Embedded Real-Time Systems (AME 3623)
Homework 2 Solutions

February 25, 2009

Question 1

1. (5pts) Given the binary number: 010111010. What is the decimal equivalent? What is the hexadecimal equivalent? Show your work.

   $2 + 8 + 16 + 32 + 128 = 186$

   $0xBA$

2. (5pts) Given the binary number: 110110111. What is the decimal equivalent? What is the hexadecimal equivalent? Show your work.

   $1 + 2 + 4 + 16 + 32 + 128 + 256 = 439$

   $0x1B7$

3. (5pts) Given the decimal number: 486. What is the binary equivalent? Show your work (all of the steps of the algorithm that we discussed in class).

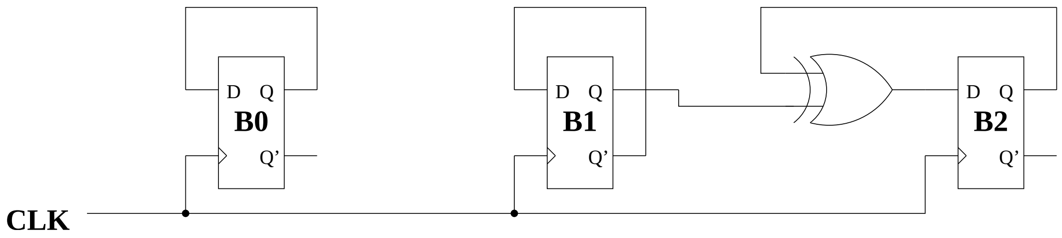
value	**binary**	i	2^i
486	000000000		
		8	256
230	100000000		
		7	128
102	110000000		
		6	64
38	111000000		
		5	32
6	111100000		
		2	4
2	111100100		
		1	2
0	111100110		

4. (5pts) Given the decimal number: 524. What is the binary equivalent? Show your work.

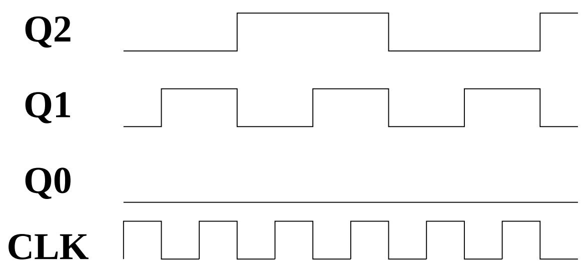
value	**binary**	i	2^i
524	0000000000		
		9	512
12	1000000000		
		3	8
4	1000001000		
		2	4
0	1000001100		

Question 2

Consider the following circuit with input CLK:



1. (10pts) Assume that the initial state is: $Q0 = 0$, $Q1 = 0$, $Q2 = 0$ Show the timing diagram for $Q0$, $Q1$ and $Q2$ as the clock (CLK) is pulsed (show 6 transitions).



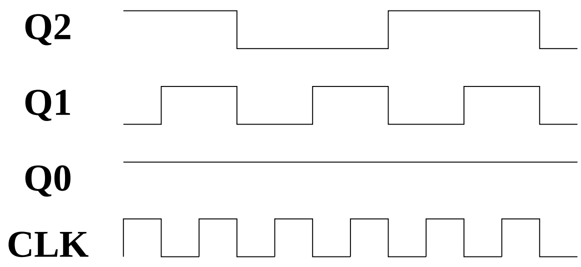
2. (10pts) Interpreting $Q2$, $Q1$, $Q0$ as a 3-bit binary number (with $Q0$ as the 1's digit), what is the sequence of values that this circuit produces?

   $Q2, Q1, Q0 = 000, 010, 100, 110, 000, 010, 100, ...$

   or:

   $0, 2, 4, 6, 0, 2, 4, ...$

3. (10pts) Assume that the initial state is: $Q0 = 1$, $Q1 = 0$, $Q2 = 1$ Show the timing diagram for $Q0$, $Q1$ and $Q2$ as the clock (CLK) is pulsed (show 6 transitions).



4. (10pts) Interpreting $Q2$, $Q1$, $Q0$ as a 3-bit binary number (with $Q0$ as the 1's digit), what is the sequence of values that this circuit produces?

   $Q2, Q1, Q0 = 101, 111, 001, 011, 101, 111, 001, ...$

   or:

   $5, 7, 1, 3, 5, 7, 1, ...$

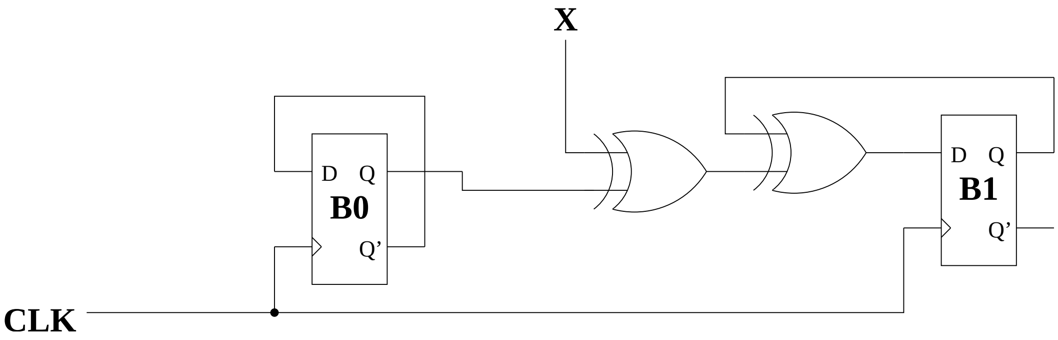
5. (10pts) What is the mathematical function of this circuit?

   The circuit counts by two on each clock cycle.

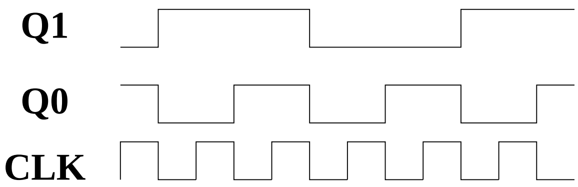
   (modulo 8 = after the counter reaches 7, it starts over again).

Question 3

Consider the following circuit with inputs CLK and X:



1. (10pts) Assume that the initial state is: $Q0 = 1$ and $Q1 = 0$. Assume also that $X = 0$. Show the timing diagram for $Q0$ and $Q1$ as the clock (CLK) is pulsed.



2. (10pts) Interpreting $Q1$, $Q0$ as a 2-bit binary number (with $Q0$ as the 1's digit), what is the sequence of values that this circuit produces?

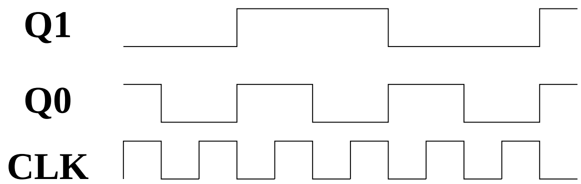
   $Q_1\,Q_0 = 01, 10, 11, 00, 01, 10, 11, ...$

3. (10pts) What is the mathematical function of this circuit when $X = 0$?

   Counts by 1 on each clock tick (modulus 4).

4. (10pts) Assume the same initial state as above, and assume that $X = 1$. Show the timing diagram for $Q0$ and $Q1$ as the clock (CLK) is pulsed.

   Note: $A \oplus 1 = \bar{A}$.



5. (10pts) What is the sequence of values that this circuit produces?

   $Q_1\, Q_0 = 01, 00, 11, 10, 01, 00, 11, ...$

6. (10pts) What is the function of this circuit when $X = 1$?

   Downward counting, modulus 4.