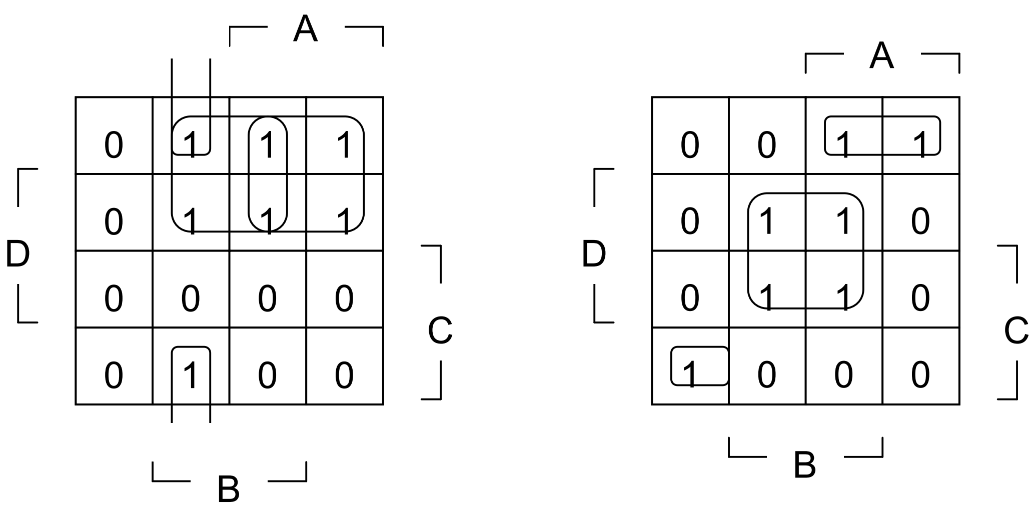
Name: ______________________

CS 4/55111 # Midterm Exam **VLSI Design**

Wednesday 3 November 2004

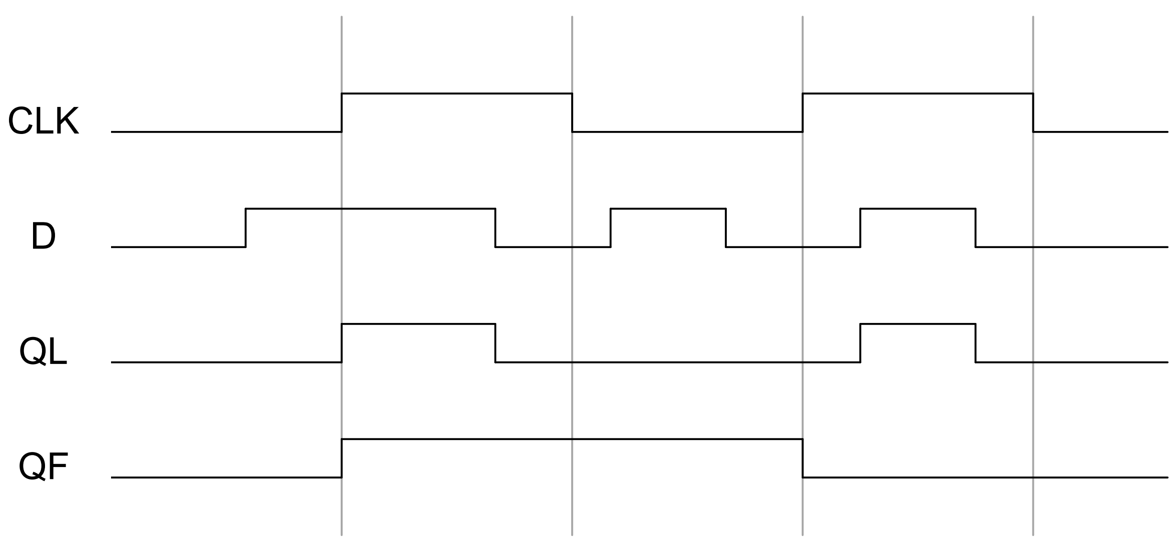
1. Given the two 4-variable Karnaugh maps below, circle the 1's and write the minimized expression below each map. (20 points)



Output = AC' + BC' + A'BD'

Output = AC'D' + BD + A'B'CD'

2. Suppose signal D is connected to the input of both a D latch and a rising-edge triggered D flip-flop. Show the output produced by the latch (QL) and the flip-flop (QF). Do not show the short propagation delay through each device. (15 points)



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3. What is a tri-state device, and what can it be used for? (10 points)

A tri-state device has an input, and a control input, and an output, and works somewhat like a water faucet. When the control input is 1, the input value flows through to the output. When the control input is 0, the output is high-impedance, meaning it is effectively off.

It can be used to implement a bi-directional output, or to control which one of a set of registers can send its value out onto a bus.

4. What capabilities are provided by Altera's graphical editor for schematic capture that make it more suitable for entering circuits than a typical drawing package (for example, using the drawing tools in Microsoft Word)? (10 points)

The graphical editor enters the circuit schematic into the Max+PlusII system, where it can be compiled, simulated, analyzed, and downloaded onto an FPLD. It also has tools specifically oriented toward drawing circuits, such as the smart tool that switches from a selection too to a line tool when appropriate, and functionality such as rubber-banding, where the connecting lines are automatically stretched or moved when a component as moved.

5. When doing a project on the Altera UP1 board, it is occasionally necessary to have two versions of a design — one to simulate, and a slightly different one to run on the board. Why is this necessary? Explain and cite one or two specific examples. (10 points)

Simulations take time to run, so while it may be desirable to have the design that runs take a second or more between events, speeding the design up during simulation makes the simulation run quicker. For example, in the stopwatch project, it was necessary to have one design to run, where the digits changed once per second, but and another design to simulate, where the digits changed more rapidly.

6. Consider the following AHDL code fragment:

```
count[ ].clk = clock;

IF load THEN
    count[ ].d = d[ ];
ELSEIF enable THEN
    count[ ].d = count[ ].q + 1;
ELSE
    count[ ].d = count[ ].q;
END IF;

q[ ] = count;
```

a. **Explain what the IF…ELSEIF…ELSE..END IF statement is doing. (10 points)**

If the **load** input is high, then the input from outside, **d**, is loaded into the counter by sending it to the counter's **d** input.

If the **load** input is not high, but the **enable** input is high, then the counter should count, which is accomplished by adding 1 to its **q** output and sending that back to its **d** input.

If neither the **load** input nor **enable** input is high, then the counter should keep its pervious value, which is accomplished by sending its **q** output back to its **d** input, making it re-store the same value.

b. **What would happen if the first line ("count[ ].clk = clock;") and the last line ("q[ ] = count;") were interchanged? Explain. (10 points)**

It won't have any effect. Since the three statements are executed concurrently, interchanging the first and last statement has no effect.

7. **The electronic lock discussed in class recognized a 5-digit password by starting in state s0, moving from that state to states s1, s2, s3, s4, and s5 with each successfully-entered digit, eventually ending up in state s5 which unlocked the lock. When the lock was in state s0, a "ready" or "start" LED was lit up; when it was in states s1 through s4 an "active" or "more" LED was lit up; and when it was in state 5 an "unlock" LED was lit up. To avoid letting the user know when an incorrect digit was entered, the state machine was modified to add another set of states. Draw a diagram showing the resulting states and state transitions, and explain this modification. (15 points)**

See class slides.