

Birzeit University

Faculty of Engineering and Technology

Department of Electrical and Computer Engineering

First Semester – 2023/2024

ENCS2340 - Digital Systems

Homework # 1

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Question 1 :

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Decimal | Binary | Octal | Hexadecimal | BCD |
| 15410 | 100110102 | 2328 | 9A16 | 0001 0101 0100 BCD |
| 29.2510 | 11101.012 | 35.28 | 1D.416 | 0010 1001.0010 0101BCD |
| 93.199910 | 1011101.00112 | 135.14638 | 5D.333 | 10010011.0001100110011001BCD |
| 17.510 | 10001.12 | 21.48 | 11.816 | 0001 0111.0101BCD |
| 0.12510 | 0.0012 | 0.18 | 0.216 | 0000 . 0001 0010 0101BCD |

Question 2 :

A ) A’C’ +A’BC + B’C’

= A’C’ +A’BC + B’C’

= A’ ( C’+BC) + B’C’ \\ BY DISTRIBUTIVE : AB+AC= A(B+C)

= A’ ( B+C` ) +B`C` \\ by Absorption Law : AB + A` = B+A`

= A`B+A`C`+B`C` \\ by Distribution

= A’B + B’C’ . \\ by Consensus

B) BC + AC’ + AB + BCD

BC + AC’ + AB + BCD

BC + A.C’ + AB \\ by Absorption Law : A+AB = A

BC + A.C’ \\ by Consensus

C) ABC + A’B’C + A’BC + ABC’ + A’B’C’

BC(A+A’) + A’B’C+ABC’+A’B’C \\ by Distributive : AB+AC= A(B+C)

BC1 + A’B’C+ABC’+A’B’C’ \\ by Complement : A+A`=1

BC(A+A’) + A’B’C+ABC’+A’B’C’ \\ by Identity : A1= A

C(A’B’ + B)+ABC’+A’B’C’ \\ by Distributive : AB+AC= A(B+C)

C(A’ + B ) + ABC’ + A’B’C’ \\ by Absorption Law : A`B + A = B + A

CA’ + CB + ABC’ + A’B’C’ \\ by Distribution

CA’ + B(C + AC’) + A’B’C’ \\ by Distributive : AB+AC= A(B+C)

CA’ + B(C+A) + A’B’C’ \\ by Absorption Law : A`B + A = B + A

B(A+C) + A’(B’C’ + C) \\ by Distributive : AB+AC= A(B+C)

B(A+C) + A’(B’+C) \\ by Absorption Law : A`B + A = B + A

BA+BC+A’(B’+C) \\ by Distribution

BA + BC+ A’B + A’C \\ by Distribution

B(A+A’) + BC + A’C \\ by Consensus

B + BC + A’C \\ by Complement : A+A`=1

B + A’C \\ by Absorption Law : A+AB = A

D) ((CD)’+A)’ + A + CD + AB

CD’’A’ + A + CD + AB \\ by Demorgan theorm

CDA’ +A + CD + AB \\ by Involution : A``= A

CDA’ + A + CD \\ by Absorption Law : A+AB = A

CDA’ +A \\ by Absorption Law : A+AB = A

CD + A \\ by Absorption Law : A+AB = A

E) (A + C + D)(A + C + D’)(A + C’ + D)(A + B’)

(A+C’+D)(A+B’)(A+C’+D)(A+B’)AD’+(A+C+D’)(A+C’+D)(A+B’)C+(A+C+D’)(A+C’+D)(A+B’)D

A+CDB’+(A+C+D’)(A+C’+D)(A+B’)D \\ by Absorption Law : A+AB = A

A+CDB’+DCA+DCB’ \\ by Distribution

A+CDB’ \\ by Absorption Law : A+AB = A

F) (WX(Y’Z + YZ’) + W’X’(Y’+Z)(Y+Z’))’

W`W +W`X + W`Y + WX`+ XX`+X`Y+W`Y+XY`+YY` [\\ distribution](file:///\\distribution)

0 + W`X + W`Y + WX`+0+X`Y+WY`+XY`+0 \\ complement

W`X+W`Y+WX`+X`Y+WY`+XY` \\ identity

WX` + W`Y + X`Y + W`X + WY` + XY` \\ commutative

WX`+W`Y+W`X+WY` \\ consensus

WX` + W`(Y`Z+YZ`)+W`X+W(YZ+Y`Z`) [\\substitution](file:///\\substitution) in place of y

WX`+W`Y`Z+W`YZ`+W`X+WYZ+WY`Z` \\DISTRIBUTIVE

Question 3:

1. F1 = ( W’X’Y’Z + W’XYZ’ +W’XYZ + WX’YZ + WX’Y’Z’ + WXY’Z’ + WXYZ + WXYZ’ )

A diagram of a machine

Description automatically generated

1. F2 = (W+X+Y+Z’)(W+X+Y’+Z)( W+X+Y’+Z’)( W+X’+Y+Z)( W+X’+Y+Z’)

( W’+X+Y+Z)( W’+X+Y+Z’)( W’+X+Y’+Z)( W’+X+Y’+Z’)( W’+X’+Y+Z)

( W’+X’+Y+Z’)( W’+X’+Y’+Z’)

A diagram of a machine

Description automatically generated

1. THE DUAL OF F1 IS :

F1 = (W+X+Y+Z’) (W+X’+Y’+Z)(W+X’+Y’+Z’)(W’+X+Y’+Z’)

(W’+X+Y+Z)(W’+X’+Y+Z) (W’+X’+Y’+Z’)(W’+X’+Y’+Z)

Question 4 :

1. f(X,Y,Z) = Σ(0,3,4)

= m0 + m3 + + m4

f’= X’Y’Z’+ X’YZ + XY’Z’

1. f= Σ(0,3,4) and g= Σ(0,2,4,6,7)

f + g = m0 + m2+m3+m4+ m6 + m7

= X’Y’Z’+ X’YZ’+X’YZ+ X’YZ’+ XYZ’ + XYZ

1. g = (1,3,5) , f` = Σ(1,2,5,6,7) 🡺 (0,3,4)

(f`.g) = M3

= XY`Z`

Question 5 :

1. (C372)16 – (395E)16 = (X)16

The first step convert the hex number to decimal number

(2\*160 + 7\*161 + 3\*162 + 12\*163 ) 🡺 (2 + 112 + 768 + 49152 )🡺 (50034)

(C372)16 = (50034)10

(14\*160 + 5\*161 + 9\*162 + 3\*163 ) 🡺 (14 + 80 + 2304+ 12288 )🡺 (14686)

(395E)16 = (14686)10

Then we need to subtract them from each other :

50034 – 14686 = (35348)10

Then convert the decimal number to hex number :

(35348 / 16 ) = 2209 With 4 rem 🡺 (2209/16 )= 138 With 1 rem 🡺(138/16)=8 with 10 rem 🡺(10/16) = 0 with 8 rem 🡺 (8A14)

(35348)10  = (8A14)16

X = (8A14)16

1. (0010 1000 0000 0111)BCD + (0001 1001 1001 0101)BCD = (X)BCD

The first step convert the BCD number to decimal number

0010 = 2 / 1000= 8 / 0000 =0 / 0111 = 7 🡺 280710

0001 =1 / 1001 = 9 / 1001 = 9 / 0101 = 5 🡺 199510

And we need to sum two number in decimal :

1995 + 2807 = 4002 10

Then convert a decimal number to BCD :

4002 🡺 (4=0100 / 0 = 0000 / 0=0000 / 2 = 0010 )

X = 0100 0000 0000 0010 BCD

1. (35)X + (18)X = (51)X

(5\*X0 + 3\*X1 ) + ( 8\*X0 + 1 \*X1) = (1\*X0+5\*X1)

3X+5 + X+8 = 5X +1

4X + 13 = 5X +1

X =12

1. (10110.11)5 = (X)15

First step we need to convert the base5 to base 15 , we should convert it to decimal then convert it to base 15 .

The integer number: (0 \* 50 + 1 \* 51 + 1\*52 + 0\*53 + 1\*54)🡺(0+5+25+0+625)🡺(655)

The fractional number : (1\*5-1 + 1\*5-2) 🡺 (0.2 +0.04) 🡺 (0.24)

(10110.11)5 🡺 (655.24)10

Now we should convert a decimal to 15 base , for the integer number :

(655/15 = 43 and 10 rem) / (43/15 = 2 and 13 rem ) / (2/15=0 and 2 rem)🡺(2DA)

For the fractional number : (0.24 \* 15 = 3.6 // 0.6 \* 15 =9 ) 🡺 (39)

So X = (2DA.39)15

1. (2404)10 = (C3A)X

2404 = (A\*X0 + 3 \*X + C\*X2)

2404 = 12 X2 + 3X + 10

0 = 12 X2 + 3X - 2394

( a=4 , b=1 , c= -798 ) , after divide it and a long math

X = 14

1. X = the 15’s complement of (2B070)15

To find the 15’s complement of a base 15 number , you would subtract each digit from 14 (14 is the big digit in base 15 ) and then add 1 to the result .

( 14-2 =12 // 14 – B = 3 // 14 -0 = E // 15– 7 =8 ) // and adding 1 to 7

(2B070)15 = (12C80)15

X = (C3E80)15

1. X = the Gray code for the binary value (101100)2

We take the XOR of the subsequent binary of digit

(1 o 0 =1 // 0 o 1=1 // 1 o 1 =0 // 1 o 0 = 1 // 0 o 0 =0 )

X = 111010

Question 6 :

1. ( 20 =1 , ….. , 211 = 2048 , 212 = 4096)

So we would need 12 bits

1. Number = 3500 \* 220/5

= 3500 \* 24

= 56000

(20=1 , …. , 215 = 32768 , 216 = 65536 )

So we would need 16 bits

1. 1) Now : you need 3 hex digits (12/4 =3 ) for 3500 students .

2) after 20 years : you need 4 hex digits (16/4 = 4) for 56,000 students.

3) comment : Hexadecimal provides a more compact and readable representation compared to binary, as each hex digit corresponds to 4 binary bits.

The use of hexadecimal is efficient for documenting binary codes, offering a concise and manageable way to represent large amounts of binary data.

Now = 3 bits

After 20 years = 4 bits

Question 7 :

1. 11001101 + 01101011

11001101 + 01101011 = 001110002

In decimal = 56 \\ carry = 1

And this is Correct (no overflow)

1. 01110010 – 10010111

We need convert the subtraction operation into adding operation (by find 2’s complement of the subtrahend ) .

01110010 – 10010111 🡺 01110010 + 01101001 = 110110112

Result is = 219 \\ no carry

And this is Overflow Occurred

1. 11111011 – 10000

We need convert the subtraction operation into adding operation (by find 2’s complement of the subtrahend ). ++ (we ask a doctor for if we need to add a bits for a negative number , we add 1 or 0 , he say’s adding 0 for it by 2’s comp )

11111011 – 00010000 🡺 11111011 + 11110000 = 11101011

Result is = 107\\ carry = 1

And this is Correct (no Overflow)

1. 01101 – 11101101

We need convert the subtraction operation into adding operation (by find 2’s complement of the subtrahend ).

00001101 – 11101101 🡺 00001101 + 00010011 = 00100000

Result is = 32 \\ no carry

And this is Correct (no Overflow)

1. 010011 – 01101

We need convert the subtraction operation into adding operation (by find 2’s complement of the subtrahend ).

00010011 – 00001101 🡺 00010011 + 11110011 = 00000110

Result is = 6 \\ carry = 1

And this is Correct (no Overflow)

1. 10011 + 101101

00010011 + 00101101 = 01000000

Result is = 64 \\ carry = 1 And this is Correct (not Overflow)

Question 8 :

1. Unsigned numbers :

A = (1011001)

Adecimal  = (1 \*20) + ( 0\*21 ) + ( 0\*22) + (1\*23) + (1\*24) + (0\*25) + (1\*26)

Adecimal = (1+0+0+8+16+0+64)

Adecimal  = 89

B = (0111010)

Bdecimal  = (0 \*20) + ( 1\*21 ) + ( 0\*22) + (1\*23) + (1\*24) + (1\*25) + (0\*26)

Bdecimal = (0+2+0+8+16+32+0 )

Bdecimal = 58

1. Signed-magnitude numbers.

A=(1011001), but the magnitude is given by the remaining bits (011001)

Amagnitude = (1 \*20) + ( 0\*21 ) + ( 0\*22) + (1\*23) + (1\*24) + (0\*25)

Amagnitude = (1+0+0+8+16+0+0)

Amagnitude=25,but the decimal value of A as a signed-magnitude number is

Amagnitude  = -25

B=(0111010) , but the magnitude is given by the remaining bits(110010)

Bmagnitude = (0 \*20) + ( 1\*21 ) + ( 0\*22) + (1\*23) + (1\*24) + (1\*25)

Bmagnitude = (0+2+0+8+16+32)

Bmagnitude = 58

1. Signed 1’s complement numbers.

A=(1011001), but the 1’s complement is given by the flip bits (100110)

A1’s complement = (0 \*20) + ( 1\*21 ) + ( 1\*22) + (0\*23) + (0\*24) + (1\*25)

A1’s complement = 0+2+4+0+0+32

A1’s complement = 38 , Since a negative , it’s 1’s complement value is

A1’s complement = -38

B = (0111010) , Since B is positive , we do not need to flip the bits, direct convert the magnitude to decimal .

B1’s complement = (0 \*20) + ( 1\*21 ) + ( 0\*22) + (1\*23) + (1\*24) + (1\*25) + (0\*26)

B1’s complement = (0+2+0+8+16+32+0) 🡺 B1’s complement = 58 .

1. Signed 2’s complement numbers. :

First , we need find the 1’s complement to A (because it’s negative) by flipping the bits , and then we need add to it 1 bits to get 2’s complement

A = (011001) 🡺 A = (100111)

A2’s complement = (1 \*20) + ( 1\*21 ) + ( 1\*22) + (0\*23) + (0\*24) + (1\*25)

A2’s complement = 1+2+4+0+0+32

A2’s complement = 39 , Since a negative , it’s 2’s complement value is

A2’s complement = -39

Question 9 :

1. F(W, X, Y, Z) = WX’Y’ + WXZ’ + W’XZ + YZ’

**Sum of Minterms (SOM) :**

F(W,X,Y,Z) = Σ m(2,5,6,7,8,9,10,12,14)

**Product of Maxterms ( POS) :**

F(W,X,Y,Z) = M(0,1,3,4,11,13,15)

1. F(A, B, C, D) = D(A’ + B) + B’D

**Sum of Minterms :**

F(W,X,Y,Z,) = Σ m (1,3,5,7,9,11,13,15 )

**Sum of Maxterms :**

F(W,X,Y,Z) = M(0,2,4,6,8,10,12,14)

1. F(A, B, C, D) = (A + B’ + C)(A + B’)(A + C’ + D’)(A + B + C + D’)(B + C’ + D’)

**Sum of Minterms :**

F(W,X,Y,Z,) = Σ m (0,2,8,9,10,12,13,14,15)

**Sum of Maxterms :**

F(W,X,Y,Z) = M(1,3,4,5,6,7,11)

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