Name: ______________________________

Problem	Points	Score
1a	10	
1b	10	
1c	10	
2a	10	
2b	10	
2c	10	
2d	10	
3a	10	
3b	10	
3c	10	
Total	**100**	

Notes:

1. The exam is closed book / closed notes. Students are allowed a copy sheet — only ONE standard US-size (8.5” x 11”) sheet of paper — on which they can write relevant information such as theorems.

2. Please show ALL work. Incorrect answers with no supporting explanations or work will be given no partial credit.

3. If I can’t read or follow your solution, it is wrong, and no partial credit will be given — PLEASE BE NEAT!

4. Please indicate clearly your answer to every problem.

5. There is sufficient space after each problem to write your solution. In case you need extra paper please see the instructor.

6. Calculators of any kind are not allowed.

Problem No. 1:

Here's your chance to save the world! As a smart engineer at NASA, you need to design a friendship message for the alien fleet orbiting around Earth. This message is a pattern of three blinking lights that continuously goes

$$111 \rightarrow 001 \rightarrow 011 \rightarrow 010 \rightarrow 110 \rightarrow 100 \rightarrow 111 \rightarrow ...$$

where 0 indicates light off, and 1 indicates on.

a) Select a suitable number of clocked J-K flip-flops and draw the state table for a sequential network that generates the above sequence. Derive the corresponding next-state maps for the flip-flops.

Solution:

b) Using the shortcut method discussed in class, derive the input equations for the clocked J-K flip-flops that implement the above network.

Solution:

c) What happens when the network starts in one of the unused states, say 000? Determine the next state to whatever extent possible.

Solution:

Problem No. 2:

You have just invented a new device — a U-V flip-flop that works as follows:

If UV = 00, the next state is the complement of the current state
If UV = 01, the next state is 0
If UV = 10, the next state is 1
If UV = 11, the next state is the same as the current state

a) Complete the following table and derive the characteristic equation for the U-V flip-flop.

Solution:

Q	**Q^+**	**U**	**V**
0	0		
0	1		
1	0		
1	1		

Q^+ = ______________________________

b) Now analyze the sequential network described below that has one input X and one output Z, and two U-V flip-flops A and B.

$$Z = AB + A'B'$$

$$U_A = B \qquad U_B = X + A'$$

$$V_A = BX \qquad V_B = (X \oplus A)'$$

Using the characteristic equation for the U-V flip-flop, derive the next-state equations for A and B. Is this network Moore or Mealy?

Solution:

c) Draw the next-state maps for the two flip-flops and the Karnaugh map for the output Z. Construct the corresponding state table.

Solution:

d) Draw the corresponding state-diagram for the network.

Solution:

Problem No. 3:

A sequence detector with an input X and output Z is used to identify whether two consecutive 0s or 1s occur in the input bit sequence. Z = 1 when this happens, and Z resets on the next clock pulse regardless of input.

a) Implement the above network as a 4-state Mealy machine. Derive the corresponding state diagram and the state table.

Solution:

b) Use two D flip-flops A and B to build the network. Derive the next-state maps and find the flip-flop input equations.

Solution:

c) Complete the following timing diagram for this network for the input sequence X = 11000, indicating false outputs if any.

Solution: