

# Embedded Real-Time Systems (AME 3623)

## Homework 3 Solutions

March 9, 2007

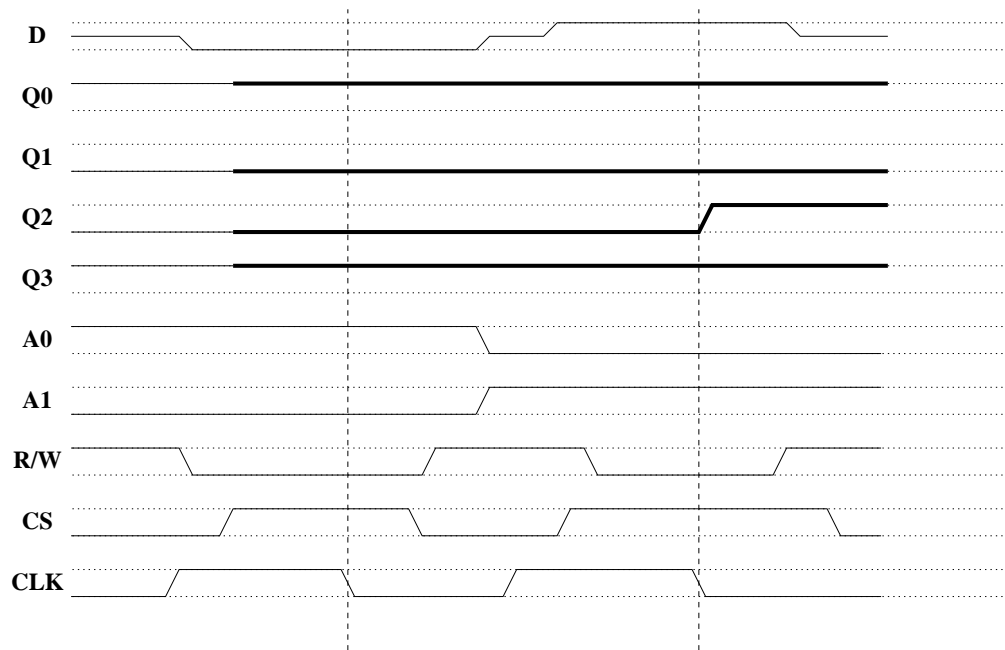
## Question 1

(10pts) Consider the four-element memory “chip” that we discussed in class (each element is “one bit wide”). Given the following timing diagram, fill in the missing traces ( $Q0$ ,  $Q1$ ,  $Q2$ , and  $Q3$ ).

Hint: first re-examine the rules for writing to and reading from a memory chip.

*Both memory accesses are write operations; they affect the state of  $Q1$  and  $Q2$ , respectively (but only when the clock transitions from high to low). However, the state of  $Q1$  does not change.*

*(answer is shown in bold)*

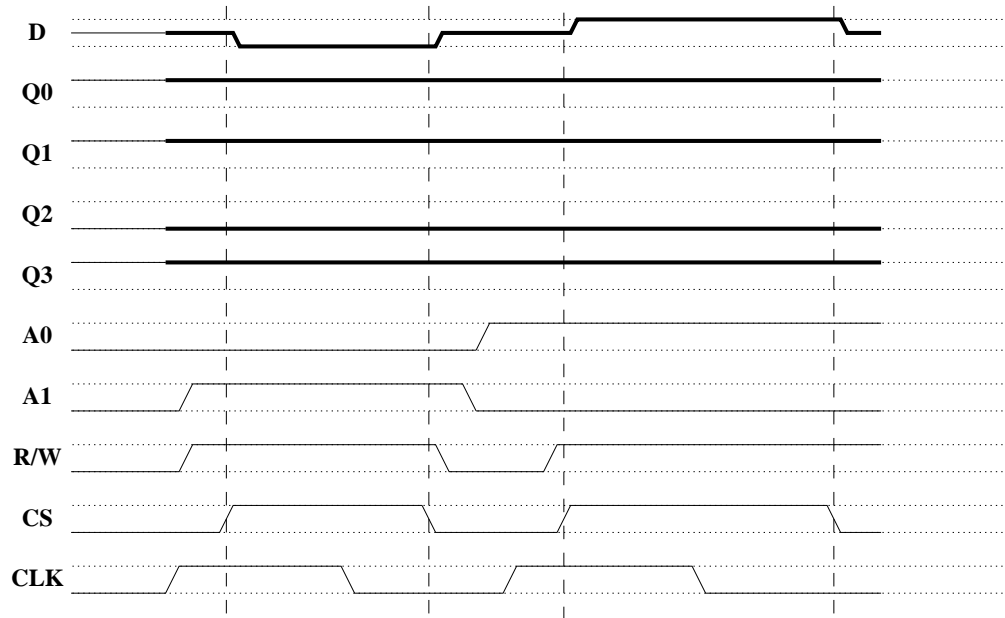


## Question 2

(10pts) Consider the same four-element memory chip. Given the following timing diagram, fill in the missing traces ( $D$ ,  $Q0$ ,  $Q1$ ,  $Q2$ , and  $Q3$ ).

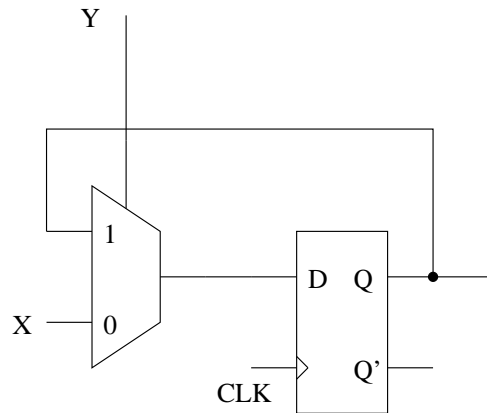
*Both of these operations are read operations of elements  $Q2$  and  $Q1$ . None of the memory elements change state. The data bus is driven during the entire time that the chip select line is high.*

*(answer is shown in bold)*



### Question 3

Consider the following circuit:



1. (10pts) Describe the behavior of this component of a memory circuit in terms of the inputs  $X$ ,  $Y$ , and  $CLK$ . Specifically, describe what  $Q$  does as these signals change.

When  $Y = 1$ ,  $Q$  never changes state no matter what  $X$  and  $CLK$  do.

When  $Y = 0$ ,  $Q$  copies the value of  $X$  when  $CLK$  transitions from high to low. In this case, we can say that  $X$  is written to this memory component.

2. (10pts) Assume memory control signals in the previous problems ( $CS$ ,  $R/W$ ,  $A1$ , and  $A0$ ), and that this is memory element number 2 (counting from 0). Give the truth table for  $Y$  given these input signals such that this memory element is written to at the appropriate time.

$CS$	$R/W$	$A1$	$A0$	$Y$
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

3. (10pts) Give the truth table for  $\bar{Y}$ .

$CS$	$R/W$	$A1$	$A0$	$\bar{Y}$
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

4. (10pts) Using what you know about  $\bar{Y}$ , design the circuit that implements  $Y$ .

