# Embedded Real-Time Systems (AME 3623)
# Homework 3 Solutions

February 24, 2006

## Question 1

1. (5pts) Given the binary number: 1001011. What is the decimal equivalent? Show your work.

   $64 + 8 + 2 + 1 = 75$

2. (5pts) Given the binary number: 111010. What is the decimal equivalent? Show your work.

   $32 + 16 + 8 + 2 = 58$

3. (5pts) Given the decimal number: 68. What is the binary equivalent? Show your work (all of the steps of the algorithm that we discussed in class).

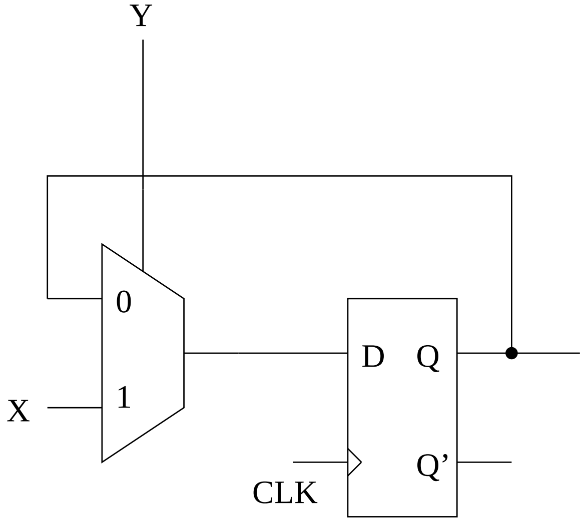
| **value** | **binary** | $i$ | $2^i$ |
|---|---|---|---|
| 68 | 0000000 | | |
| | | 6 | 64 |
| 4 | 1000000 | | |
| | | 2 | 4 |
| 0 | 1000100 | | |

4. (5pts) Given the decimal number: 122. What is the binary equivalent? Show your work.

| **value** | **binary** | $i$ | $2^i$ |
|---|---|---|---|
| 122 | 0000000 | | |
| | | 6 | 64 |
| 58 | 1000000 | | |
| | | 5 | 32 |
| 26 | 1100000 | | |
| | | 4 | 16 |
| 10 | 1110000 | | |
| | | 3 | 8 |
| 2 | 1111000 | | |
| | | 1 | 2 |
| 0 | 1111010 | | |

## Question 2

Given the following circuit:




(15pts) Explain in detail what this circuit does in terms of its inputs ($X$, $Y$, and $CLK$). (Multiplexer notation note: the 0 and 1 tell you which input is selected when $Y$ is in these states)

When $Y = 0$, the flip-flop will maintain its current state (even as the clock cycles).

When $Y = 1$, the flip-flop stores the value of $X$ when the clock transitions from high to low.

(Note: this is going to become a critical component in the design of our RAM)

# Question 3

Following the steps below (and our design procedure from class), design a counter that counts down from 7 to 2. After 2, the counter returns to 7.

1. (10pts) Show the truth table

   Our general approach will be to use D flip-flops with a common clock signal driving each one. So – we are looking to design a combinatorial circuit that will transform the set of $Qi$'s (representing the current state) into a representation of the next state (the $Di$'s). In addition, since the 000 and 001 cases never occur, we can treat these as "don't care" conditions.

| Q2 | Q1 | Q0 | D2 | D1 | D0 |
|---|---|---|---|---|---|
| 0 | 0 | 0 | x | x | x |
| 0 | 0 | 1 | x | x | x |
| 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 | 0 |

2. (15pts) Show the Karnaugh map for the first bit, the clusters, and the resulting algebraic expression.

$D0$

| | | | | | |
|---|---|---|---|---|---|
| | | | | Q2 | |
| | $Q2Q1$ | | Q1 | | |
| $Q0$ | | 00 | 01 | 11 | 10 |
| $Q0$ | 0 | x | 1 | 1 | 1 |
| | 1 | x | 0 | 0 | 0 |

$D0 = \overline{Q0}$

3. (15pts) Show the Karnaugh map for the second bit, the clusters, and the resulting algebraic expression.

$D1$

| | | | | | |
|---|---|---|---|---|---|
| | | | | Q2 | |
| | $Q2Q1$ | | Q1 | | |
| $Q0$ | | 00 | 01 | 11 | 10 |
| $Q0$ | 0 | x | 1 | 0 | 1 |
| | 1 | x | 1 | 1 | 0 |

$D1 = \overline{Q0}\ \overline{Q1} + Q0Q1 + Q1\overline{Q2} = \overline{Q0 \oplus Q1} + Q1\overline{Q2} = \overline{Q0} \oplus Q1 + Q1\overline{Q2}$

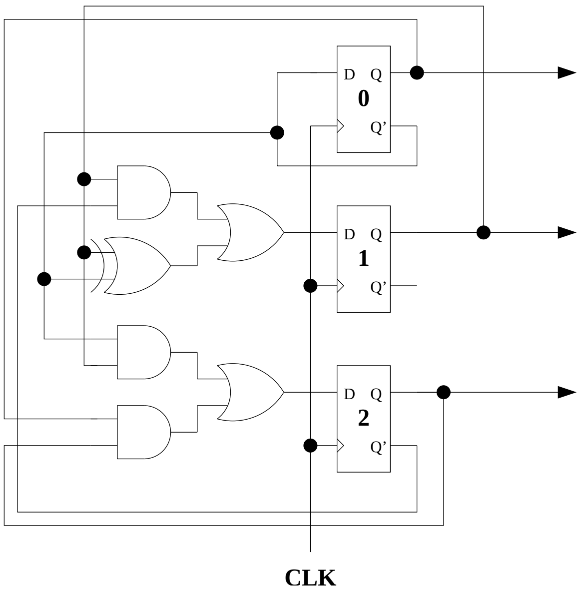
4. (15pts) Show the Karnaugh map for the third bit, the clusters, and the resulting algebraic expression.

$D2$

| | | | | Q2 | |
|---|---|---|---|---|---|
| | $Q2Q1$ | | Q1 | | |
| $Q0$ | | 00 | 01 | 11 | 10 |
| $Q0$ | 0 | x | 1 | 1 | 0 |
| | 1 | x | 0 | 1 | 1 |

$D2 = \overline{Q0}\ Q1 + Q0Q2$

5. (15pts) Show the full circuit




# Question 4

How much time did you spend on this assignment?