow & (11 \times 4096) + (2 \times 256) + (15 \times 16) + \\ & (8 \times 1)\end{aligned}$$

$$\Rightarrow 45056 + 512 + 240 + 8$$

$$\Rightarrow 45816_{10} \text{ Ans.}$$

Example 2.28

Convert decimal number 650 to hexadecimal by repeated division by 16

$$\Rightarrow \frac{650}{16} = 40.625 \Rightarrow 0.625 \times 16 \\ \Rightarrow 10 \text{ (A)}$$

$$\Rightarrow \frac{40}{16} = 2.5 \Rightarrow 0.5 \times 16 \\ \Rightarrow 8$$

$$\Rightarrow \frac{2}{16} = 0.125 \Rightarrow 0.125 \times 16 \\ \Rightarrow 2$$

$$\Rightarrow 650_{10} = \begin{matrix} 2 \\ 8 \\ A \end{matrix}_{16} \text{ Ans.}$$

Example 2.29

Add following hexadecimal numbers,

a) $23_{16} + 16_{16}$

$$\begin{array}{r} 23_{16} \\ + 16_{16} \\ \hline 39_{16} \end{array}$$

b) $58_{16} + 22_{16}$

$$\begin{array}{r} 58_{16} \\ + 22_{16} \\ \hline 7A_{16} \end{array}$$

$$c) 2B_{16} + 84_{16}$$

$$2B_{16}$$

$$\begin{array}{r} 84_{16} \\ \hline AF_{16} \end{array}$$

$$d) \cancel{BE}_{10} + DF_{16} + AC_{16}$$

$$\begin{array}{r} DF_{16} \\ AC_{16} \\ \hline 18B_{16} \end{array}$$

$$F+C = 15+12 = 27 \Rightarrow 27-16=11$$

$$D+A+1 = 13+10+1 \Rightarrow 24$$

$$24-16=8$$

Example 2.30

Subtract the following hexadecimal numbers:

$$a) 84_{16} - 2A_{16}$$

$$\Rightarrow 2A_{16} = \underline{\underline{00101010}}_{(2)} \quad \text{1's complement of } 2A$$

2's complement of 2A

$$\Rightarrow \underline{\underline{11010101}}_{(2)}$$

$$+1$$

$$\underline{\underline{11010110}}_{(2)} = D6_{16}$$

$$\Rightarrow 84_{16}$$

$$8+13=21$$

$$21-16=5$$

$$+ D6_{16}$$

$$\underline{\underline{5A_{16}}} \text{ Ans.}$$

b) $\text{OB}_{16} \text{ C3}_{16} - \text{OB}_{16}$
 $\Rightarrow \text{OB}_{16} = 00001011$

2's complement of OB_{16}

$$\Rightarrow 11110100$$

$$+ 1$$

$$\underline{\underline{11110101}} \Rightarrow \text{F5}_{16}$$

$$\Rightarrow \text{C3}_{16} \quad 12 + 15 = 27$$

$$+ \text{F5}_{16}$$

$$27 - 16 = 11$$

$$\underline{\underline{\text{B8}_{16}}} \text{ Ans.}$$

Section 2.8

37. Convert each hexadecimal number to binary.

a) 46_{16}

$$\begin{array}{r} 4 \\ 0100 \\ \hline 6 \\ 0110 \end{array}$$

$$\Rightarrow 46_{16} = 01000110_2 \text{ Ans.}$$

b) 54_{16}

$$\begin{array}{r} 5 \\ 0101 \\ \hline 6 \\ 0110 \end{array}$$

$$\Rightarrow 54_{16} = 01010110_2 \text{ Ans.}$$

B4₁₆

c) B 4
1011 0100

$$\Rightarrow B4_{16} = 10110100_2 \text{ Ans.}$$

d) 1A3₁₆

1 A 3
0001 1010 0011

$$\Rightarrow 1A3_{16} = 000110100011_2 \text{ Ans.}$$

e) FA₁₆

F A
1111 1010

$$\Rightarrow FA_{16} = 11111010_2 \text{ Ans.}$$

f) ABC₁₆

A B C
1010 1011 1100

$$\Rightarrow ABC_{16} = 101010111100_2 \text{ Ans.}$$

g) ABCD₁₆

A B C D
1010 1011 1100 1101

$$\Rightarrow ABCD_{16} = 1010101111001101_2 \text{ Ans.}$$

Ans.

38. Convert binary number to hexadecimal.

a) 1111

$$\begin{array}{r} \underline{1111} \\ F \end{array} \Rightarrow F_{16} \text{ Ans.}$$

b) 1011

$$\begin{array}{r} \underline{1011} \\ B \end{array} \Rightarrow B_{16} \text{ Ans.}$$

c) 11111

$$\begin{array}{r} \underline{0001} \quad \underline{1111} \\ 1 \qquad \qquad F \end{array}$$

$$\Rightarrow 1F_{16} \text{ Ans.}$$

d) 10101010

$$\begin{array}{r} \underline{1010} \quad \underline{1010} \\ A \qquad A \end{array} \Rightarrow AA_{16} \text{ Ans.}$$

e) 10101100

$$\begin{array}{r} \underline{1010} \quad \underline{1100} \\ A \qquad C \end{array} \Rightarrow AC_{16} \text{ Ans.}$$

f) 10111011

$$\begin{array}{r} \underline{1011} \\ B \end{array} \quad \begin{array}{r} \underline{1011} \\ B \end{array} \Rightarrow BB_{16} \text{ Ans.}$$

39. Convert each hexadecimal number to decimal.

a) 42_{16}

$$\begin{array}{r} 4 \\ \overbrace{0100} \\ 2 \\ \overbrace{0010} \end{array}$$

$$\Rightarrow (0 \times 2^7) + (1 \times 2^6) + (0 \times 2^5) + (0 \times 2^4) + \\ (0 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$$

$$\Rightarrow 64 + 2$$

$$\Rightarrow 66_{10} \text{ Ans.}$$

b) 64_{16}

$$\begin{array}{r} 6 \\ \overbrace{0110} \\ 4 \\ \overbrace{0100} \end{array}$$

$$\Rightarrow (1 \times 2^6) + (1 \times 2^5) + (1 \times 2^2)$$

$$\Rightarrow 64 + 32 + 4$$

$$\Rightarrow 100_{10} \text{ Ans.}$$

c) $2B_{16}$

$$\begin{array}{r} 2 \\ \overline{0010} \end{array} \quad \begin{array}{r} B \\ \overline{1011} \end{array}$$

$$\begin{aligned} &\Rightarrow (1 \times 2^5) + (1 \times 2^3) + (1 \times 2^1) + (1 \times 2^0) \\ &\Rightarrow 32 + 8 + 2 + 1 \\ &\Rightarrow 43_{10} \text{ Ans.} \end{aligned}$$

d) $4D_{16}$

$$\begin{array}{r} 4 \\ \overline{0100} \end{array} \quad \begin{array}{r} D \\ \overline{1101} \end{array}$$

$$\begin{aligned} &\Rightarrow (1 \times 2^6) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^0) \\ &\Rightarrow 64 + 8 + 4 + 1 \\ &\Rightarrow 77_{10} \text{ Ans.} \end{aligned}$$

e) BC_{16}

$$\begin{array}{r} B \\ \overline{1011} \end{array} \quad \begin{array}{r} C \\ \overline{1100} \end{array}$$

$$\begin{aligned} &\Rightarrow (1 \times 2^7) + (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) \\ &\Rightarrow 128 + 32 + 16 + 8 + 4 \\ &\Rightarrow 188_{10} \text{ Ans.} \end{aligned}$$

f) FF_{16}

$$\begin{array}{r} F \\ \overline{1111} \end{array} \quad \begin{array}{r} F \\ \overline{1111} \end{array}$$

$$\begin{aligned} &\Rightarrow (1 \times 2^7) + (1 \times 2^6) + (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + \\ &\quad (1 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) \end{aligned}$$

$$\Rightarrow 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 \\ \Rightarrow 255_{10} \text{ Ans.}$$

g) $6F1_{16}$

$$\begin{array}{r} 6 \\ \overline{0110} \end{array} \quad \begin{array}{r} F \\ \overline{1111} \end{array} \quad \begin{array}{r} 1 \\ \overline{0001} \end{array}$$

$$\Rightarrow (1 \times 2^{10}) + (1 \times 2^9) + (1 \times 2^7) + (1 \times 2^6) + \\ (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^0) \\ \Rightarrow 1024 + 512 + 128 + 64 + 32 \\ + 16 + 1 \\ \Rightarrow 1777_{10} \text{ Ans.}$$

h) ABC_{16}

$$\begin{array}{r} A \\ \overline{1010} \end{array} \quad \begin{array}{r} B \\ \overline{1011} \end{array} \quad \begin{array}{r} C \\ \overline{1100} \end{array}$$

$$\Rightarrow (1 \times 2^{11}) + (1 \times 2^9) + (1 \times 2^7) + (1 \times 2^5) + \\ (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) \\ \Rightarrow 2048 + 512 + 128 + \cancel{64} + 32 + 16 \\ + 8 + 4 \\ \Rightarrow 2748_{10} \text{ Ans.}$$

40. Convert each decimal number to hexadecimal.

a) 10

$$\Rightarrow \frac{10}{16} = 0.625 \Rightarrow 0.625 \times 16 = 10$$

$$\Rightarrow 10_{10} = A_{16} \text{ Ans.}$$

b) 15

$$\Rightarrow \frac{15}{16} = 0.9375 \Rightarrow 0.9375 \times 16 = 15$$

$$\Rightarrow 15_{10} = F_{16} \text{ Ans.}$$

c) 32

$$\Rightarrow \frac{32}{16} = 2.0 \Rightarrow 0 \times 16 = 0$$

$$\Rightarrow \frac{2}{16} = 0.125 \Rightarrow 0.125 \times 16 = 2$$

$$\Rightarrow 32_{10} = 20_{16} \text{ Ans.}$$

d) 365

$$\Rightarrow \frac{365}{16} = 22.8125 \Rightarrow 0.8125 \times 16 = 13 (\text{D})$$

$$\Rightarrow \frac{22}{16} = 1.375 \Rightarrow 0.375 \times 16 = 6$$

$$\Rightarrow \frac{1}{16} = 0.0625 \Rightarrow 0.0625 \times 16$$

$$\Rightarrow 365_{10} = \underline{\underline{664}}_{16} \text{ Ans.}$$

e) 54

$$\Rightarrow \frac{54}{16} = 3.375 \Rightarrow 0.375 \times 16$$

$$\Rightarrow \frac{3}{16} = 0.1875 \Rightarrow 0.1875 \times 16$$

$$\Rightarrow 54_{10} = \underline{\underline{63}}_{16} \text{ Ans.}$$

f) 3652

$$\Rightarrow \frac{3652}{16} = 228.25 \Rightarrow 0.25 \times 16$$

$$\Rightarrow \frac{228}{16} = 14.25 \Rightarrow 0.25 \times 16$$

$$\Rightarrow \frac{14}{16} = 0.875 \Rightarrow 0.875 \times 16$$

$$\Rightarrow 3652_{10} = E44_{16} \text{ Ans.}$$

g) 7825

$$\Rightarrow \frac{7825}{16} = 489.0625 \Rightarrow 0.0625 \times 16$$

$$\Rightarrow \frac{489}{16} = 30.5625 \Rightarrow 0.5625 \times 16$$

$$\Rightarrow \frac{30}{16} = 1.875 \Rightarrow 0.875 \times 16 \\ = 14 \text{ (E)}$$

$$\Rightarrow \frac{1}{16} = 0.0625 \Rightarrow 0.0625 \times 16 \\ = 1$$

$$\Rightarrow 7825_{10} = 1E91_{16} \text{ Ans.}$$

b) 8925

$$\Rightarrow \frac{8925}{16} = 557.8125 \Rightarrow 0.8125 \times 16 \\ = 13 \text{ (D)}$$

$$\Rightarrow \frac{557}{16} = 34.8125 \Rightarrow 0.8125 \times 16 \\ = 13 \text{ (D)}$$

$$\Rightarrow \frac{34}{16} = 2.125 \Rightarrow 0.125 \times 16 \\ = 2$$

$$\Rightarrow \frac{2}{16} = 0.125 \Rightarrow 0.125 \times 16 \\ = 2$$

$$\Rightarrow 8925 = 22DD_{16} \text{ Ans.}$$

41. Perform following addition.

a) $25_{16} + 33_{16}$

$$\begin{array}{r} 25_{16} \\ + 33_{16} \\ \hline 68_{16} \end{array}$$

b) $43_{16} + 62_{16}$

$$\begin{array}{r} 43_{16} \\ + 62_{16} \\ \hline A5_{16} \end{array}$$

$10 \equiv A$

c) $AH_{16} + F5_{16}$

$$\begin{array}{r} AH_{16} \\ + F5_{16} \\ \hline 199_{16} \end{array}$$

$$10+15=25$$

$$25-16=9$$

d) $FC_{16} + AE_{16}$

$$\begin{array}{r} FC_{16} \\ + AE_{16} \\ \hline 1AA_{16} \end{array}$$

$$12+14=26$$

$$26-16=10$$

$$10+15=25 \quad 26-16=10$$

42. Perform the following subtraction.

a) $60_{16} - 39_{16}$

$$\begin{array}{r} 60_{16} \\ - 39_{16} \\ \hline \end{array}$$

2's complement of 39
 $\Rightarrow 39_{16} = 0011\ 1001_2$
 $\Rightarrow 11000110$

$$\begin{array}{r} + 1 \\ \hline 11000111 \end{array} = C7_{16}$$

$$\begin{array}{r} 60_{16} \\ + C7_{16} \\ \hline 127_{16} \end{array}$$

Ans.
 $6+12=18$
 $18-16=2$ 1 carry.

b) $AB_{16} - 98_{16}$

$$\Rightarrow 98_{16} = 1001\ 1000$$

2's complement of 98_{16}

$$0110'0'1'11$$

$$\begin{array}{r} + 1 \\ \hline 01101000 \end{array} = 68_{16}$$

$$\Rightarrow \begin{array}{r} A5_{16} \\ + 68_{16} \\ \hline 10D_{16} \text{ Ans.} \end{array} \quad \begin{array}{l} 5+8=13 \\ 10+6=16 \\ 16-16=0 \end{array} \quad \begin{array}{l} 1 \text{ carry} \\ \dots \end{array}$$

c) $F1_{16} - A6_{16}$

$$\Rightarrow A6_{16} = 101000110$$

2's complement of $A6_{16}$

$$01011001$$

$$\begin{array}{r} + 1 \\ \hline 01011010 = 5A_{16} \end{array}$$

$$\Rightarrow F1_{16}$$

$$+ 5A_{16}$$

$$\overrightarrow{14B_{16}} \text{ Ans.}$$

$$10+1=11$$

$$15+5=20$$

$$20-16=4 \quad 1 \text{ carry}$$

d) $AC_{16} - 10_{16}$

$$\Rightarrow 10_{16} = 00010000_2$$

2's complement of 10_{16}

$$1110111111$$

$$\begin{array}{r} + 1 \\ \hline 11110000 = FO_{16} \end{array}$$

$$\Rightarrow A C_{16}$$

$$+ FO_{16}$$

$$\overrightarrow{19C_{16}} \text{ Ans.}$$

$$10+15=25$$

$$25-16=9$$

1 carry

OCTAL NUMBERS:-

Example 2.31

Convert following to binary.

a) 13_8

$$\begin{array}{r} 1 \\ \times \\ \hline 001 \end{array} \quad \begin{array}{r} 3 \\ \times \\ \hline 0101 \end{array}$$

$$\Rightarrow 13_8 = 00101_2 \text{ Ans.}$$

b) 25_8

$$\begin{array}{r} 2 \\ \times \\ \hline 010 \end{array} \quad \begin{array}{r} 5 \\ \times \\ \hline 0101 \end{array}$$

$$\Rightarrow 25_8 = 010101_2 \text{ Ans}$$

c) 140_8

$$\begin{array}{r} 1 \\ \times \\ \hline 001 \end{array} \quad \begin{array}{r} 4 \\ \times \\ \hline 100 \end{array} \quad \begin{array}{r} 0 \\ \times \\ \hline 000 \end{array}$$

$$\Rightarrow 140_8 = 001100000_2 \text{ Ans.}$$

d) 7526_8

$$\begin{array}{r} 7 \\ \times \\ \hline 111 \end{array} \quad \begin{array}{r} 5 \\ \times \\ \hline 101 \end{array} \quad \begin{array}{r} 2 \\ \times \\ \hline 010 \end{array} \quad \begin{array}{r} 6 \\ \times \\ \hline 110 \end{array}$$

$$\Rightarrow 7526_8 = 111101010110_2 \text{ Ans.}$$

Example 2.32

Convert following binary numbers to octal.

a) 110101

$$\begin{array}{r} 110 \quad 101 \\ \hline 6 \quad 5 \end{array}$$

$$= 65_8 \text{ Ans.}$$

b) 101111001

$$\begin{array}{r} 101 \quad 111 \quad 001 \\ \hline 5 \quad 7 \quad 1 \end{array} = 571_8 \text{ Ans.}$$

c) 100110011010

$$\begin{array}{r} 100 \quad 110 \quad 011 \quad 010 \\ \hline 4 \quad 6 \quad 3 \quad 2 \end{array}$$

$$= 4632_8 \text{ Ans.}$$

d) 11010000100

$$\begin{array}{r} 1000 \quad 0100 \\ \hline 011 \quad 010 \quad 000 \quad 100 \\ \hline 3 \quad 2 \quad 0 \quad 4 \\ \hline \end{array}$$
$$= 3204_8 \text{ Ans.}$$

Section 2.9

43. Convert each octal number to decimal.

a) 14_8

$$\Rightarrow (1 \times 8^1) + (4 \times 8^0)$$

$$\Rightarrow 8 + 4$$

$$\Rightarrow 12_{10} \text{ Ans.}$$

b) 53_8

$$\Rightarrow (5 \times 8^1) + (3 \times 8^0)$$

$$\Rightarrow (5 \times 8) + (3 \times 1) = 40 + 3$$

$$\Rightarrow 43_{10} \text{ Ans.}$$

c) 67_8

$$\Rightarrow (6 \times 8^1) + (7 \times 8^0)$$

$$\Rightarrow (6 \times 8) + (7 \times 1) = 48 + 7$$

$$\Rightarrow 55_{10} \text{ Ans.}$$

d) 174_8

$$\Rightarrow (1 \times 8^2) + (7 \times 8^1) + (4 \times 8^0)$$

$$\Rightarrow 64 + 56 + 4$$

$$\Rightarrow 124_{10} \text{ Ans.}$$

e) 635_8

$$\Rightarrow (6 \times 8^2) + (3 \times 8^1) + (5 \times 8^0)$$
$$\Rightarrow 384 + 24 + 5$$
$$\Rightarrow 413_{10} \text{ Ans.}$$

f) 254_8

$$\Rightarrow (2 \times 8^2) + (5 \times 8^1) + (4 \times 8^0)$$
$$\Rightarrow 128 + 40 + 4$$
$$\Rightarrow 172_{10} \text{ Ans.}$$

g) 2673_8

$$\Rightarrow (2 \times 8^3) + (6 \times 8^2) + (7 \times 8^1) + (3 \times 8^0)$$
$$\Rightarrow 1024 + 384 + 56 + 3$$
$$\Rightarrow 1467_{10} \text{ Ans.}$$

h) 7777_8

$$\Rightarrow (7 \times 8^3) + (7 \times 8^2) + (7 \times 8^1) + (7 \times 8^0)$$
$$\Rightarrow 3584 + 448 + 56 + 7$$
$$\Rightarrow 4095_{10} \text{ Ans.}$$

44. Convert each decimal number to octal by repeated division by 8.

a) 23

$$\Rightarrow \frac{23}{8} = 2.875 \Rightarrow 0.875 \times 8 \\ = 7$$

$$\Rightarrow \frac{2}{8} = 0.25 \Rightarrow 0.25 \times 8 \\ = 2$$

$$\Rightarrow 23_{10} = 27_8 \text{ Ans.}$$

b) 45

$$\Rightarrow \frac{45}{8} = 5.625 \Rightarrow 0.625 \times 8 \\ = 5$$

$$\Rightarrow \frac{5}{8} = 0.625 \Rightarrow 0.625 \times 8 \\ = 5$$

$$\Rightarrow 45_{10} = 55_8 \text{ Ans.}$$

c) 65

$$\Rightarrow \frac{65}{8} = 8.125 \Rightarrow 0.125 \times 8 \\ = 1$$

$$\Rightarrow \frac{8}{8} = 1.0 \Rightarrow 0.0 \times 8 \\ = 0$$

$$\Rightarrow \frac{1}{8} = 0.125 \Rightarrow 0.125 \times 8 \\ = 1$$

$$\Rightarrow 65_{10} = 101_8 \text{ Ans.}$$

d) 84

$$\Rightarrow \frac{84}{8} = 10.5 \Rightarrow 0.5 \times 8 \\ = 4$$

$$\Rightarrow \frac{10}{8} = 1.25 \Rightarrow 0.25 \times 8 \\ = 2$$

$$\Rightarrow \frac{1}{8} = 0.125 \Rightarrow 0.125 \times 8 \\ = 1$$

$$\Rightarrow 84_{10} = 124_8 \text{ Ans.}$$

e) 124

$$\Rightarrow \frac{124}{8} = 15.5 \Rightarrow 0.5 \times 8 \\ = 4$$

$$\Rightarrow \frac{15}{8} = 1.875 \Rightarrow 0.875 \times 8 \\ = 7$$

$$\Rightarrow \frac{1}{8} = 0.125 \Rightarrow 0.125 \times 8 \\ = 1$$

$$\Rightarrow 124_{10} = 174_8 \text{ Ans.}$$

f) 156

$$\Rightarrow \frac{156}{8} = 19.5 \Rightarrow 0.5 \times 8 \\ = 4$$

$$\Rightarrow \frac{19}{8} = 2.375 \Rightarrow 0.375 \times 8 \\ = 3$$

$$\Rightarrow \frac{2}{8} = 0.25 \Rightarrow 0.25 \times 8 \\ = 2$$

$$\Rightarrow 156_{10} = 234_8 \text{ Ans.}$$

g) $\frac{654}{8} = 81.75 \Rightarrow 0.75 \times 8 = 6$

$\Rightarrow \frac{81}{8} = 10.125 \Rightarrow 0.125 \times 8 = 1$

$\Rightarrow \frac{10}{8} = 1.25 \Rightarrow 0.25 \times 8 = 2$

$\Rightarrow \frac{1}{8} = 0.125 \Rightarrow 0.125 \times 8 = 1$

$\Rightarrow 654_{10} = 12\overset{1}{\$}6_8 \text{ Ans.}$

h) 9999

$\Rightarrow \frac{9999}{8} = 1249.875 \Rightarrow 0.875 \times 8 = 7$

$\Rightarrow \frac{1249}{8} = 156.125 \Rightarrow 0.125 \times 8 = 1$

$\Rightarrow \frac{156}{8} = 19.5 \Rightarrow 0.5 \times 8 = 4$

$\Rightarrow \frac{19}{8} = 2.375 \Rightarrow 0.375 \times 8 = 3$

$\Rightarrow \frac{2}{8} = 0.25 \Rightarrow 0.25 \times 8 = 2$

$\Rightarrow 9999_{10} = 23417_8 \text{ Ans.}$

45. Convert each octal number into binary.

a) 17_8

$$\Rightarrow \begin{array}{r} 1 \\ \overline{001} \end{array} \quad \begin{array}{r} 7 \\ \overline{111} \end{array}$$

$$\Rightarrow 17_8 = 001111_2 \text{ Ans.}$$

b) 26_8

$$\Rightarrow \begin{array}{r} 2 \\ \overline{010} \end{array} \quad \begin{array}{r} 6 \\ \overline{110} \end{array}$$

$$\Rightarrow 26_8 = 010110_2 \text{ Ans.}$$

c) 145_8

$$\Rightarrow \begin{array}{r} 1 \\ \overline{001} \end{array} \quad \begin{array}{r} 4 \\ \overline{100} \end{array} \quad \begin{array}{r} 5 \\ \overline{101} \end{array}$$

$$\Rightarrow 145_8 = 001100101_2 \text{ Ans.}$$

d) 456_8

$$\Rightarrow \begin{array}{r} 4 \\ \overline{100} \end{array} \quad \begin{array}{r} 5 \\ \overline{101} \end{array} \quad \begin{array}{r} 6 \\ \overline{110} \end{array}$$

$$\Rightarrow 456_8 = 100101110_2 \text{ Ans.}$$

e) 653_8

$$\Rightarrow \begin{array}{r} 6 \\ \hline 110 \end{array} \quad \begin{array}{r} 5 \\ \hline 101 \end{array} \quad \begin{array}{r} 3 \\ \hline 0101 \end{array}$$

$$\Rightarrow 653_8 = 110101011_2 \text{ Ans.}$$

f) 777_8

$$\Rightarrow \begin{array}{r} 7 \\ \hline 111 \end{array} \quad \begin{array}{r} 7 \\ \hline 111 \end{array} \quad \begin{array}{r} 7 \\ \hline 111 \end{array}$$

$$\Rightarrow 777_8 = 111111111_2 \text{ Ans.}$$

46. Convert each binary number to octal.

a) 100
 $\Rightarrow 100_2 = 4_8$ Ans.

b) 110
 $\Rightarrow 110_2 = 6_8$ Ans.

c) 1100
 $\Rightarrow \begin{array}{r} 001 \\ \hline 1 \end{array} \quad \begin{array}{r} 100 \\ \hline 4 \end{array} \Rightarrow 14_8$ Ans.

d) 1111
 $\Rightarrow \begin{array}{r} 001 \\ \hline 1 \end{array} \quad \begin{array}{r} 111 \\ \hline 7 \end{array} = 17_8$ Ans.

e) 11001
 $\Rightarrow \begin{array}{r} 011 \\ \hline 3 \end{array} \quad \begin{array}{r} 001 \\ \hline 1 \end{array} = 31_8$ Ans.

f) 11110
 $\Rightarrow \begin{array}{r} 0111 \\ \hline 3 \end{array} \quad \begin{array}{r} 110 \\ \hline 6 \end{array} = 36_8$ Ans.

8) ~~1~~ 10011
 $\Rightarrow \begin{array}{r} 110 \\ \hline 6 \end{array} \quad \begin{array}{r} 011 \\ \hline 3 \end{array} = 63_8 \text{ Ans.}$

b) 101010
 $\Rightarrow \begin{array}{r} 101 \\ \hline 5 \end{array} \quad \begin{array}{r} 010 \\ \hline 2 \end{array} = 52_8 \text{ Ans.}$

i) 10101111
 $\Rightarrow \begin{array}{r} 010 \\ \hline 2 \end{array} \quad \begin{array}{r} 101 \\ \hline 5 \end{array} \quad \begin{array}{r} 111 \\ \hline 7 \end{array} = 257_8 \text{ Ans.}$

BINARY CODED DECIMAL (BCD) :-

Example 2.33

Convert following decimal numbers to BCD.

a) 35

$$\Rightarrow \begin{array}{r} 3 \\ \hline 0011 \end{array} \quad \begin{array}{r} 5 \\ \hline 0101 \end{array}$$

b) 98

$$\begin{array}{r} 9 \\ \hline 1001 \end{array} \quad \begin{array}{r} 8 \\ \hline 1000 \end{array}$$

c) 170

$$\begin{array}{r} 1 \\ \underline{7} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{111} \\ 0111 \end{array} \quad \begin{array}{r} 0 \\ \underline{0000} \\ 0000 \end{array}$$

d) 2469

$$\begin{array}{r} 2 \\ \underline{4} \\ 0010 \end{array} \quad \begin{array}{r} 4 \\ \underline{100} \\ 0100 \end{array} \quad \begin{array}{r} 6 \\ \underline{110} \\ 0110 \end{array} \quad \begin{array}{r} 9 \\ \underline{001} \\ 1001 \end{array}$$

Example 2.34

Convert following BCD to decimal.

a) 10000110

$$\begin{array}{r} 1000 \quad 0110 \\ \hline 8 \quad 6 \end{array} = 86$$

b) 001101010001

$$\begin{array}{r} 0011 \quad 0101 \quad 0001 \\ \hline 3 \quad 5 \quad 1 \\ = 351 \end{array}$$

c) 1001010001110000

$$\begin{array}{r} 1001 \quad 0100 \quad 0111 \quad 0000 \\ \hline 9 \quad 4 \quad 7 \quad 0 \\ \Rightarrow 9470 \end{array}$$

Example 2.35

Add the following BCD numbers

a) $0011 + 0100$

$$\begin{array}{r} 0011 \\ + 0100 \\ \hline 0111 \end{array}$$

b) $00100011 + 00010101$

$$\begin{array}{r} 0010 \quad '00'11 \\ + 0001 \quad 0101 \\ \hline 0011 \quad 1000 \end{array}$$

c) $10000110 + 00010011$

$$\begin{array}{r} 1000 \quad '0'110 \\ + 0001 \quad 0011 \\ \hline 1001 \quad 1001 \end{array}$$

d) $010001010000 + 010000010111$

$$\begin{array}{r} '0100 \quad 01'01 \quad 0000 \\ + 0100 \quad 0001 \quad 0111 \\ \hline 1000 \quad 0110 \quad 0111 \end{array}$$

Example 2.36

Add following BCD numbers.

a) $1001 + 0100$

1001

$+ 0100$

$\hline 1101$

Invalid BCD.

$+ 0110$

Add 6

$\hline 0001 \quad 0011$

Valid.

b) $1001 + 1001$

1001

$+ 1001$

$\hline 1 \quad '0'010$

Invalid

$+ 0110$

Add 6

$\hline 0001 \quad 10000$

c) $00010110 + 00010101$

0001

$'0110$

$+ 0001$

0101

0010

$'1'011$

$+ 0110$

$\hline 0011 \quad 0001$

Add 6

d) $01100111 + 01010011$

$$\begin{array}{r}
 0110 \quad 0111 \\
 + 0111 \quad 0011 \\
 \hline
 1000
 \end{array}$$

$$\begin{array}{r}
 0110 \quad 0111 \\
 + 0101 \quad 0011 \\
 \hline
 11011 \quad 1010
 \end{array}$$

$$\begin{array}{r}
 + 0110 \quad + 0110 \\
 \hline
 0001 \quad 0010 \quad 0000
 \end{array}$$

Section 2.10

47. Convert each of the following decimal numbers to 8421 BCD.

a) 10

$$\Rightarrow \begin{array}{r}
 1 \\
 \hline
 0001
 \end{array} \quad \begin{array}{r}
 0 \\
 \hline
 0000
 \end{array}$$

b) 13

$$\begin{array}{r}
 1 \\
 \hline
 0001
 \end{array} \quad \begin{array}{r}
 3 \\
 \hline
 0011
 \end{array}$$

c) 18

$$\Rightarrow \begin{array}{r} 1 \\ \hline 0001 \end{array} \quad \begin{array}{r} 8 \\ \hline 1000 \end{array}$$

d) 21

$$\Rightarrow \begin{array}{r} 2 \\ \hline 0010 \end{array} \quad \begin{array}{r} 1 \\ \hline 0001 \end{array}$$

e) 25

$$\Rightarrow \begin{array}{r} 2 \\ \hline 0010 \end{array} \quad \begin{array}{r} 5 \\ \hline 0101 \end{array}$$

f) 36

$$\Rightarrow \begin{array}{r} 3 \\ \hline 0011 \end{array} \quad \begin{array}{r} 6 \\ \hline 0110 \end{array}$$

g) 44

$$\Rightarrow \begin{array}{r} 4 \\ \hline 0100 \end{array} \quad \begin{array}{r} 4 \\ \hline 0100 \end{array}$$

h) 57

$$\Rightarrow \begin{array}{r} 5 \\ \hline 0101 \end{array} \quad \begin{array}{r} 7 \\ \hline 0111 \end{array}$$

i) 69

$$\Rightarrow \begin{array}{r} 6 \\ \hline 0110 \end{array} \quad \begin{array}{r} 9 \\ \hline 1001 \end{array}$$

$$\begin{array}{r} 6 \\ \hline 0110 \end{array} \quad \begin{array}{r} 9 \\ \hline 1001 \end{array}$$

j) 98

$$\Rightarrow \begin{array}{r} 9 \\ \hline 1001 \end{array} \quad \begin{array}{r} 8 \\ \hline 1000 \end{array}$$

k) 125

$$\Rightarrow \begin{array}{r} 1 \\ \hline 0001 \end{array} \quad \begin{array}{r} 2 \\ \hline 0010 \end{array} \quad \begin{array}{r} 5 \\ \hline 0101 \end{array}$$

l) 156

$$\Rightarrow \begin{array}{r} 1 \\ \hline 0001 \end{array} \quad \begin{array}{r} 5 \\ \hline 0101 \end{array} \quad \begin{array}{r} 6 \\ \hline 0110 \end{array}$$

48. Convert into binary.

a) 10

$$\begin{array}{r} 10 \\ 2 \Big| \\ 5 - 0 \\ 2 \Big| \\ 2 - 1 \\ 2 \Big| \\ 1 - 0 \end{array}$$

$$\Rightarrow 1010_2$$

4 bits binary

8 bits BCD

b) 13

$$\begin{array}{r} 13 \\ 2 \Big| \\ 6 - 1 \\ 2 \Big| \\ 3 - 0 \\ 1 - 1 \end{array}$$

$$\Rightarrow 1101_2$$

4 bits binary

8 bits BCD

c) 18

$$\begin{array}{r} 18 \\ 2 \Big| \\ 9 - 0 \\ 2 \Big| \\ 4 - 1 \\ 2 \Big| \\ 2 - 0 \\ 1 - 0 \end{array}$$

$$\Rightarrow 10010_2$$

5 bits binary

8 bits BCD

d) 21

$$\begin{array}{r} 21 \\ 2 \Big| \\ 10 - 1 \\ 2 \Big| \\ 5 - 0 \\ 2 \Big| \\ 2 - 1 \\ 1 - 0 \end{array}$$

$$\Rightarrow 10101_2$$

5 bits binary

8 bits BCD

e) 25

$$\begin{array}{r} 25 \\ 2 \Big| 12 - 1 \\ 2 \Big| 6 - 0 \\ 2 \Big| 3 - 0 \\ 2 \Big| 1 - 1 \end{array}$$

$$\Rightarrow \cancel{1} \cancel{0} 11001_2$$

5 bits binary
8 bits BCD

f) 36

$$\begin{array}{r} 36 \\ 2 \Big| 18 - 0 \\ 2 \Big| 9 - 0 \\ 2 \Big| 4 - 1 \\ 2 \Big| 2 - 0 \\ 1 - 0 \end{array}$$

$$\Rightarrow 100100_2$$

6 bits binary
8 bits BCD.

g) 44

$$\begin{array}{r} 44 \\ 2 \Big| 22 - 0 \\ 2 \Big| 11 - 0 \\ 2 \Big| 5 - 1 \\ 2 \Big| 2 - 1 \\ 1 - 0 \end{array}$$

$$\Rightarrow 101100_2$$

6 bits binary
8 bits BCD.

h) 57

$$\begin{array}{r} 57 \\ 2 \Big| 28 - 1 \\ 2 \Big| 14 - 0 \\ 2 \Big| 7 - 0 \\ 2 \Big| 3 - 1 \\ 1 - 1 \end{array}$$

$$\Rightarrow 111001_2$$

6 bits binary
8 bits BCD.

i) 69

$$\begin{array}{r}
 69 \\
 2 \Big| 69 \\
 2 \quad 34 - 1 \\
 2 \quad 17 - 0 \\
 2 \quad 8 - 1 \\
 2 \quad 4 - 0 \\
 2 \quad 2 - 0 \\
 2 \quad 1 - 0
 \end{array}$$

$\Rightarrow 1000101_2$
7 bits binary
8 bits BCD

j) 98

$$\begin{array}{r}
 98 \\
 2 \Big| 98 \\
 2 \quad 49 - 0 \\
 2 \quad 24 - 1 \\
 2 \quad 12 - 0 \\
 2 \quad 6 - 0 \\
 2 \quad 3 - 0 \\
 2 \quad 1 - 1
 \end{array}$$

$\Rightarrow 1100010_2$
7 bits binary
8 bits BCD

k) 125

$$\begin{array}{r}
 125 \\
 2 \Big| 125 \\
 2 \quad 62 - 1 \\
 2 \quad 31 - 0 \\
 2 \quad 15 - 1 \\
 2 \quad 7 - 1 \\
 2 \quad 3 - 1 \\
 2 \quad 1 - 1
 \end{array}$$

$\Rightarrow 100111101_2$
7 bits binary
12 bits BCD

l) 156

$$\begin{array}{r}
 156 \\
 2 \Big| 156 \\
 2 \quad 78 - 0 \\
 2 \quad 39 - 0 \\
 2 \quad 19 - 1 \\
 2 \quad 9 - 1 \\
 2 \quad 4 - 1 \\
 2 \quad 2 - 0 \\
 2 \quad 1 - 0
 \end{array}$$

$\Rightarrow 10011100_2$
8 bits binary
12 bits BCD

49. Convert following decimal numbers to BCD.

a) 104

$$\Rightarrow \begin{array}{r} 1 \\ \underline{0} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{0000} \\ 0000 \end{array} \quad \begin{array}{r} 4 \\ \underline{0100} \\ 0100 \end{array}$$

b) 128

$$\Rightarrow \begin{array}{r} 1 \\ \underline{2} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{0010} \\ 0010 \end{array} \quad \begin{array}{r} 8 \\ \underline{1000} \\ 1000 \end{array}$$

c) 132

$$\Rightarrow \begin{array}{r} 1 \\ \underline{3} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{0011} \\ 0011 \end{array} \quad \begin{array}{r} 2 \\ \underline{0010} \\ 0010 \end{array}$$

d) 150

$$\Rightarrow \begin{array}{r} 1 \\ \underline{5} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{0101} \\ 0101 \end{array} \quad \begin{array}{r} 0 \\ \underline{0000} \\ 0000 \end{array}$$

e) 186

$$\Rightarrow \begin{array}{r} 1 \\ \underline{8} \\ 0001 \end{array} \quad \begin{array}{r} 0 \\ \underline{1000} \\ 1000 \end{array} \quad \begin{array}{r} 6 \\ \underline{0110} \\ 0110 \end{array}$$

f) $\begin{array}{r} 210 \\ 2 \quad 1 \quad 0 \\ \Rightarrow 0010 \quad 0001 \quad 0000 \end{array}$

g) $\begin{array}{r} 359 \\ 3 \quad 5 \quad 9 \\ \Rightarrow 0011 \quad 0101 \quad 1001 \end{array}$

h) $\begin{array}{r} 547 \\ 5 \quad 4 \quad 7 \\ \Rightarrow 0101 \quad 0100 \quad 01\cancel{1}11 \end{array}$

i) $\begin{array}{r} 1051 \\ 1 \quad 0 \quad 5 \quad 1 \\ \Rightarrow 0001 \quad 0000 \quad 0101 \quad 0001 \end{array}$

50. Convert each BCD to decimal -

a) 0001
 $\Rightarrow 1$ Ans.

b) 0110
 $\Rightarrow 5$ Ans.

c) 1001
 $\Rightarrow 9$ Ans.

d) 00011000
 $\Rightarrow 00011000$
 $\Rightarrow 18$ Ans-

e) 00011001
⇒ 0001 1001
⇒ 19 Ans.

f) 00110010
⇒ 0011 0010
⇒ 32 Ans.

g) 0100 0101
⇒ 0100 0101
⇒ 4 5 Ans.

h) 1001 1000
⇒ 1001 1000
⇒ 98 Ans.

i) 100001110000
⇒ 1000 0111 0000
⇒ 8 70 Ans.

51. Convert each BCD number to decimal.

a) 10000000
⇒ 1000 0000
⇒ 80 Ans.

b) 001000110111
⇒ 0010 0011 0111
⇒ 237 Ans.

c) 001101000110

⇒ 0011 0100 0110

⇒ 346 Ans.

d) 010000100001

⇒ 0100 0010 0001

⇒ 421 Ans.

e) 011101010100

⇒ 0111 0101 0100

⇒ 754 Ans.

f) 100000000000

⇒ 1000 0000 0000

⇒ 800 Ans.

g) 100101111000

⇒ 1001 0111 1000

⇒ 978 Ans.

h) 0001011010000011

⇒ 0001 0110 1000 0011

⇒ 1683 Ans.

i) 1001000000011000

⇒ 1001 0000 0001 1000

⇒ 9018 Ans.

j) 0110011001100111

⇒ 0110 0110 0110 0111

⇒ 6667 Ans.

52. Add the following BCD numbers.

a) $0010 + 0001$

$$\begin{array}{r} 0010 \\ + 0001 \\ \hline 0011 \end{array}$$

b) $0101 + 0011$

$$\begin{array}{r} 0101 \\ + 0011 \\ \hline 1000 \end{array}$$

c) $0111 + 0010$

$$\begin{array}{r} 0111 \\ + 0010 \\ \hline 1001 \end{array}$$

d) $1000 + 0001$

$$\begin{array}{r} 1000 \\ + 0001 \\ \hline 1001 \end{array}$$

e) $00011000 + 00010001$

$$\begin{array}{r} 0001 \\ + 0001 \\ \hline 0010 \end{array} \quad \begin{array}{r} 1000 \\ + 0001 \\ \hline 1001 \end{array}$$

f) $01100100 + 00110011$

$$\begin{array}{r}
 01100100 \\
 0110 \quad 0100 \\
 + 0011 \quad 0011 \\
 \hline
 1001 \quad 0111
 \end{array}$$

g) $01000000 + 01000111$

$$\begin{array}{r}
 01000000 \\
 0100 \quad 0000 \\
 + 0100 \quad 0111 \\
 \hline
 1000 \quad 0111
 \end{array}$$

h) $10000101 + 00010011$

$$\begin{array}{r}
 1000 \quad 10101 \\
 + 0001 \quad 0011 \\
 \hline
 1001 \quad 1000
 \end{array}$$

53. Add following BCD numbers.

a) $1000 + 0110$

1000

$+ 0110$

$\hline 11110$

Invalid

$+ 0110$

Add G

$\hline 00100000$

Ans:

b) $0111 + 0101$

$$\begin{array}{r} 0111 \\ + 0101 \\ \hline 11100 \end{array}$$

Invalid

$$\begin{array}{r} 11100 \\ + 0110 \\ \hline 00010010 \end{array}$$

Add 6

c) $1001 + 1000$

$$\begin{array}{r} 1001 \\ + 1000 \\ \hline 00010001 \end{array}$$

Invalid.

$$\begin{array}{r} 00010001 \\ + 0110 \\ \hline 0111 \end{array}$$

Add 6.

d) $1001 + 0111$

$$\begin{array}{r} 1001 \\ + 0111 \\ \hline 0000 \end{array}$$
$$\begin{array}{r} 0000 \\ + 0110 \\ \hline 00010110 \end{array}$$

Invalid

Add 6

e) $00100101 + 00100111$

$$\begin{array}{r}
 00100101 \\
 + 00100111 \\
 \hline
 0100'0 1100 \\
 + 0110 \\
 \hline
 0101 0010
 \end{array}$$

f) $01010001 + 01011000$

$$\begin{array}{r}
 0101 0001 \\
 + 0101 1000 \\
 \hline
 1'010 1001 \\
 + 0110 \\
 \hline
 0001 0000 1001
 \end{array}$$

g) $10011000 + 10010111$

$$\begin{array}{r}
 1001 1000 \\
 + 1001 0111 \\
 \hline
 0001 0010 1'111 \\
 + 0110 \\
 \hline
 0001 0011 0101
 \end{array}$$

b) $010101100001 + 011100001000$

$$\begin{array}{r}
 '01'01 \quad 0110 \quad 0001 \\
 + 0111 \quad 0000 \quad 1000 \\
 \hline
 '1100 \quad 0110 \quad 1001 \\
 + 0110 \\
 \hline
 0001 \quad 0010 \quad 0110 \quad 1001
 \end{array}$$

54. Convert each pair of decimal numbers to BCD, and add as indicated.

a) $4 + 3$

$$\Rightarrow 4 = 0100, 3 = 0011$$

$$\begin{array}{r}
 0100 & & 4 \\
 + 0011 & & + 3 \\
 \hline
 0111 & & 7
 \end{array}$$

b) $5 + 2$

$$\Rightarrow 5 = 0101, 2 = 0010$$

$$\begin{array}{r}
 0101 & & 5 \\
 + 0010 & & + 2 \\
 \hline
 0111 & & 7
 \end{array}$$

c) $6 + 4$

$$\Rightarrow 6 = 0110, 4 = 0100$$
$$\begin{array}{r} 0110 \\ + 0100 \\ \hline 11010 \end{array}$$

Invalid

$$\begin{array}{r} 6 \\ + 4 \\ \hline 10 \end{array}$$
$$\begin{array}{r} 0110 \\ + 0110 \\ \hline 10010 \end{array}$$

Add 6

$$\begin{array}{r} 0001 0000 \\ \hline \end{array}$$

d) $17 + 12$

$$\Rightarrow 17 = 0001 00111, 12 = 0001 0010$$
$$\begin{array}{r} 0001 00111 \\ + 0001 0010 \\ \hline 0010 1001 \end{array}$$

17
+ 12
—
29

e) $28 + 23$

$$\Rightarrow 28 = 0010 1000$$

$$23 = 0010 0011$$

$$\begin{array}{r} 0010 1000 \\ + 0010 0011 \\ \hline 0100 11011 \end{array}$$

$\begin{array}{r} 28 \\ + 23 \\ \hline 51 \end{array}$

Invalid

$$\begin{array}{r} + 0110 \\ \hline 0101 0001 \end{array}$$

Add 6

f) $65 + 58$

$$\Rightarrow 65 = 0110 \ 0101$$

$$58 = 0101 \ 1000$$

$$\begin{array}{r} 65 \\ + 58 \\ \hline 123 \end{array}$$

$$\begin{array}{r} \cancel{04} \ 0110 \ 0101 \\ + \ 0101 \ 1000 \\ \hline 1'0'1'1 \ 1101 \ \text{Invalid} \\ + \ 0110 \ 0110 \ \text{Add6.} \\ \hline 0001 \ 0010 \ 0011 \end{array}$$

g) $113 + 101$

$$\Rightarrow 113 = 0001 \ 0001 \ 0011$$

$$101 = 0001 \ 0000 \ 0001$$

$$\begin{array}{r} 113 \\ + 101 \\ \hline 214 \end{array} \quad \begin{array}{r} 0001 \ 0001 \ 0'0'11 \\ + \ 0001 \ 0000 \ 0001 \\ \hline 0010 \ 0001 \ 0100 \end{array}$$

h) $295 + 157$

$$\Rightarrow 295 = 0010 \ 1001 \ 0101$$

$$157 = 0001 \ 0101 \ 0111$$

295
+ 157

$$\begin{array}{r} 0010 \ 1001 \ 0'1'01 \\ + \ 0001 \ 0101 \ 0111 \\ \hline 0'0'1'1 \ 1'1'1'0 \ 1'1'00 \ \text{Invalid} \\ + \ 0110 \ 0110 \ \text{Add6.} \\ \hline 0100 \ 0101 \ 0010 \end{array}$$