

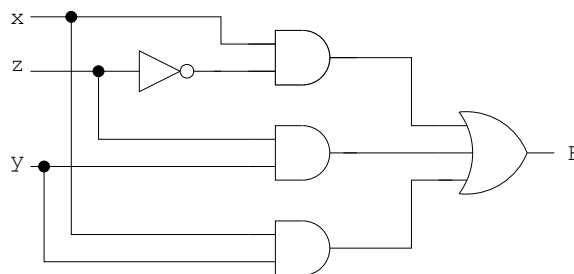
EE 231
Final Exam
December 18, 2008

Name: _____

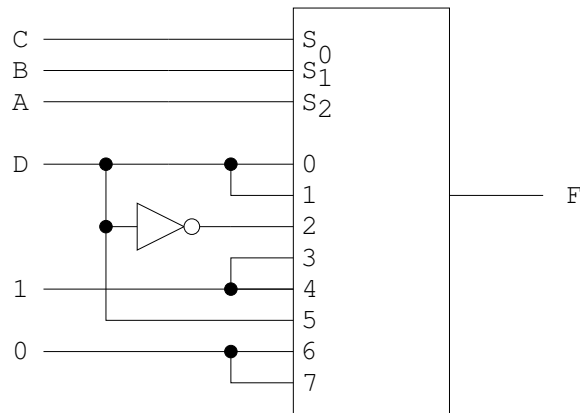
Show all work. Partial credit will be given. No credit will be given if an answer appears with no supporting work.

1. Circle the correct answer to questions below:

- (a) A serial shift register with complemented feedback from the output of the last flip-flop to the input of the first is called a:
 A. Binary Counter B. Gray Code Counter C. Johnson Counter D. Ring Counter
- (b) A finite state machine in which the output depends on the present state and the present inputs is called a:
 A. Mealy machine B. Mannie machine C. Moore machine D. Vending machine
- (c) A finite state machine in which the output depends only on the present state is called a:
 A. Mealy machine B. Mannie machine C. Moore machine D. Vending machine
- (d) Boundary scan is a technology which allows an engineer to:
 A. Verify that the size of the printed wiring board is correct
 B. Verify the complete functionality of a manufactured board
 C. Verify that the inputs and outputs of a chip with boundary scan are not connected to power or ground
 D. All of the above
- (e) A unit which tells an engineer the failure rate of a component is called a:
 A. FIT B. BSDL C. CPLD D. EST
- (f) The D flip-flop is an example of what type of Boolean circuit?
 A. Sequential B. Combinational C. Mealy machine D. PAL



- (g) The figure above implements the Boolean function:
 A. $F(x, y, z) = \sum(2, 3, 5, 6)$
 B. $F(x, y, z) = \sum(3, 4, 6, 7)$
 C. $F(x, y, z) = \sum(1, 3, 6, 7)$
 D. $F(x, y, z) = \sum(0, 2, 4, 6)$



(h) The figure above implements the Boolean function:

- A. $F(A, B, C, D) = \sum(0, 2, 3, 5, 6, 8, 12, 13)$
- B. $F(A, B, C, D) = \sum(1, 3, 4, 6, 7, 8, 12, 13)$
- C. $F(A, B, C, D) = \sum(0, 2, 4, 5, 7, 8, 9, 11)$
- D. $F(A, B, C, D) = \sum(1, 3, 4, 6, 7, 8, 9, 11)$

```
reg [1:0] R1, R2, R3;
```

```
always @(posedge clock)
    R1 = R1 + 2'h3;
    R2 = R1 + 2'h1;
    R3 = R1 - R2;
```

(i) For the Verilog code above, $R1 = 2'h1$, $R2 = 2'h2$, and $R3 = 2'h3$ before the clock edge. What is the value of $R3$ after the clock edge?

- A. 0 B. 1 C. 2 D. 3

```
reg [1:0] R1, R2, R3;
```

```
always @(posedge clock)
    R1 <= R1 + 2'h3;
    R2 <= R1 + 2'h1;
    R3 <= R1 - R2;
```

(j) For the Verilog code above, $R1 = 2'h1$, $R2 = 2'h2$, and $R3 = 2'h3$ before the clock edge. What is the value of $R3$ after the clock edge?

- A. 0 B. 1 C. 2 D. 3

2. Simplify the following Boolean equation using Boolean algebra:

$$(A + B)'(A' + B')$$

3. Represent the following numbers in 8-bit two's complement form:

(a) +37

(b) -37

4. A RAM chip has 13 address lines and 16 data lines.

(a) How many words (unique address locations) does the RAM hold?

(b) How many bytes does the RAM hold?

5. The following two problems deal with the Hamming code for error detection and correction. The numbers are of the form $P_1 P_2 D_3 P_4 D_5 D_6 D_7 P_8 D_9 D_{10} D_{11} D_{12} P_{13}$, where P_{13} is the overall parity bit.

(a) Consider the binary number 11011011_2 . Generate the Hamming code for the number which will allow you to correct one-bit errors and detect two-bit errors.

(b) You read the number 0 0110 0010 0100 from a memory which uses error detection and correction. What was the original 8-bit data word which was written to memory?

6. Answer the following questions about combinational logic functions:

(a) Consider the function $F(w, x, y, z) = \sum(0, 1, 2, 3, 4, 5, 6, 7, 9, 12, 13, 14)$

i. Draw a Karnaugh map for the function.

ii. Identify the prime implicants, and indicate which ones are essential.

iii. Write down a minimum sum of products for the function.

iv. Write down a minimum product of sums for the function.

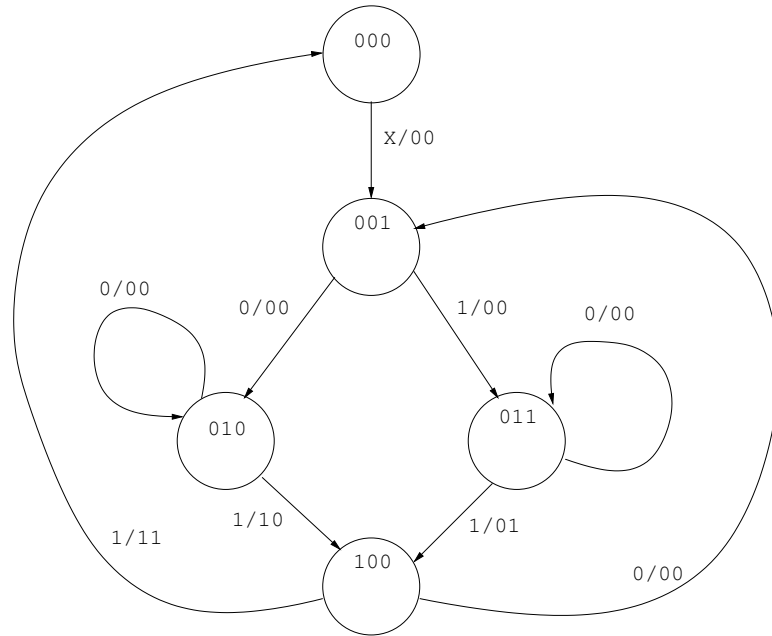
(b) Consider the function $F(w, x, y, z) = \sum(3, 5, 6, 7, 13)$ and $d(w, x, y, z) = \sum(1, 2, 4, 12, 15)$, where the d states are don't cares.

i. Draw a Karnaugh map for the function.

ii. Write down a minimum sum of products for the function.

- (c) Consider the Boolean function $F(w, x, y) = \sum(0, 3, 4, 5)$. Implement this function using a 4x1 multiplexer and an inverter.

7. The figure below shows a state diagram for a digital circuit. The state is held in three D flip-flops $Q_2Q_1Q_0$, the input to the system is x , and the outputs are y and z .

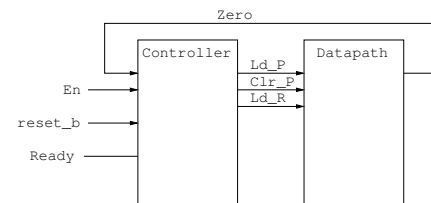
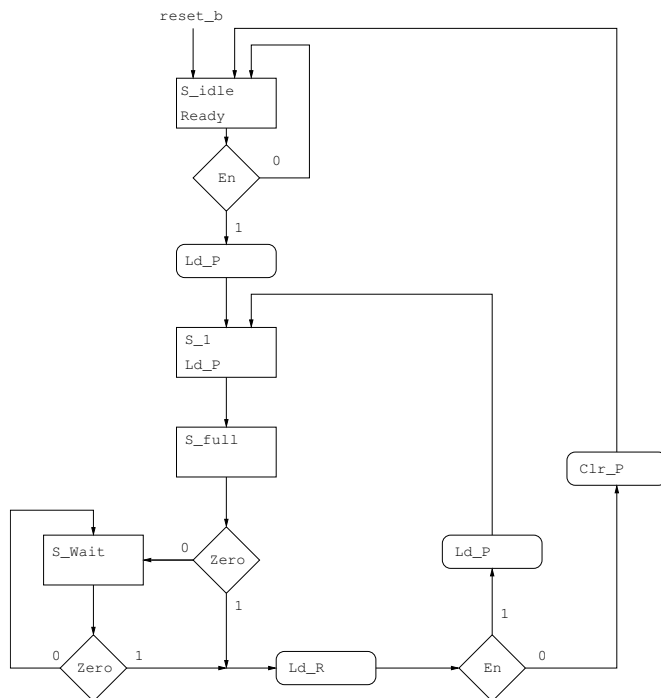


- (a) Is this a Moore machine or a Mealy machine? Explain.

- (b) Tabulate the state transition table for this circuit, showing the next states and outputs based on the current states and inputs to the controller.

- (c) Write down the equations for the next state (the inputs $D_2D_1D_0$ to the three D flip-flops) and outputs (y and z).

8. The figure below shows the ASMD for a controller.



(a) Draw the state transition diagram for the circuit.

(b) Tabulate the state transition table for the circuit, showing the next states and outputs based on the current states and inputs to the controller.