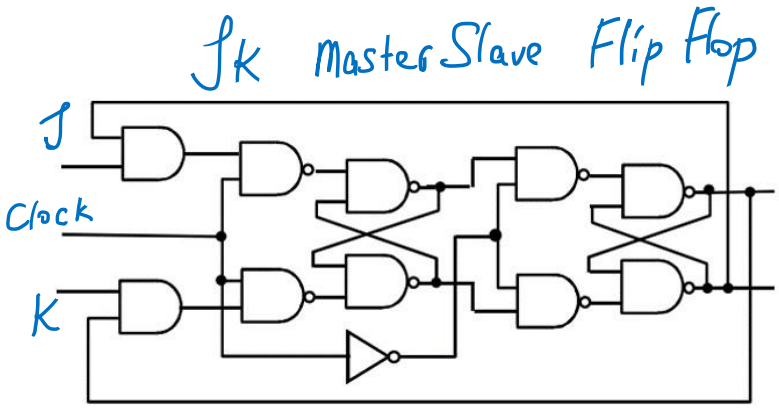
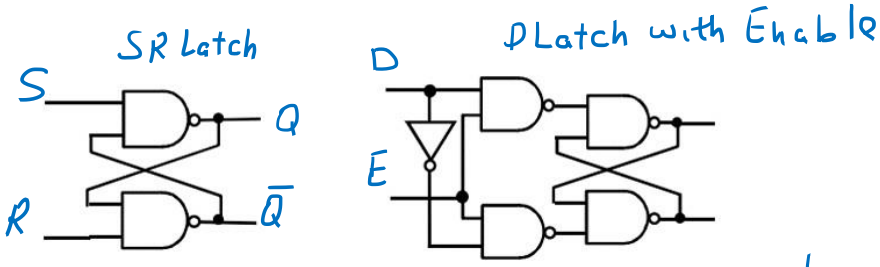
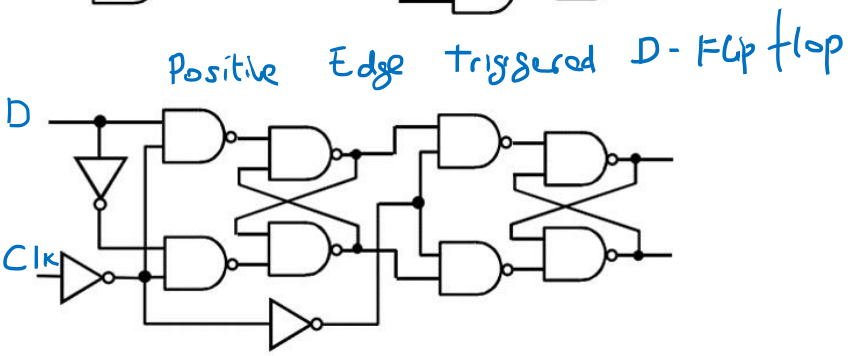
Problem 1(10%)

From the given figures below identify each appropriate flip-flops or latches and provide labels for inputs and outputs, the types of the flip-flops (e.g. positive edge trig. flip flop)





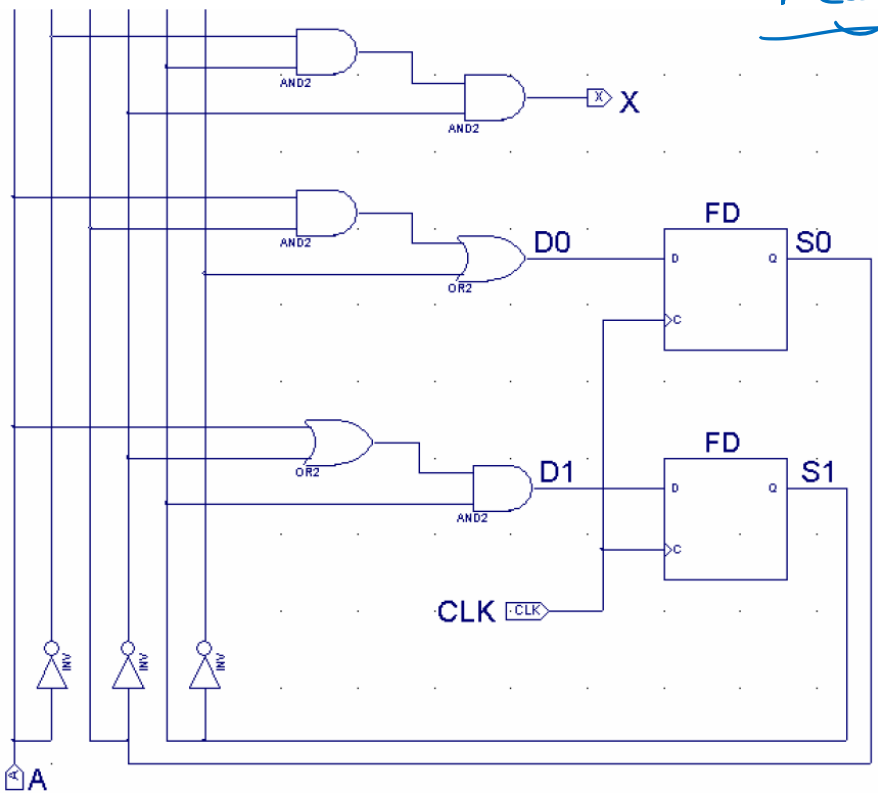


Problem 2(15%)

Provide your answers to the following questions:

a) Is the sequential circuit shown below, a Mealy or a Moore model circuit?

Mealy circuit



b) Write down the next state and output equations.

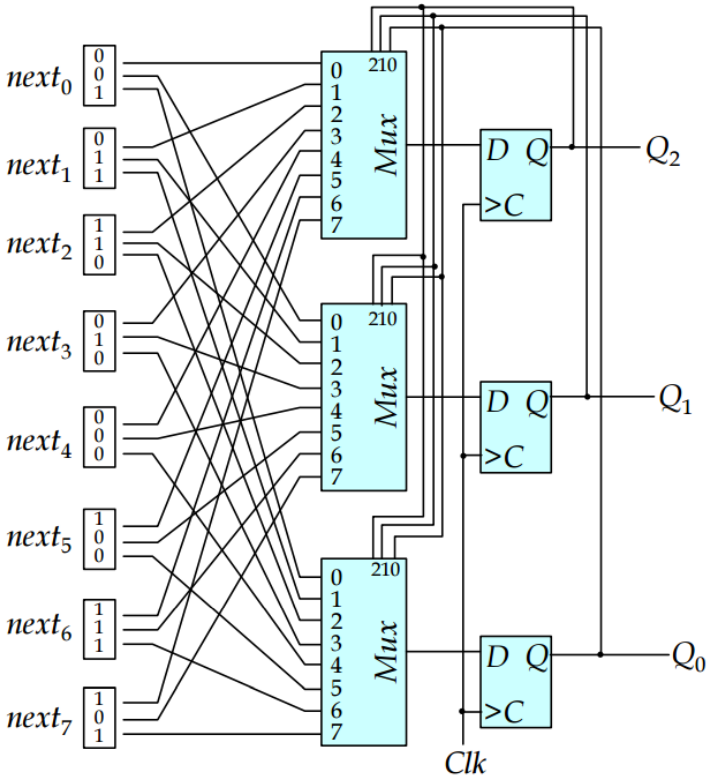
$D_0 = A S_0 + \bar{S}_1$ $D_1 = (A + \bar{S}_0) S_1$ $X = \bar{A} S_1 \bar{S}_0$

c) Make a state transition table.

S_0S_1	A	X	D_0D_1
00	0	0	10
00	1	0	10
01	0	0	01
01	1	0	01
10	0	1	10
10	1	0	10
11	0	0	00
11	1	0	11

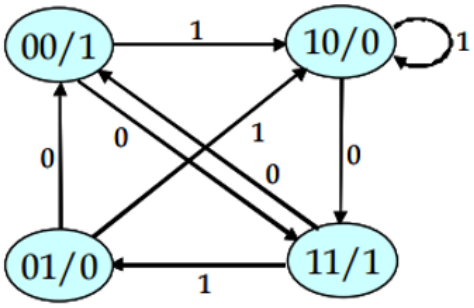
Problem 3(15%)

The circuit shown below implements a ”universal” counter that will count in arbitrary order. What values for the inputs $next_0$, ..., $next_7$ will cause the counter to implement the Gray code sequence ”000, 001, 011, 010, 110, 111, 101, 100”? Write the values next to the wires in the blank spaces given.



Problem 4 (20%)

Provide a schematic and a state equations of a sequential circuit that corresponds to the state diagram shown below.



AB X	$D_A D_B$	Y
00 0	11	1
00 1	10	1
01 0	00	0
01 1	10	0
10 0	11	0
10 1	10	0
11 0	00	1
11 1	01	1

A \ BX	00	01	11	10
0	1	1	1	0
1	1	1	0	0

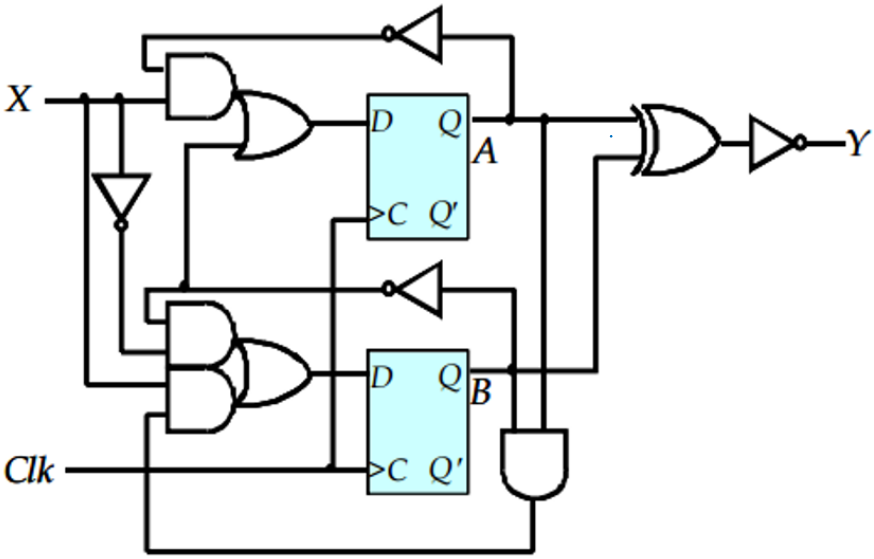
$$D_A = B' + A'X$$

A \ BX	00	01	11	10
0	1	0	0	0
1	1	0	1	0

$$D_B = B'X' + ABX$$

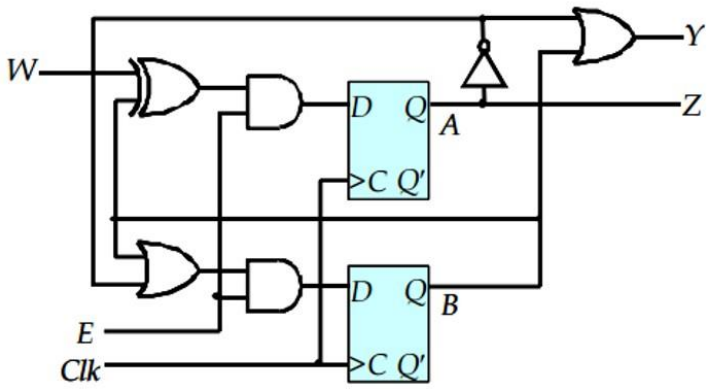
A \ BX	00	01	11	10
0	1	1	0	0
1	0	0	1	1

$$Y = (A \oplus B)'$$

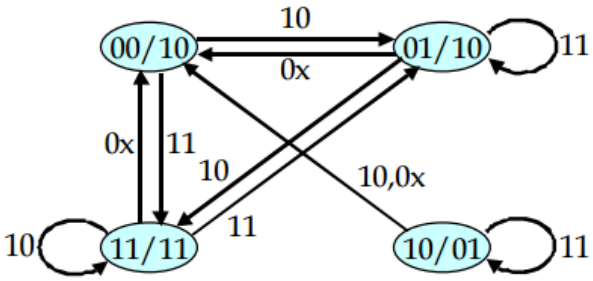


Problem 5(15%)

Sketch a state diagram for the following sequential circuit.



AB	EW	$D_A D_B$	YZ
00	0x	00	10
01	0x	00	10
10	0x	00	01
11	0x	00	11
00	10	01	10
00	11	11	10
01	10	11	10
01	11	01	10
10	10	00	01
10	11	10	01
11	10	11	11
11	11	01	11



Problem 6(15%)

Consider an SRAM with 2K words of 32 bits each.

a) How many address bits are needed to address these words? (Reminder $1024 = 2^{10}, 4096 = 2^{12}, 16,384 = 2^{14}, 65,536 = 2^{16}$.)

11

b) Assuming that the central memory array has the same number of rows as it has columns, how many rows are there?

256

c) How many words are stored in each row?

8

d) How many of the address bits are used by the row decoder?

8

e) How many are used by the column decoder?

3

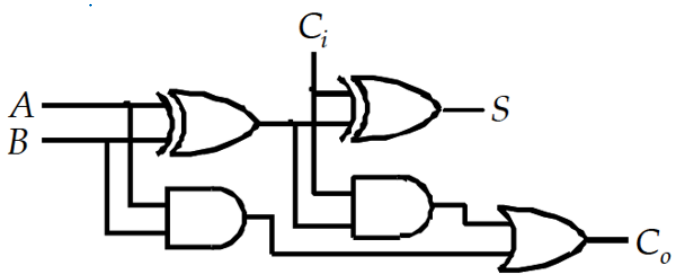
Problem 7 (10%)

Provide your answers the following questions:

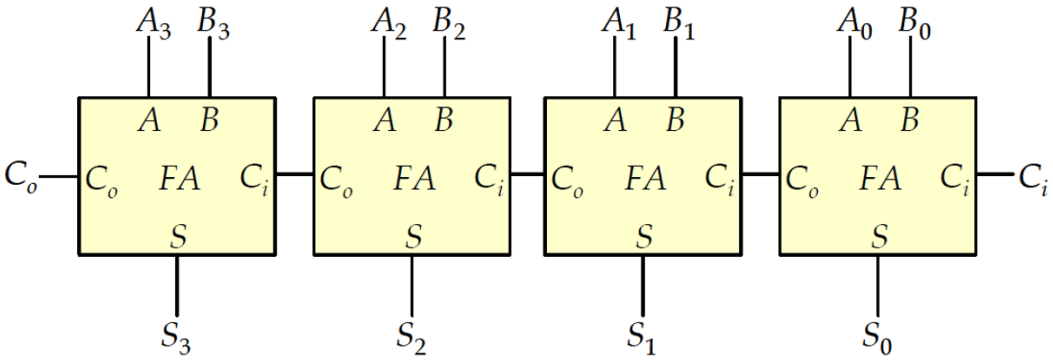
1. Provide the Boolean equations for a full-adder

$S = A \oplus B \oplus C_i \qquad C_o = AB + BC_i + AC_i$

2. Draw a logic diagram for full-adder



3. Using full-adders draw a block diagram of a 4 bit adder, making sure that outputs to your full adder blocks.



Problem 8(10%)

Provide your answers to the following problem sets:

a) What is the 2s complement of the 8 bit binary number corresponding to the hex value e5?

e5 = 11100101, so the 2s-complement of this is 0001 1011

b) What is the decimal equivalent of e5 (as a signed value)?

0001 1011 = 16 + 8 + 2 + 1 = 27, so e5 is −27

c) Compute the difference: 011011-001101 using six bit binary arithmetic, by taking the 2s complement of the second operand and then adding.

011011 − 001101 = 011011 + (110010 + 1) = 011011 + 110011 = 001110