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This assignment is due on 30 Nov 2021

Please remember to write your name and student number.

You must complete the following assignment and submit a PDF of relevant questions. Handwritten submissions and proprietary formats (e.g. Pages or MS Word) will not be accepted. You will also need to upload LogicWork circuit design file. Then upload a single ZIP file to Moodle.

Submission File structure:

```

submission.zip
  - circuit1-1.cct
  - circuit1-2.cct
  - circuit1-3.cct
  - circuit2.cct
  - circuit3.cct
  - circuit5.cct
  - circuit6.cct
  - lib.clf

```

The circuit files 1-1, 1-2 are 0.5pt each, 1-3 1pts, the rest are 2pt each.

Lab 3

1. Save the library and circuit files we created in class containing the following designs in the final ZIP file:

(1) *D* latch (circuit1-1.cct);

(2) *D* flip-flop (circuit1-2.cct);

(3) Implement $D_A = \bar{X}A + XY$, $D_B = \bar{X}B + XA$, $Z = XB$ (circuit1-3.cct);

(4) Draw the state table and diagram for (3) (1pt).

2. A sequential circuit has three D flip-flops A, B, and C, and one input X. The circuit is described by the following input equations:

$$D_A = (B\bar{C} + \bar{B}C)X + (BC + \bar{B}\bar{C})\bar{X}$$

$$D_B = A$$

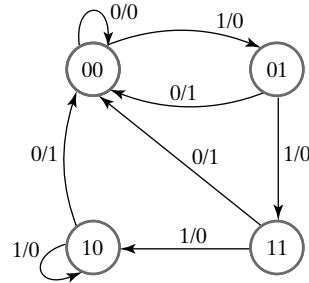
$$D_C = B$$

A. Derive the state table for the circuit (1pt).

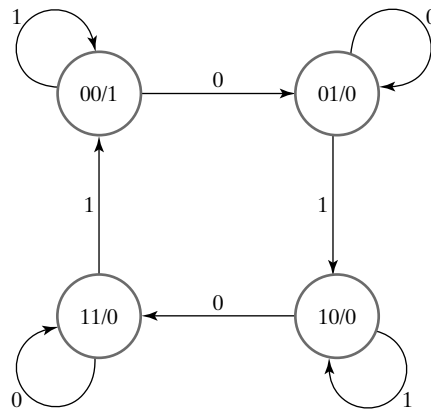
B. Draw the state diagram (1pt).

C. Implement the circuit in logicworks, save as (circuit2.cct)

3. For the following state diagram.



- A. Starting from state 00 in the following state diagram, determine the state transitions and output sequence that will be generated when an input sequence of 10011011110 is applied (1pt).
 - B. Draw the state table, perform flip-flop input equation determination and output equation determination (1pt).
 - C. Implement the circuit in logicworks as (circuit3.cct)
4. A sequential circuit has two flip-flops *A* and *B*, one input *X*, and one output *Y*. The state diagram is shown in the following figure. Draw the state table, and perform 1-hot state assignment (2pt).



5. Draw the state diagram of rotator, write down the equations for each *D* flip-flop (1pt), and complete the implementation (circuit5.cct).

Start state $X_3X_2X_1X_0$: original 4-bit, implement using binary switches

Input *Y*

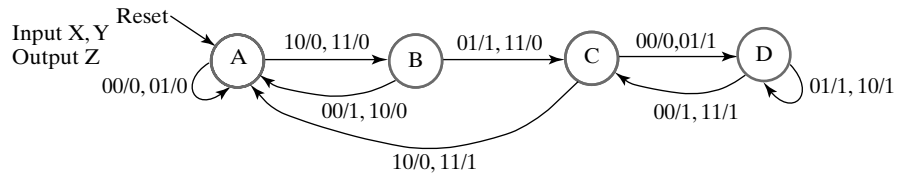
0: for left rotation (output $X_2X_1X_0X_3$);

1: for right rotation (output $X_0X_3X_2X_1$);

Behaviour

Every CLK triggers a shift

6. Find a state-machine diagram that is equivalent to the following state diagram. Reduce the complexity of the transition conditions as much as possible. Attempt to make outputs unconditional by changing Mealy outputs to Moore outputs. Make a state assignment to your state-machine diagram and find an implementation for the corresponding sequential circuit using *D* flop-flops, AND gates, OR gates, and inverters.



- (1) Draw the state-machine diagram (1pt).
- (2) Write down the Flip-Flop Input Equations and Output Equations (1pt).
- (3) Implement the circuit, save as `circuit6.cct`.