A_2
Assignment 2

CS 3482; Professor Tang

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1. **Question:**

   Construct and package D Flip-flop (call it `D-FF`) and D Latch (call it `Dlatch`). Compare the functions of your `D-FF` and D-latch using the following circuit[1]. Show your test circuit and a wave form that demonstrates that

   (a) `D-FF` changes its value `Q(FF)` from 0 to 1 and 1 to 0 at rising edges of D,

   (b) D-latch changes its values `Q(Latch)` from 0 to 1 and 1 to 0 (following D) when $G = 1$.

   You need to annotate on the wave form for the changes above.

   Answer:

   Insert Answer here

2. **Question:**

   Build and package a 4-bit register (call it `Reg-4`). Test your 4-bit register using the following circuit[2]. Show your simulation to demonstrate that your register can transfer its data to another one at the same time it receives new data.

   You need to build and package a quadruple 2-to-1 multiplexer without enable control first. Name it as `4mux-2` with the corresponding pin names in the circuit.

   Show your test circuit and a wave form to demonstrate that registers A, B and C store and rotate hex B, 6 and A at each rising edges of `CLK`. You need to annotate on the wave form for the changes of registers.

   Answer:

   Insert Answer here

3. **Question:**

   Design and implement a 4-bit up counter (call it `UCT4`) as a finite-state machine using D flip-flops following the steps as follows:

[1] Question related diagrams and graphics have been omitted.

[2] See footnote 1

(a) Draw the truth tables for D_3, D_2, D_1, D_0 of the flip-flops in terms of Q_3, Q_2, Q_1, Q_0 of the previous cycle.

(b) Use Karnaugh map to find the simplest sum-of-product equations for D_3, D_2, D_1, D_0.

(c) Implement the counter using the equations obtained and show the internal circuit of the counter.

(d) Build a circuit to test your `UCT4`. Show the test circuit and a wave form to demonstrate that

i. The counter `UCT-4` can increase the counter output from hex 0 to F and goes back to 0 after F.

ii. The Q_3, Q_2, Q_1 and Q_0 changes values at the same time when the output changes from F to 0.

You need to annotate on the wave form for the two points above.

Answer:

Insert Answer here

4. **Question:**

Design and implement a 4-bit up counter with parallel load (call it `UCT4-LD`) based on the up-counter of finite-state machine you built above with the following pins:

- `CLR` for the active-low clear to set the counter to all 0.
- G for the input to change the counter value at the rising edge of clock cycle
- D_{30} for the parallel load data input 1
- `LD` to control the parallel data load. When `LD` = 1, the counter receives the parallel data from D_{30} at the rising edge of G. When `LD` = 0, the counter value is incremented at the rising edge of G.
- Q_{30} to output the 4-bit value of the counter

You need to use the quadruple 2-to-1 multiplexer you built in lab 4.

(a) Build the `UCT4-LD` and show the internal circuit of the counter.

(b) Build a circuit to test your `UCT4-LD`. Show the test circuit and a wave form to demonstrate that

i. The counter `UCT4-LD` can increase the counter output from hex 0 to 5, then load hex A to the counter, and then switch to the counting mode to count from A to F and then to 0.

You need to annotate on the wave form for the time of each change.

Answer:

Insert Answer here

5. **Question:**

   Build and package a 16x8 RAM memory array called `RAM16x8` using D-latches and package. Show the internal circuit of your `RAM16x8`. (Use the reduced size).

   Answer:

   Insert Answer here

6. **Question:**

   Use the following test circuit[3] to test your 16x8 bi-directional memory system.

   Show your test circuit and a wave form of test that writes hex 37 and A7 to memory locations 7 and 8, respectively, and then reads locations 7 and 8.

   You need to annotate on the wave form for the relevant times of these writings and readings.

   Answer:

   Insert Answer here

7. **Question:**

   Then remove all the input devices and replace them with input and bi-directional pins and package and call it `MyMemoryChip`.

   (a) Show the internal circuit of `MyMemoryChip`.

   (b) Test your `MyMemoryChip` with the following circuit[4].

   Show your test circuit and a wave form of the test that writes hex 8C and 6E to location 9 and A, respectively, and then reads locations 9 and A.

   You need to annotate on the wave for the relevant times of the writings and readings.

   Answer:

   Insert Answer here

[3] See footnote 1
[4] See footnote 1