ECED2200- Digital Circuits- Winter 2020
Final Exam
April 21, 2020- 8:30 am to 8:30 pm

This booklet contains 3 pages and 6 questions
Preferably

- **Use white sheets to answer the questions**
- **Once done, preferably, scan your answers and upload the scans to the Final exam dropbox on BS**
- **If you do not have a scanner, take a photo with your smartphone, but please pay attention to the quality of the photo.**

Give as much detail as you can in your answers
Maximum grade: 40

Question 1 (10 points)

A. Design an asynchronous counter that counts 1, 3, 5, 7, 9, 11, 13, 15 using JK-MS-FFs
B. Draw the circuit
C. Design a synchronous counter that counts the same sequence in part a: 1, 3, 5, 7, 9, 11, 13, 15 using JK-MS-FFs
D. Draw the circuit
E. Given that the complexity (cost) of a circuit is calculated as the number of gates in the circuit, which of the synchronous and asynchronous counters is more complex?

Question 2 (8 points)

A. Design a Moore 010 sequence detector using D-MS-FFs
B. Draw the circuit using only AND, OR, NOT gates
C. Redesign the sequence detector of part (a) as a Mealy machine using D-MS_FFs.
D. Draw the circuit
E. Given that the number of gates represents the complexity (cost) of the circuit, which circuit is more complex?

Question 3 (6 points)

Analyze the sequential circuit shown in Figure 1 (draw the state diagram).

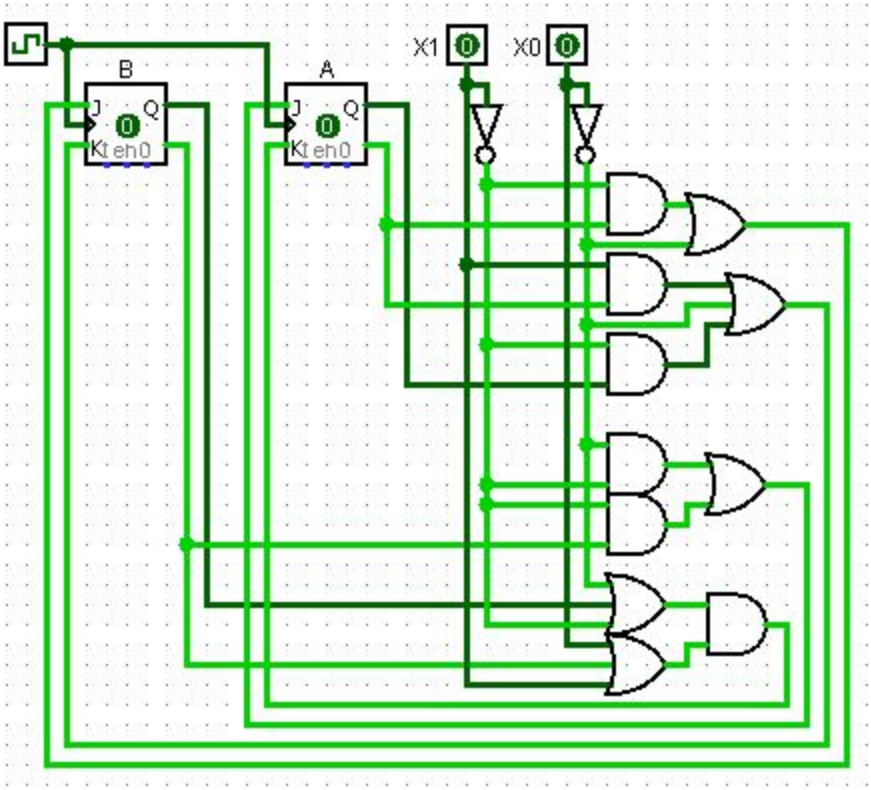

Figure 1: Sequential circuit for the analysis question

Question 4 (2 points)

Explain the operation of the bidirectional shift register shown in Figure 2. Particularly explain the functionality of inputs X and S.

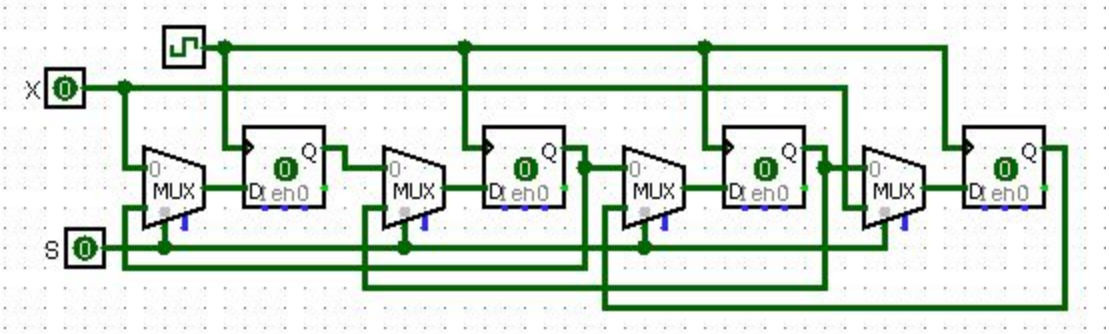

Figure 2: shift register

Question 5 (8 points)

Given the circuit in Figure 3

A. Write the equation of the output f (without minimization)
B. Minimize the function f (you can do this however you want as long as it is done “manually” (not using a website) and well explained)
C. Draw the circuit of the minimized function
D. If we want to build the simplified circuit you found in parts B and C using only multiplexers, what kind of multiplexers would you use (how many data inputs/selection inputs)? Why?
E. Build the circuit of question 5 using the multiplexer(s) that you chose in the previous

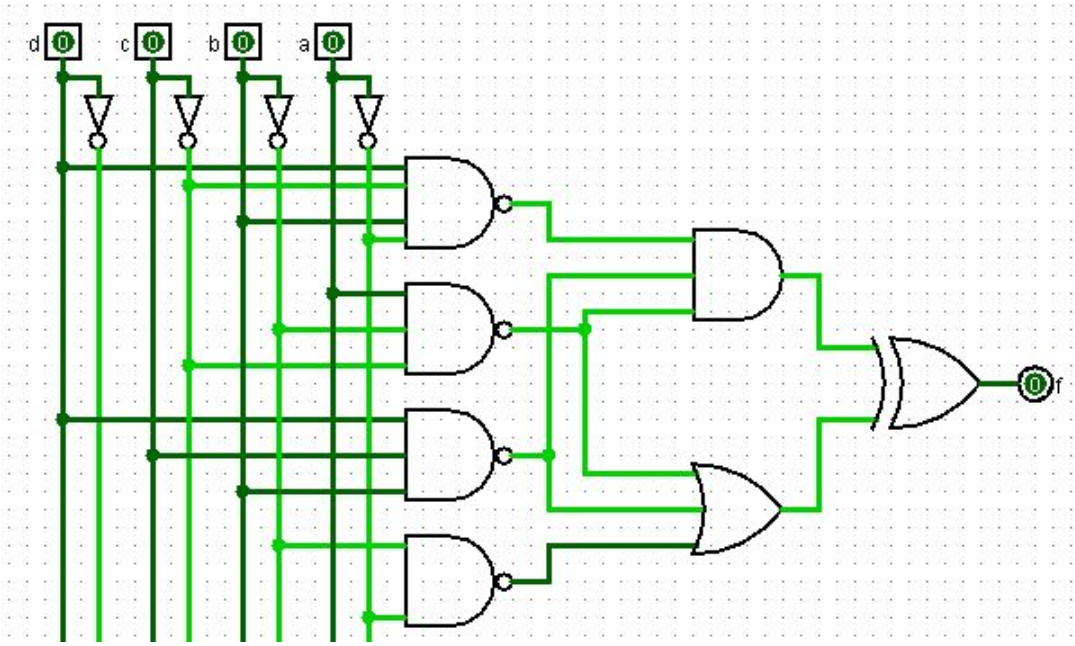

Figure 3: Combinational circuit

Question 6 (6 points)

We want to create a state machine that simulates the situation when a new virus (such as COVID-19) is discovered[1]. A simplified state diagram is given in Figure 4.

a. How many flipflops this state machine will need to be implemented? Why?
b. How many combinational inputs does this state machine have? Why?
c. Given the information of part a and part b of this question, draw the Moore state machine of the state diagram of Figure 4. You need to code the states and the transition conditions in the Moore state diagram.
d. Build and draw the circuit that implements your Moors state machine using MS-JK-FFs.

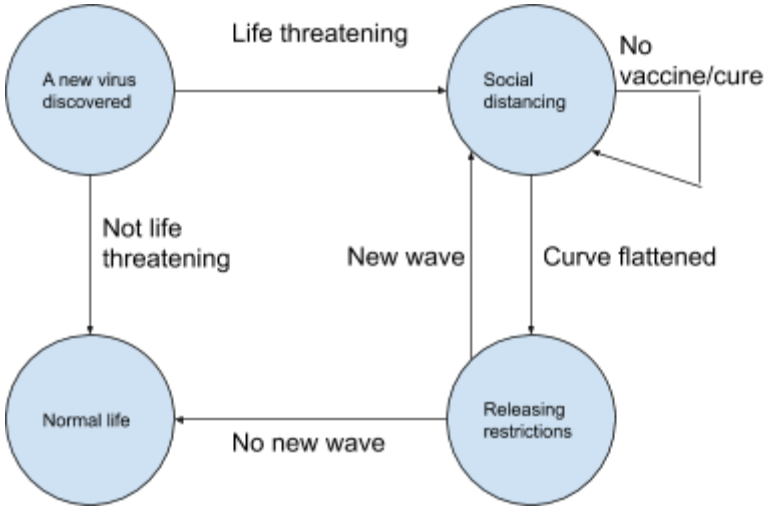

Figure 4: state diagram

[1] This is a simplistic approach and not, by any means, a scientific/official approach to the situation. It is there only as a question in the exam.