الجامعة الألمانية الأردنية
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CE 211

Digital Systems

Homework # 1

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Question 1

Decimal Digit	5-3-2-1 Code			
	5	3	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	1	0	0
4	0	1	0	1
5	1	0	0	0
6	1	0	0	1
7	1	0	1	0
8	1	1	0	0
9	1	1	0	1

$(9731)_{10}$ -----→ $(1101101001000001)_{5\text{-}3\text{-}2\text{-}1}$

1101

1010

0100

0001

Question 2

$X^2 - 13x + 32 = 0$ → equation 1

Then

X = 5 and x = 4 are solutions for the equation above

$(x-5)(x-4) = 0$ → in base 10

$X^2 - 5x - 4x - 20 = 0$ → $x^2 - 9x + 20 = 0$ → equation 2

Compare 1 & 2

$(X^2 - 13x + 32)_b = 0$

$(13)_b = (9)_{10}$

$3*b^0 + 1*b^1 = 9$ → $3 + b = 9$ → b = 6.

the base of the numbers is 6

also we can find it

$2*b^0 + 3*b^1 = 20$ → $2 + 3b = 20$ → $3b = 18$ → $b = 6$

Question 3

8 7 6 5 4 3 2 1 0

a. $(100010110)_2 \rightarrow (278)_{10}$

M =9, n = 0, r = 2

$= \sum_{i=-n}^{i=m-1} b^i *(2)^i=$

$0*2^0+1*2^1+1*2^2+0*2^3+1*2^4+0*2^5+0*2^6+0*2^7+1*2^8 =$

$0 + 2 + 4 + 0 + 16 + 0 + 0 + 0+ 256 = (278)_{10}$

7 6 5 4 3 2 1 0

b.$(10101011)_2 \rightarrow (171)_{10}$

m = 8, n = 0, r= 2

$= \sum_{i=-n}^{i=m-1} b^i *(2)^i=$

$1*2^0+1*2^1+0*2^2+1*2^3+0*2^4+1*2^5+0*2^6+1*2^7 =$

$1 + 2 + 0 + 8 + 0 + 32 + 0 + 128 = (171)_{10}$

9 8 7 6 5 4 3 2 1 0

c.$(1011011011)_2 \rightarrow (731)_{10}$

m = 10, n = 0, r= 2

$= \sum_{i=-n}^{i=m-1} b^i *(2)^i=$

$1*2^0+1*2^1+0*2^2+1*2^3+1*2^4+0*2^5+1*2^6+1*2^7+ 1*2^7+0*2^8 +1*2^9 =$

$1 + 2 + 0 + 8 + 16 + 0 + 64 + 128 + 512= (731)_{10}$

d.$(10000000000)_2 \rightarrow (1024)_{10}$

m = 11, n = 0, r= 2

$= \sum_{i=-n}^{i=m-1} b^i * (2)^i =$

$0*2^0+0*2^1+0*2^2+0*2^3+0*2^4+0*2^5+0*2^6+0*2^7+0*2^7+0*2^8+0*2^9+1*2^{10}$
$= (1024)_{10}$

Question 4

a. **$(217)_{10} \rightarrow (11011001)_2$**
b. **$(186)_{10} \rightarrow (10111010)_2$**
c. **$(265)_{10} \rightarrow (100001001)_2$**
d. **$(957)_{10} \rightarrow (1110111101)_2$**

186 / 2 = 93	0(LSB)
93/2 = 46	1
46/2 = 23	0
23/2 = 11	1
11/2 = 5	1
5/2 = 2	1
2/2 = 1	0
1/2 = 0	1 (MSB)

217 / 2 = 108	1(LSB)
108/ 2 = 54	0
54/2 = 27	0
27/2 = 13	1
13/2 = 6	1
6/2 = 3	0
3/2 = 1	1
1/2= 0	1(MSB)

957/2 = 478	1(LSB)
478/2 = 239	0
239/2 = 119	1
119/2= 59	1
59/2= 29	1
29/2= 14	1
14/2= 7	0
7/2= 3	1
3/2 = 1	1
1/2 = 0	1 (MSB)

265/2 = 132	1 (LSB)
132/2 = 66	0
66/2 = 33	0
33/2 = 16	1
16/2= 8	0
8/2=4	0
4/2=2	0
2/2 = 1	0
1/2 = 0	1 (MSB)

Question 5

1 0

a.$(36)_{16} \rightarrow (54)_{10}$

$m = 2, n = 0, r = 16$

$= \sum_{i=-n}^{i=m-1} h^i * (16)^i =$

$6*16^0+3*16^1 = (54)_{10}$

---

3 2 1 0

b. $(ABCD)_{16} \rightarrow (43981)_{10}$

$m = 3, n = 0, r = 16$

$= \sum_{i=-n}^{i=m-1} h^i * (16)^i =$

$D*16^0+C*16^1 +B*16^2 + A * 16^3 = (43981)_{10}$

---

1 0

c. $(89)_{16} \rightarrow (137)_{10}$

$m = 4, n = 0, r = 16$

$= \sum_{i=-n}^{i=m-1} h^i * (16)^i =$

$9*16^0+8*16^1 = (137)_{10}$

---

3 2 1 0

d. $(2000)_{16} \rightarrow (8192)_{10}$

$m = 2, n = 0, r = 16$

$= \sum_{i=-n}^{i=m-1} h^i * (16)^i =$

$0*16^0+0*16^1 +0*16^2+2*16^3 = (8192)_{10}$

Question 6

a.$(372)_{10} \rightarrow (174)_{16}$

b.$(2313)_{10} \rightarrow (909)_{16}$

c.$(33)_{10} \rightarrow (21)_{16}$

d.$(1024)_{10} \rightarrow (400)_{16}$

2313 / 16 = 144 9

144 /16 = 9 0

9/16 = 0 9

372 / 16 = 23 4 (LSB)

23/16 = 1 7

1 / 16 = 0 1 (MSB)

1024/16 = 64 0

64 /16 = 4 0

4/16 = 0 4

33 / 16 = 2 1 (LSB)

2 / 1 6 = 0 2 (MSB)

Question 7

a.$(010101010101)_{6\text{-}3\text{-}1\text{-}1} \rightarrow (444)_{10}$

b.$(000110000100)_{6\text{-}3\text{-}1\text{-}1} \rightarrow (163)_{10}$

c.$(10111)_{6\text{-}3\text{-}1\text{-}1} \rightarrow (15)_{10}$

d.$(1110101)_{6\text{-}3\text{-}1\text{-}1} \rightarrow (54)_{10}$

a.$(010101010101) \rightarrow (444)_{10}$

0101/0101/0101

4 / 4 / 4 and concatenate them.

b. $(000110000100) \rightarrow (163)_{10}$

0001 / 1000 / 0100

1 / 6 / 3

c.$(10111) \rightarrow (15)_{10}$

0001 / 0111

1 / 5

d.$(1110101) \rightarrow ()_{10}$

0111 / 0101

5 / 4

Question 8

a.$(38)_{10} \rightarrow$ ($\color{red}{1}$ 0110 1011)$_{\text{Excess-3code+}\color{red}{\text{even-parity-bit}}}$

$(38)_{10} \rightarrow (00111000)_{BCD} \rightarrow (01101011)_{\text{Excess-3code}}$

0011 +0011	1000+0011
0110	1011

b.$(275)_{10} \rightarrow$ ($\color{red}{1}$ 0101 1010 1000)$_{\text{Excess-3code+}\color{red}{\text{even-parity-bit}}}$

$(275)_{10} \rightarrow (001001110101)_{BCD} \rightarrow (010110101000)_{\text{Excess-3code}}$

0010+0011	0111 +0011	0101+0011
0101	1010	1000

c.$(9201)_{10} \rightarrow$ ($\color{red}{1}$ 1100 0101 0011 0100)$_{\text{Excess-3code+}\color{red}{\text{even-parity-bit}}}$

$(9201)_{10} \rightarrow (1001001000000001)_{BCD} \rightarrow (1100010100110100)_{\text{Excess-3code}}$

1001+0011	0010+0011	0000+0011	0001+0011
1100	0101	0011	0100

d.$(51)_{10} \rightarrow$ ($\color{red}{0}$ 1000 0100)$_{\text{Excess-3code+}\color{red}{\text{even-parity-bit}}}$

$(51)_{10} \rightarrow (01010001)_{BCD} \rightarrow (10000100)_{\text{Excess-3code}}$

0101+0011	0001+0011
1000	0100

Question 9

a. $(01101)_{2,2S'\ complement}$ = $(+13)_{10}$

+ve

R = 2, m= 5,n = 0 → $\sum_{-n}^{m-1} b_i * 2^i = 1*2^0 + 0*2^1 + 1*2^2 + 1*2^3 + 0*2^4 = 13$

b. $(11101)_{2,2S'\ complement}$ = $(-3)_{10}$

-ve applying 2S' comp → $(00011)_{2,2S'\ complement}$ =(3) then add the – sign → $(-3)_{10}$

c. (01111011) = $(+123)_{10}$

+ve $(01111011)_{2,2S'\ complement}$ → $(+123)_{10}$

d. (11111111) = $(-1)_{10}$

-ve $(11111111)_{2,2S'\ complement}$ →applying 2S' comp → $(0000001)_{2,2S'\ complement}$

→ $(1)_{10}$ then add the – sign → $(-1)_{10}$

e. (01111111) = $(+127)_{10}$

+ve $(01111111)_{2,2S'\ complement}$ → $(+127)_{10}$

f. (10000000) = $(-128)_{10}$

-ve $(10000000)_{2,2S'\ complement}$ →applying 2S' comp → $(10000000)_{2,2S'\ complement}$

→ $(1)_{10}$ then add the – sign → $(-1)_{10}$

Question 10

a.(-87) + (256)

Min #of bits = 10

$(256)_{10} \rightarrow (0100000000)_2$

$(+256)_{10} \rightarrow$ using 10-bits $\rightarrow (0100000000)_{2,2scomp,signed}$

$(87)_{10} \rightarrow (0001010111)_2$

$(+87)_{10} \rightarrow$ using 10-bits $\rightarrow (0001010111)_{2,2scomp,signed}$

$(-87)_{10} \rightarrow$ using 10-bits $\rightarrow (1110101001)_{2,2scomp,signed}$

Then adding

$(0100000000)_{2,2scomp,signed}$

$(1110101001)_{2,2scomp,signed}$

$(10010101001)_{2,2scomp,signed} \rightarrow (0010101001)_{2,2scomp,signed} \rightarrow (+169)$

discard $\rightarrow$ **no overflow**

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a.(-35) + (65)

Min #of bits = 8

$(65)_{10} \rightarrow (01000001)_2$

$(+65)_{10} \rightarrow$ using 8-bits $\rightarrow (01000001)_{2,2scomp,signed}$

$(35)_{10} \rightarrow (00100011)_2$

$(+35)_{10} \rightarrow$ using 10-bits $\rightarrow (00100011)_{2,2scomp,signed}$

$(-35)_{10} \rightarrow$ using 10-bits $\rightarrow (11011101)_{2,2scomp,signed}$

Then adding

$(01000001)_{2,2scomp,signed}$

$(11011101)_{2,2scomp,signed}$

$(100011110)_{2,2scomp,signed} \rightarrow (00011101)_{2,2scomp,signed} \rightarrow (+30)_{10} \rightarrow$ **no overflow**

discard

c.(+490) + (+22)

Min #of bits = 10

$(490)_{10} \rightarrow (0111101010)_2$

$(+490)_{10} \rightarrow$ using 10-bits $\rightarrow (0111101010)_{2,2scomp,}$

$(22)_{10} \rightarrow (10110)_2$

$(+22)_{10} \rightarrow$ using 10-bits $\rightarrow (0000010110)_{2,2scomp,si}$

Then adding

$(0111101010)_{2,2scomp,signed}$

$(0000010110)_{2,2scomp,signed}$

$(1000000000)_{2,2scomp,signed} \rightarrow$ overflow

The min #of bits to avoid overflow condition is 11-bits

Using 11-bits

$(00111101010)_{2,2scomp}$

$(00000010110)_{2,2scomp}$

$(01000000000)_{2,2scomp}$

$\rightarrow (+512)_{10}$

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d.(-255) + (-230)

Min #of bits = 9

$(255)_{10} \rightarrow (011111111)_2$

$(+255)_{10} \rightarrow$ using 9-bits $\rightarrow (011111111)_{2,2scomp}$

$(-255)_{10} \rightarrow$ using 9-bits $\rightarrow (100000001)_{2,2scomp}$

$(230)_{10} \rightarrow (011100110)_2$

$(+230)_{10} \rightarrow$ using 9-bits $\rightarrow (011100110)_{2,2scomp}$

$(-230)_{10} \rightarrow$ using 9-bits $\rightarrow (100011010)_{2,2scomp}$

Then adding

$(100000001)_{2,2scomp,signed}$

$(100011010)_{2,2scomp,signed}$

$(1000011011)_{2,2scomp,signed} \rightarrow (000011011) \rightarrow$ overflow

discard

The min #of bits to avoid overflow condition is 10-bits

Using 10-bits

$(1100000001)_{2,2scomp}$

$(1100011010)_{2,2scomp}$

$(11000011011)_{2,2scomp}$

discard

$(-485)=(1000011011)_{2,2scomp}$

Check by applying 2S'comp

(0111100101)

e.(-129) + (128)

Min #of bits = 9

$(128)_{10} \rightarrow (010000000)_2$

$(+128)_{10} \rightarrow$ using 9-bits $\rightarrow (010000000)_{2,2scomp,signed}$

$(129)_{10} \rightarrow (010000001)_2$

$(+129)_{10} \rightarrow$ using 9-bits $\rightarrow (010000001)_{2,2scomp,signed}$

$(-129)_{10} \rightarrow$ using 9-bits $\rightarrow (101111111)_{2,2scomp,signed}$

Then adding

$$\begin{array}{l} (010000000)_{2,2scomp,signed} \\ \underline{(101111111)_{2,2scomp,signed}} \\ (111111111)_{2,2scomp,signed} \rightarrow (-1)_{10} \end{array}$$

$\rightarrow$ no overflow

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f.(+986) + (+123)

Min #of bits = 11

$(986)_{10} \rightarrow (01111011010)_2$

$(+986)_{10} \rightarrow$ using 11-bits $\rightarrow (01111011010)_{2,2scomp}$

$(123)_{10} \rightarrow (00001111011)_2$

$(+123)_{10} \rightarrow$ using 11-bits $\rightarrow (00001111011)_{2,2scomp}$

Then adding

$$\begin{array}{l} (01111011010)_{2,2scomp,signed} \\ \underline{(00001111011)_{2,2scomp,signed}} \\ (10001010101)_{22,2scomp,signed} \rightarrow \text{overflow} \end{array}$$

The min #of bits to avoid overflow condition is 12-bits

Using 12-bits

$$\begin{array}{l} (001111011010)_{2,2scomp} \\ \underline{(000001111011)_{2,2scomp}} \\ (010001010101)_{2,2scomp} \end{array}$$

$\rightarrow (+1109)_{10}$