Computing Machinery II
Assignment 2

Synchronous Sequential Logic: Gray Code Up/Down Counter

A 4-bit Gray Code counts upward (from 0 to 15) using the following pattern:

0000, 0001, 0011, 0010, 0110, 0111, 0101, 0100, 1100, 1101, 1111, 1110, 1010, 1011, 1001, 1000

Once 1000 (15 in decimal) is reached, the code "wraps around" to 0000 (0 in decimal).

Create a synchronous sequential logic circuit that implements a Gray Code counter. The circuit will have one input called *Direction*: if 0, the counter counts up; if 1, it counts down.

The circuit will have 4 outputs, one for each bit in the Gray Code. Implement your design using JK flip-flops.

Use the design method outlined in class, and create a report showing all steps:

1. State the problem in words.
2. Create a state diagram for the design.
3. Determine the inputs, outputs, number of flip-flops needed and their type.
4. Derive the excitation table for the state machine.
5. Derive the circuit output functions and flip-flop input functions, using the map method.
6. Draw the logic diagram for the circuit.

This report should be printed out and submitted on paper. Your diagrams and tables can be hand written or created using a graphics program.

Circuit Simulation

Implement your design in the *Logisim* application, using 4 LEDs for the output (one for each bit of the Gray Code). Arrange things so that the two inputs appear on the left, the synchronous circuitry in the middle, and the display LEDs on the right. Save your design in a file called *assign2.circ*, which will be submitted electronically using D2L.

Bonus (20% if fully implemented)

Reimplement your design using T flip-flops instead of JK flip-flops. Document this second design in your report, showing steps 3 – 6 from the design procedure above. Implement this design using *Logisim* and save it in a file called *assign2bonus.circ*, which will be submitted electronically using D2L.

New Skills Needed for this Assignment:

- Ability to work with flip-flops and their characteristic tables and equations
- Ability to create a state diagram
- Understanding of flip-flop excitation tables
- Ability to design clocked sequential circuits following the prescribed design procedure

Submit the following:

1. Your report on paper. Submit this using the assignment boxes located on the main floor of the Math Sciences Building (in the main floor Computer Science lab area).
2. Your *Logisim* file: *assign2.circ* (and *assign2bonus.circ* if doing the bonus) submitted using D2L.

Computing Machinery II
Assignment 2 Grading

Student:_____

Report			
Statement of problem	4	_____	
State diagram	16	_____	
Determine input/output variables/flip-flops	5	_____	
Excitation table	17	_____	
Output & flip-flop input functions	16	_____	
Logic diagram	16	_____	
Circuit simulation in Logisim	10	_____	
Total	**84**	**_____**	**_____%**
Bonus (20% if fully implemented)			**_____%**
Assignment Grade			**_____%**