Mid-term Exam (Solutions)

1 a)

4	0100 1010	both represent 4
6	0110 1100	both represent 6
7	0111 1101	both represent 7
9	1111	

b) 387 in 2421 code representation may be written as

0011 1110 0111

Complementing each bit in this coded representation, we get

1100 0001 1000

which is the code for the decimal number 612, which is 9's complement of 387 because 999 - 387 = 612.

c) Note that it is sufficient to argue for each digit separately.

Consider the 2421 code for any of the 9 digits : $b_3 b_2 b_1 b_0$

Complementing these bits is the same as subtracting them from 1111 , which is the 2421 code for 9 .

Thus, the effect of this subtraction/ bit-complementation is the same as taking 9's complement of the decimal digit.

d) BCD codes are not self-complementing.

consider the decimal number 777.

The BCD representation of 777 is

0111 0111 0111

complementing the bits, we get

1000 1000 1000

which is the BCD representation of 888, which is not the 9's complement of 777. (9's complement of 777 is 222.)

e) Yes, excess-3 codes are self-complementing.

Note that the excess-3 code for any decimal digit K is the same as binary code for K+3.

Therefore, flipping each bit of the excess-3 code gives us the flipped bits for binary of K+3

= 1's complement of K+3

= binary representation of 15-(K+3)

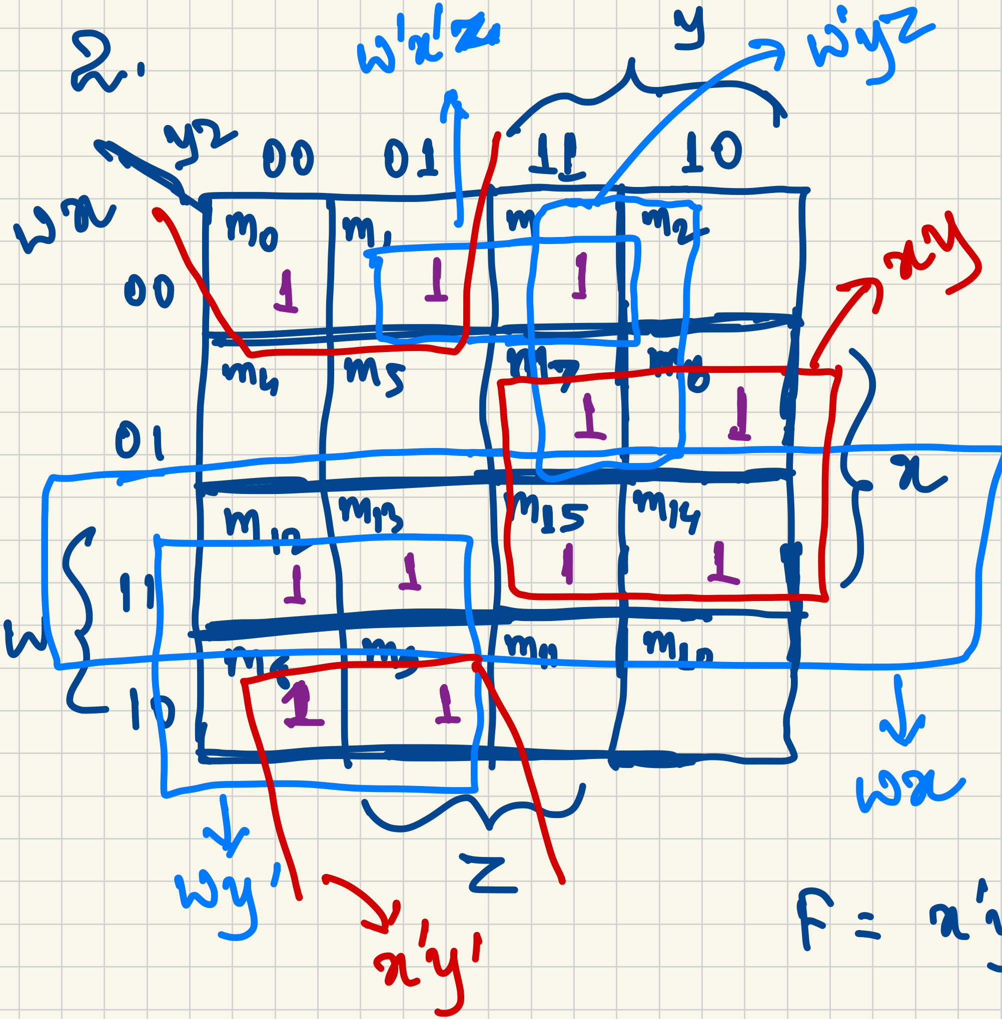
(15 because there a 4-bits in the code)

= binary of 12-K

= binary of 9-K+3

= excess-3 code for (9-K).

2.



The prime implicants are:

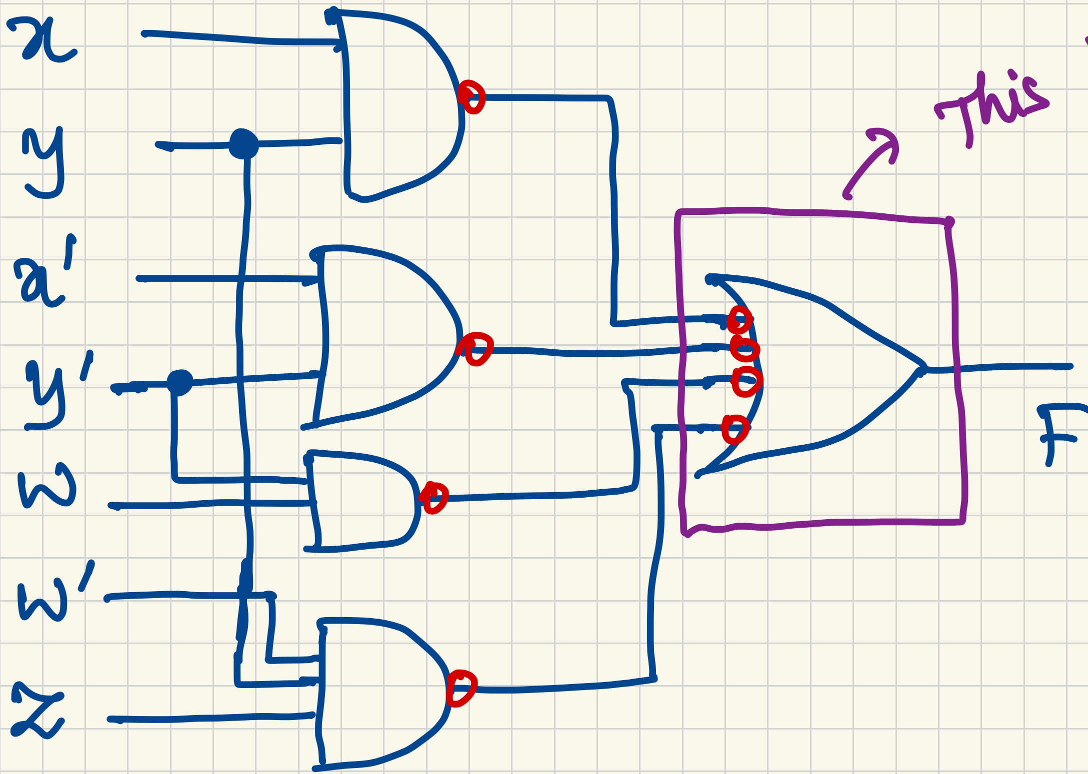
wy', wx, xy, $x'y'$, $w'yz$, and $w'x'z$.

The essential prime implicants are

$x'y'$, xy

$$F = x'y' + xy + w'yz + wy'$$

$$F = x'y' + xy + w'yz + wy'$$



This is a NAND-gate in invert-OR graphical representation.

3. We will prove the XNOR is commutative as well as associative.

Commutativity

$$x \text{ XNOR } y = xy + x'y'$$

$$= yx + y'x' \quad \text{(multiplication/and is commutative)}$$

$$= y \text{ XNOR } x$$

Associativity

$$(x \text{ XNOR } y) \text{ XNOR } z = (xy + x'y')z + (xy + x'y')'z'$$

$$= xyz + x'y'z + x'yz' + xy'z'$$

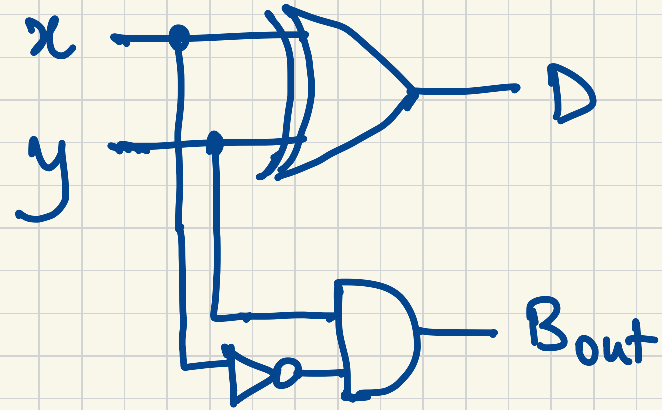
$$= x(yz + y'z') + x'(y'z + yz')$$

$$= x(yz + y'z') + x'(yz + y'z')'$$

$$= x \text{ XNOR } (y \text{ XNOR } z)$$

4. a)

x	y	B_{out}	D
0	0	0	0
0	1	1	1
1	0	0	1
1	1	0	0



$D = x \oplus y$

$B_{out} = x'y$

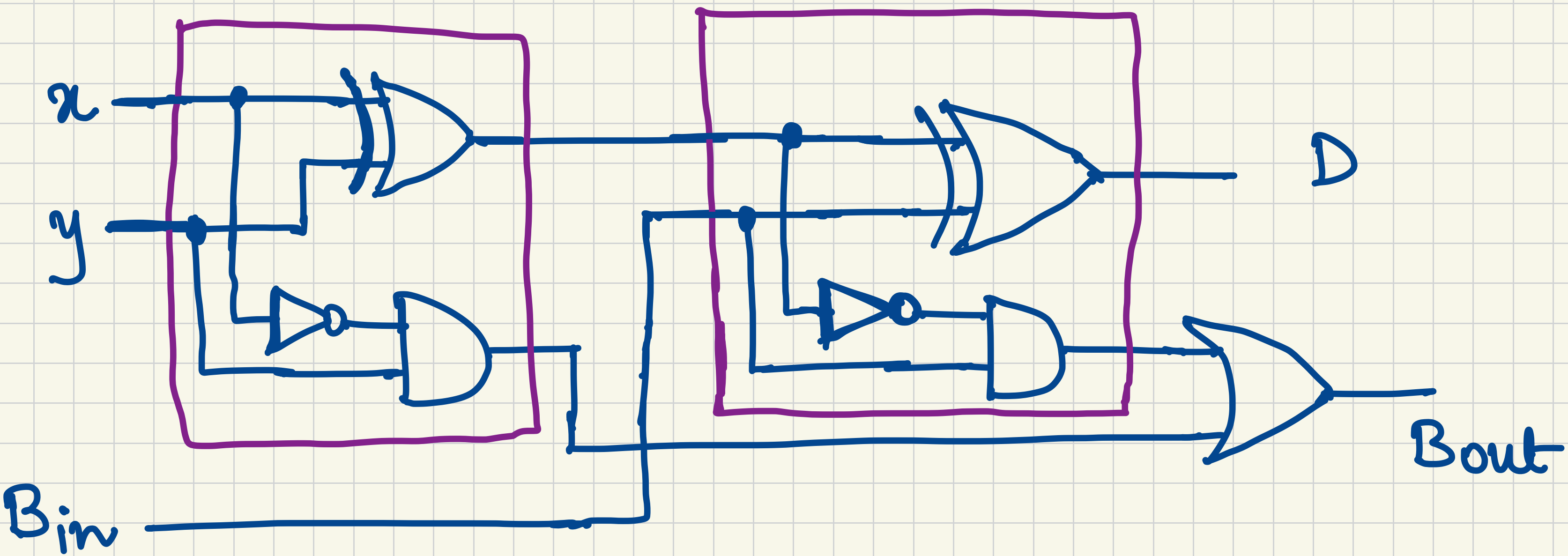
Half - subtractor

b)

x	y	B_{in}	B_{out}	D
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
1	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$$D = x \oplus y \oplus z$$

$$B_{out} = x'y + z(xy + x'y')$$



Full subtractor circuit diagram using two half-subtractors.

5. 8's complement of $(1750)_8$ can be obtained by first taking 7's complement and then adding 1.

$$\begin{array}{r} 7777 \\ -\ 1750 \\ \hline 6027 \end{array}$$

Adding 1 to it gives $(6030)_8$ which is the 8's complement of $(1750)_8$.

To verify, let us take 8's complement of $(6030)_8$.

7's complement gives 1747;

and then upon adding 1 we get

$$
\begin{array}{r}
1747 \\
+ \quad 1 \\
\hline
(1750)_8
\end{array}
$$

Therefore, the answer is correct.