IIT KHARAGPUR

Switching Circuit Laborartory
CS29204

Assignment: 2

Group 01

Nikhil Saraswat (20CS10039)

Abhijeet Singh (20CS30001)

Gopal (20CS30021)

Rohit Kumar Prajapati (20CS30041)

Problem 1 (BCD)

Problem Statement: -

- Develop circuits to convert from 4-bit binary to 2-digit BCD.

Description of the Solution including Logic Expression: -

4-bit binary to 2-digit BCD

In this problem we have four inputs A, B, C and D. A represents the third bit of 4 bit binary, B represents the second bit of 4 bit binary, C represents first bit of 4 bit binary and D represents zeroth bit of 4 bit binary.

We have to convert it into 5-bit BCD but since BCD is usually of 8 bits so we are adding 3 buffer bits P, Q and R at the starting of output.

For S: The input at A and the input at B is passed through a common AND gate and also the input add A and the input at C is passed through a common AND gate. The output provided by these two AND gates is then passed through a OR gate to obtain final output at S which is the fourth bit of BCD.

Output at S = AB+AC

For T: The input provided at B and C is passed through a NOT gate which is then combined at an AND gate with the input provided at A. The output of this AND gate is the final output of T which is the third bit of BCD.

Output at T = AB'C'

For U: The output obtained by passing input of A through NOT gate and input provided at B is combined by an AND gate. Another AND gate combines the input provided at B and C. The output of the above two AND gates is passed through a OR gate and the output obtained through this is the final output obtained at U.

Output at U = A'B+BC

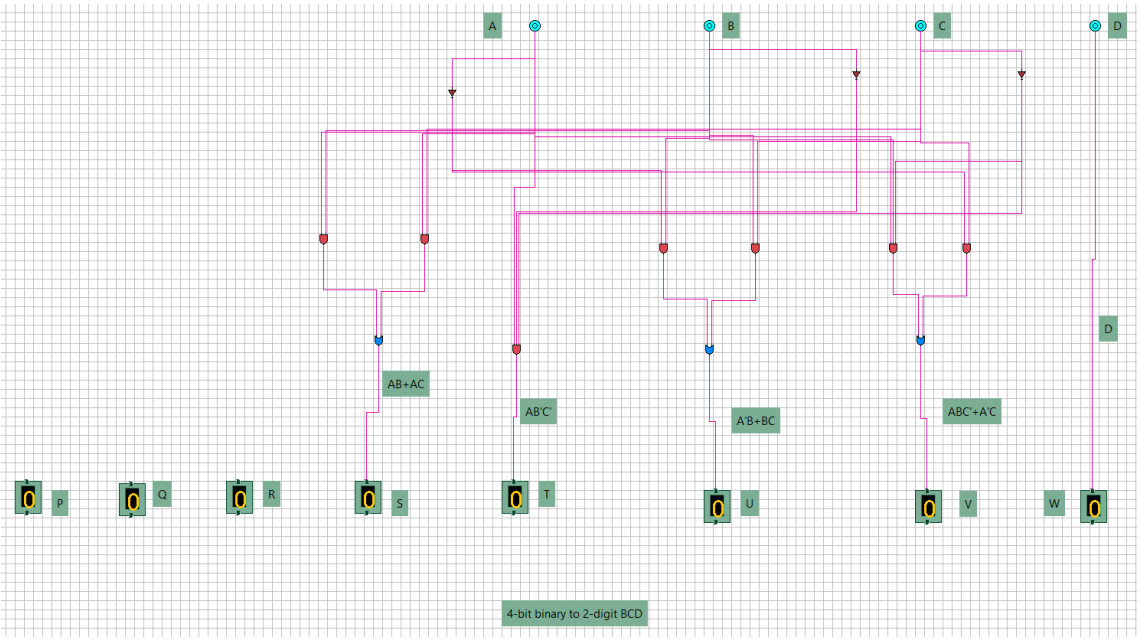
For V: The input provided at A and B is combined with the output obtained by passing the input of C through NOT gate at an AND gate. At another AND gate input provided by C and output provided by passing by the input of A through NOT gate is combined. The output obtained by the above two AND gates is passed through a OR gate to obtain the final output of V which is the first bit of BCD.

Output at V: ABC'+A'C

For W: The input provided at D is the output at W which is zeroth bit of BCD.

Output at W=D

Circuit Diagram: -



Problem 2 (Gray)

Problem Statement: -

- Develop circuits to convert from 4-bit Gray to 4-bit binary and vice-versa.

Description of the Solution including Logic Expression: -

4-bit Gray to 4-bit binary

For P: A represents the third bit of Gray and the input provided at A is the output obtained at P which is the third bit of binary.

Output at P = A

For Q: B represents the second bit of Gray. The input provided at A and the input provided at B is passed through XOR gate to obtain the final output at Q which is second bit of binary.

Output at Q = A⊕B

For R: C represents the first bit of Gray. The input at A and the input at B is passed through XOR gate and the output then obtained and the input provided at C is again passed through a XOR gate. The output obtained through this XOR gate is the final output obtained at R which is the first bit of binary.

Output at R = A⊕B⊕C

For S: D is the zeroth bit of Gray. The output obtained at R and input provided at D is then passed through XOR gate to obtain the final output at S which is zeroth bit off binary.

Output at S = A⊕B⊕C⊕D

4-bit binary to-bit Gray

For P: The input provided at A is the final output provided at P.

Output at P = A

For Q: The input provided at A and the input provided at B is passed through a XOR gate to obtain final output at Q.

Output at Q = A⊕B

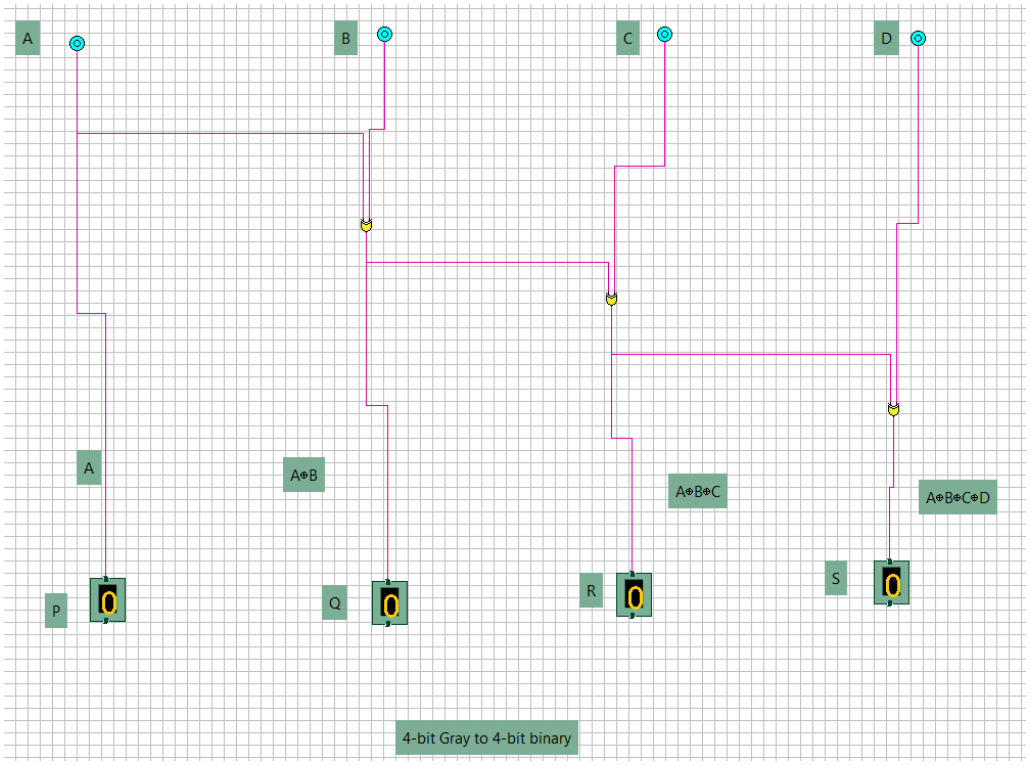
For R: Similarly, the input provided at B and the input provided at C is passed through a XOR gate to obtain the final output at R.

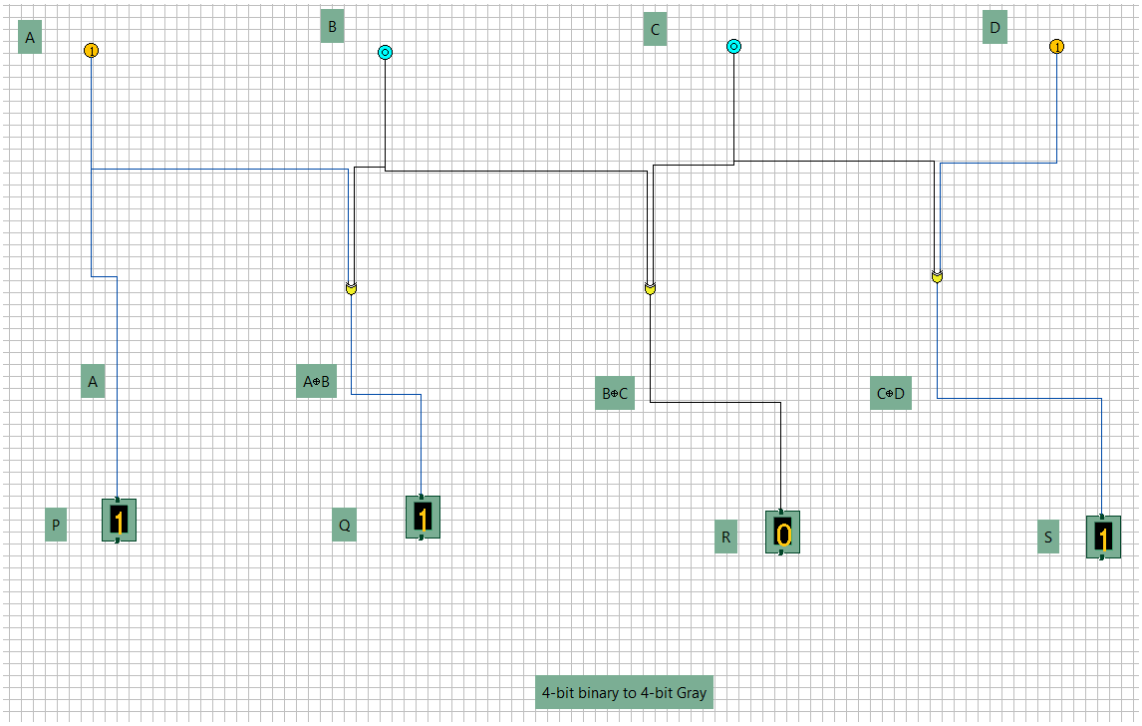
Output at R = B⊕C

For S: Similarly, the input provided at C and the input provided at D is passed through a XOR gate to obtain the final output at S.

Output at S = C⊕D

Circuit Diagram: -





Problem 3 (Excess-3)

Problem Statement: -

- Develop a half adder for handling two bits.
- Develop a full adder using half adders and any additional logic.
- Develop a ripple carry adder needed for this assignment using full adders.
- Develop circuits to convert from excess-3 to 4-bit binary and vice-versa.

Description of the Solution including Logic Expression: -

Half Adder

Input -: A, B

Sum of the half adder is obtained by passing the inputs of A and B through XOR gate whereas carry of half adder is obtained by passing the inputs of A and B by AND gate.

Sum = A⊕B

Carry= A.B

Full Adder

Inputs: - P, Q, Carry-in

Components Used: - Two half adders and an OR gate.

Carry out=P.Q + Q.C-in + P.C-in

Sum=(Cin)⊕(P⊕Q)

Ripple Carry Adder

Inputs: - Two four-bit numbers and a carry-in.

Components Used: - 4 full adders.

Two numbers which are written in four-bit form along with Carry-in is taken as input. The carry-out obtained from the first full adder is used as carry-in for the second full adder and so on.

So = Ao⊕Bo⊕Cin

S1 = A1⊕B1⊕Co

S2 = A2⊕B2⊕C1

S3 = A3⊕B3⊕C2

Carry-out = A3B3⊕B3C2⊕C2A3

Excess-3 to 4-Bit Binary

Inputs: - W, X, Y, Z

Components Used: - 7 AND gates, 3 NOT gates, and 3 OR gates

Output at A = WX+WYZ

Output at B = X'Y'+X'Z'+XYZ

Output at C = Y⊕Z

Output at D = Z'

Excess-3 to 4-Bit Binary

Inputs: - A, B, C and D

Components Used: - 4 AND gates, 3 NOT gates, and 4 OR gates

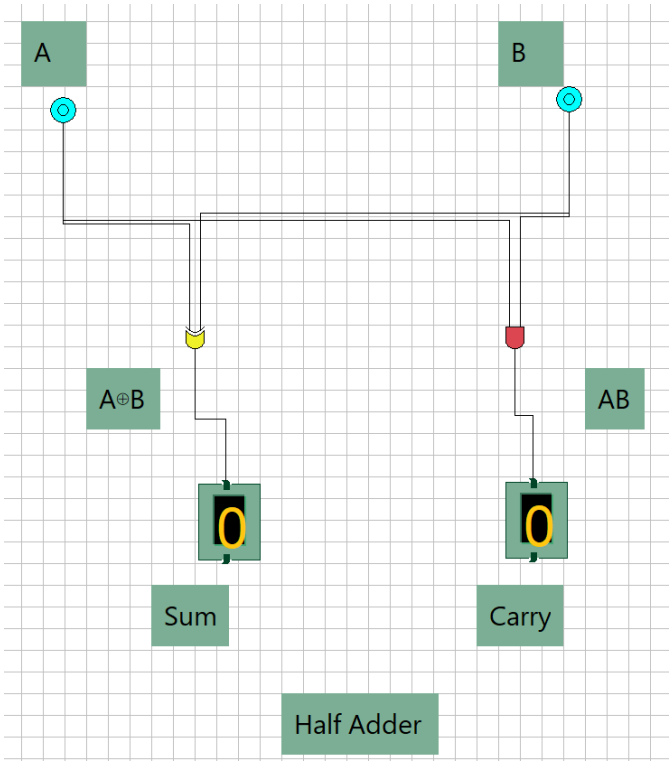
Output at W = A+BC+BD

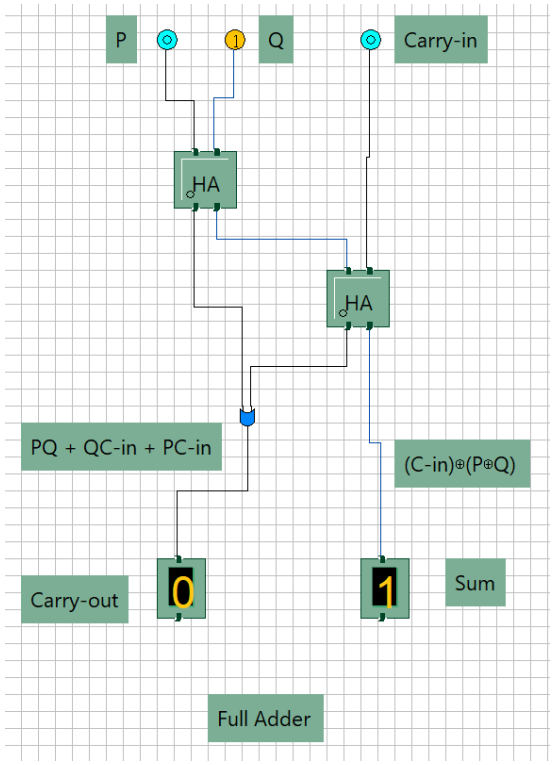
Output at X = B'C+B'D+BC'D'

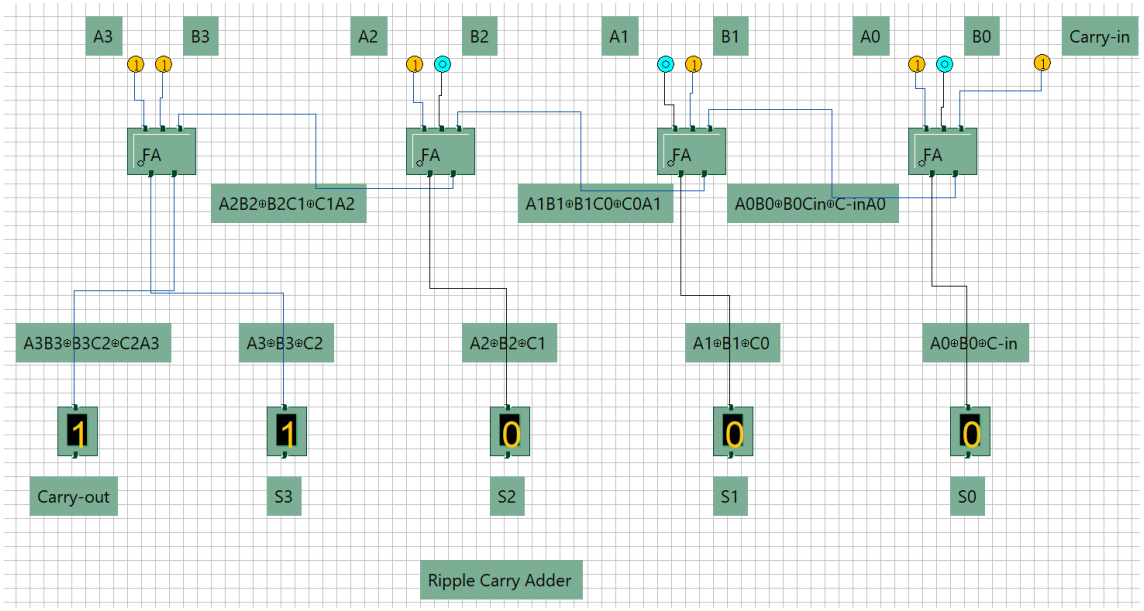
Output at Y = CD+C'D'

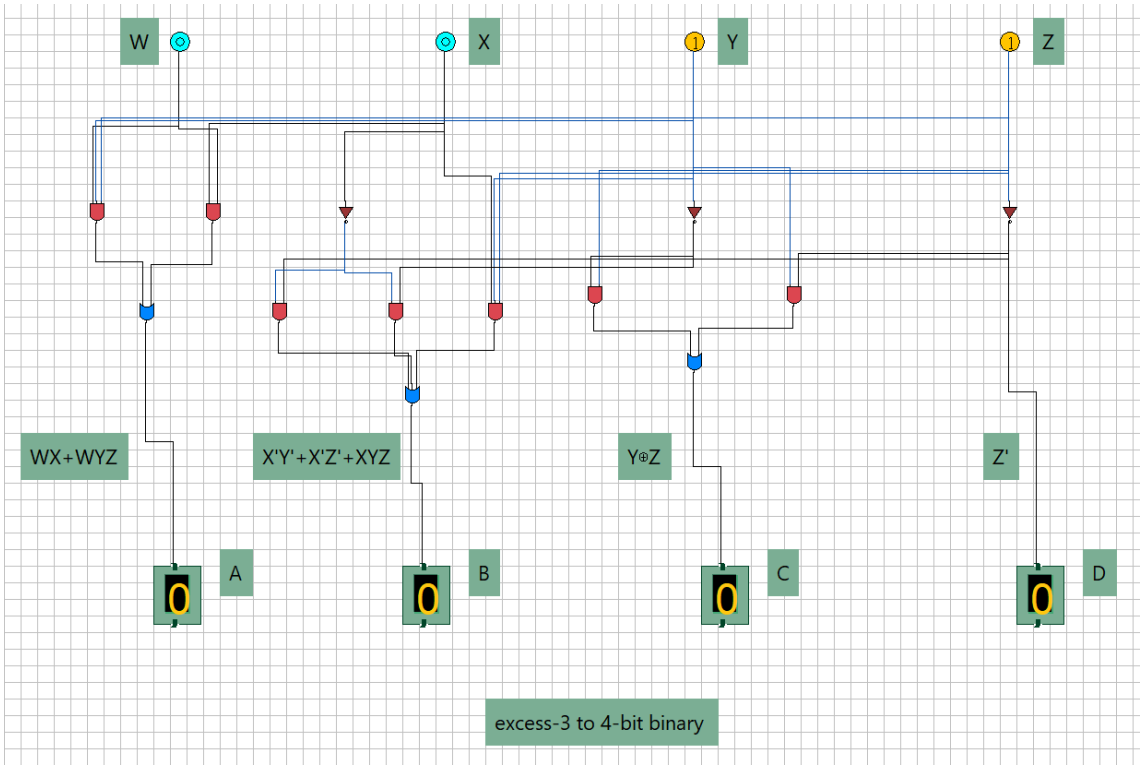
Output at Z = D'

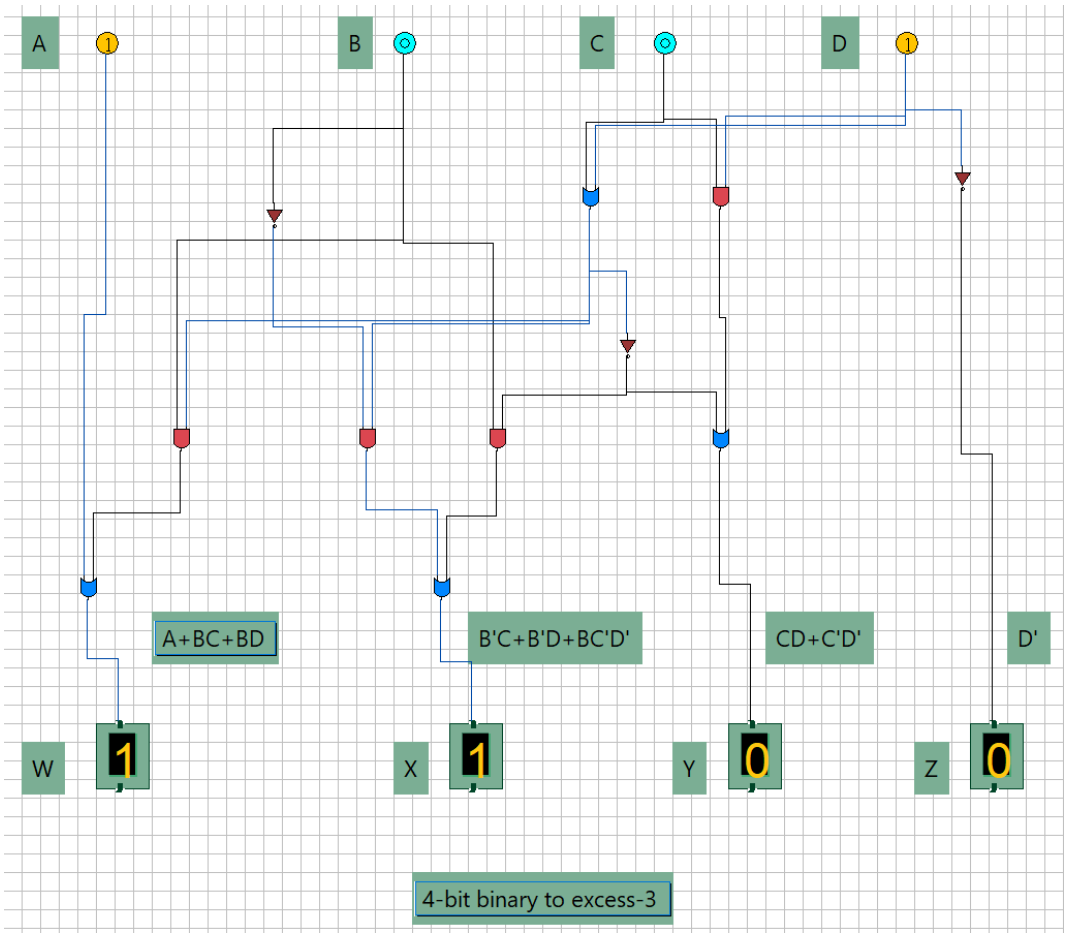
Circuit Diagram: -








W
X
Y
Z
WX+WYZ
X'Y'+X'Z'+XYZ
Y⊕Z
Z'
A
B
C
D
excess-3 to 4-bit binary


A
B
C
D
A+BC+BD
B'C+B'D+BC'D'
CD+C'D'
D'
W
X
Y
Z
4-bit binary to excess-3

–: THE END :–