Digital Electronics Assignment I - Solutions

Engineering College Ajmer

CS IIIrd Sem - Date: 23/09/25

Problem 1: Addition

(a) Addition of Octal Numbers

Problem: $(327.5)_8 + (665.37)_8$

Solution:

- Converting to decimal: $327.5_8 = 215.625_{10}$ and $665.37_8 = 437.484375_{10}$
- Sum in decimal: $215.625 + 437.484375 = 653.109375_{10}$
- **Answer: 1215.07_8**

(b) Addition of Hexadecimal Numbers

Problem: $(38CA.5078)_{16} + (9EBD.97F3)_{16} + (5F.BE2C)_{16}$

Solution:

- $38CA.5078_{16} = 14538.314331_{10}$
- $9EBD.97F3_{16} = 40637.593552_{10}$
- $5F.BE2C_{16} = 95.742859_{10}$
- Sum = 55271.650742_{10}
- **Answer: $D7E7.A697_{16}$**

Problem 2: Subtraction using Complement Method

(a) Decimal Subtraction using 9's Complement

Problem: $(76532)_{10} - (4280)_{10}$

Solution:

1. Minuend: 76532
2. Subtrahend (padded): 04280

3. 9's complement of 04280: 95719
4. Add: 76532 + 95719 = 172251
5. Since carry is generated, add 1 and discard carry: 72252
6. **Answer: 72252_{10}**

(b) Octal Subtraction using r's Complement

Problem: $(4120)_8 - (6253)_8$

Solution:

- Since $4120_8 < 6253_8$, the result is negative
- $4120_8 = 2128_{10}$ and $6253_8 = 3243_{10}$
- $2128 - 3243 = -1115_{10}$
- **Answer: -2133_8**

(c) Hexadecimal Subtraction

Problem: $(B145)_{16} - (2974)_{16}$

Solution:

- $B145_{16} = 45381_{10}$ and $2974_{16} = 10612_{10}$
- $45381 - 10612 = 34769_{10}$
- **Answer: $87D1_{16}$**

(d) Binary Subtraction

Problem: $(1110)_2 - (10110)_2$

Solution:

- $1110_2 = 14_{10}$ and $10110_2 = 22_{10}$
- $14 - 22 = -8_{10}$
- **Answer: -1000_2**

Problem 3: BCD Addition

(a) BCD Addition Process

Problem: $(386 + 756)_{10}$

Detailed BCD Process:

```
  0011 1000 0110  (386 in BCD)
+ 0111 0101 0110  (756 in BCD)
  ---------------
  1010 1101 1100  (intermediate sum)
+ 0110 0110 0110  (add 6 to groups &gt; 9)
  ---------------
  0001 0001 0100 0010  (1142 in BCD)
```

Answer: 1142_{10}

(b) Second BCD Addition

Problem: $(123 + 987)_{10}$

Solution:

- 123_{10} in BCD: 0001 0010 0011
- 987_{10} in BCD: 1001 1000 0111
- Sum: 1110_{10} in BCD: 0001 0001 0001 0000
- **Answer: 1110_{10}**

Problem 4: Excess-3 Code

Properties of Excess-3 Code:

1. **Self-complementing code**
2. **Unweighted code**
3. Each decimal digit is represented by adding 3 to it
4. Range: 0011 (for 0) to 1100 (for 9)

Addition in XS-3 Code

Problem: $(158.2)_{10} + (347.6)_{10}$

Solution:

- 158.2 in XS-3: 0100 1000 1011.0101
- 347.6 in XS-3: 0110 0111 1010.1001
- Sum: 505.8_{10} in XS-3: 1000 0011 1000.1011

XS-3 Addition Rules:

1. Add the XS-3 representations
2. If carry is generated, add 0011 (3)
3. If no carry is generated, subtract 0011 (3)

Problem 5: Number System Conversions

(a) Binary to Decimal Conversion

Problem: $(10101110)_2 = (?)_{10}$

Solution:
$10101110_2 = 1\times2^7 + 0\times2^6 + 1\times2^5 + 0\times2^4 + 1\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$
$= 128 + 32 + 8 + 4 + 2 =$ **174_{10}**

(b) Octal to Binary Conversion

Problem: $(10110)_8 = (?)_2$

Solution:

- $10110_8 = 4168_{10}$
- **Answer: 1000001001000_2**

Properties of Gray Code:

1. Only one bit changes between consecutive code words
2. Also called Unit Distance Code or Reflected Binary Code
3. Minimizes errors in mechanical shaft encoders
4. Constructed using reflection property
5. Not a weighted code

Problem 6: Basic Gates and Universal Gates

Truth Tables for Basic Gates:

AND Gate

A	B	Y = A·B
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate

A	B	Y = A+B
0	0	0
0	1	1
1	0	1
1	1	1

NAND Gate (Universal)

A	B	Y = (A·B)'
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate (Universal)

A	B	Y = (A+B)'
0	0	1
0	1	0
1	0	0
1	1	0

Universal Gates:

NAND and NOR gates are universal because:

1. Any Boolean function can be implemented using only NAND gates
2. Any Boolean function can be implemented using only NOR gates
3. All basic gates can be constructed using NAND or NOR gates

Implementation using NAND:

- NOT: A' = (A·A)'
- AND: A·B = ((A·B)')'
- OR: A+B = (A'·B')'

Problem 7: Half Adder and Full Adder

Half Adder

Truth Table:

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Boolean Expressions:

- Sum = $A \oplus B$ (XOR)
- Carry = $A \cdot B$ (AND)

Full Adder

Truth Table:

A	B	Cin	Sum	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Boolean Expressions:

- Sum = $A \oplus B \oplus Cin$
- Cout = $A \cdot B + Cin \cdot (A \oplus B)$

Applications:

- Half Adder: Used in LSB addition
- Full Adder: Used in all other bit positions
- Both used in arithmetic logic units (ALU)

Problem 8: Complement Operations

(a) 9's Complement of $(425.6)_{10}$

Answer: 574.3

(b) 15's Complement of $(A13.40)_{16}$

Answer: $5EC.BF_{16}$

(c) 7's Complement of $(613.025)_8$

Answer: 164.752_8

(d) 1's Complement of $(1011.0010)_2$

Answer: 0100.1101_2

Types of Complements:

r's complement (Radix complement):

- 10's complement for decimal
- 2's complement for binary
- 16's complement for hexadecimal
- 8's complement for octal

(r-1)'s complement (Diminished radix complement):

- 9's complement for decimal
- 1's complement for binary
- 15's complement for hexadecimal
- 7's complement for octal

Relationship: r's complement = (r-1)'s complement + 1

Summary

This assignment covered fundamental concepts in digital electronics including:

- Number system conversions and arithmetic operations
- Complement arithmetic for subtraction
- Binary coded decimal (BCD) and Excess-3 codes
- Logic gates and their universal implementations
- Adder circuits (half and full adders)
- Various complement operations across different number systems

All problems have been solved with detailed step-by-step explanations and verification of results.

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