Name _____

ECE Box _____

ECE 2029
Homework 5 – Solution

C18

Problem 1 - 5 points total

a) Whenever MENU button is pressed, input is given to the system. However, next setting depends on given input as well as the current setting. In other words, the next output state depends on input and current state of the system. Thus, TV remote's menu access system employs **sequential** logic.

b) Alarm sound is the output of the system. System enable/arming switch is an input to the system and motion sensors can be considered as states of the system. Alarm is sounded only if system is enabled, i.e., output depends only on current input. Thus, home security system employs **combinational** logic.

Problem 2)

Vahid 3.1: Compute clock period for the following frequencies.

Period = 1/Frequency

a) 50kHz = 50,000Hz
   Period = 1/50,000Hz = 0.00002s = **20µs**

b) 300MHz = 300,000,000Hz
   Period = 1/300,000,000Hz = **3.33ns**

c) 3.4 GHz = 3,400,000,000Hz
   Period = 1/3,400,000,000Hz = **0.294ns**

d) 10 GHz = 10,000,000,000Hz
   Period = 1/10,000,000,000Hz = **0.100ns**

e) 1THz = 1,000,000,000,000Hz
   Period = 1/ 1,000,000,000,000Hz = **1.00ps**

Vahid 3.3: Compute the clock frequency for the following clock periods

Frequency = 1/Period

a) 1s

Frequency = 1/1 = **1Hz**

b) 1ms = 0.001s

Frequency = 1/.001s = 1000Hz = **1kHz**

c) 20ns = 0.000000020s

Frequency = 1/0.000000020s = 50,000,000 = **50MHz**

d) 1ns = 0.000000001s

Frequency = 1/0.000000001s = 1,000,000,000= **1GHz**

e) 1.5ps = 0.0000000000015s

Frequency = 1/ 0.0000000000015s = 1,500,000,000,000= **1.5THz**

You can also do these calculations mentally using the prefixes. For example, the prefix "pico" in scientific notation is 10^{-12}. Because the frequency is the inverse of the period (and vice versa), the sign of the exponent is flipped. The prefix "tera" in scientific notation is 10^{12}, so a period of 1.5 picoseconds yields a frequency of 1.5 terahertz.

Problem 3)

a) S-R Latch

S	**R**	**Q**	**Qn**
0	0	Last Q	Last Qn
0	1	0	1
1	0	1	0
1	1	0	0

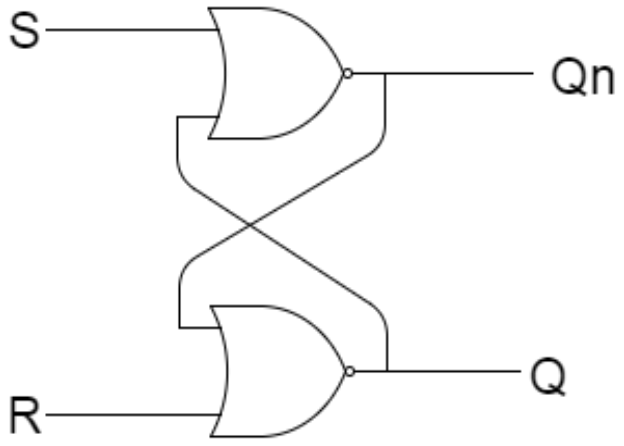
S-R Latch with Enable (C)

C	**S**	**R**	**Q**	**Qn**
0	*	*	Last Q	Last Qn
1	0	0	Last Q	Last Qn
1	0	1	0	1
1	1	0	1	0
1	1	1	0	0

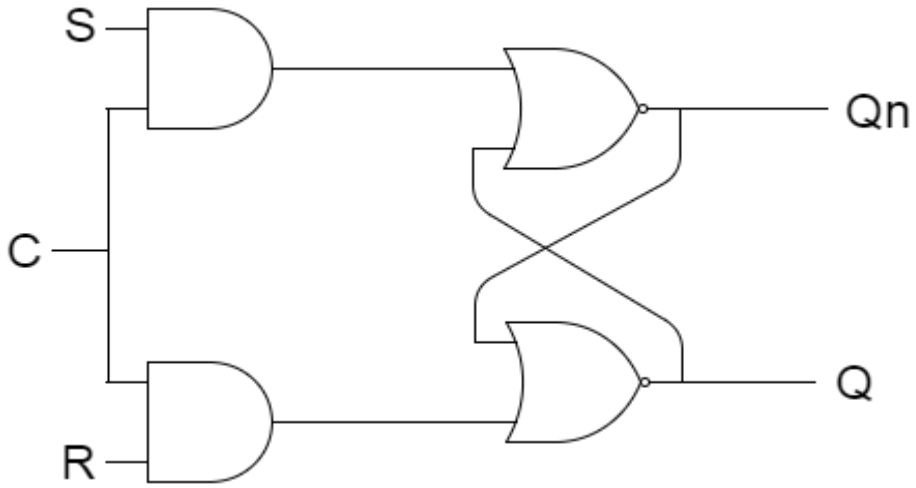
D-Latch with Enable (C)

C	**D**	**Q**	**Qn**
0	*	Last Q	Last Qn
1	0	0	1
1	1	1	0

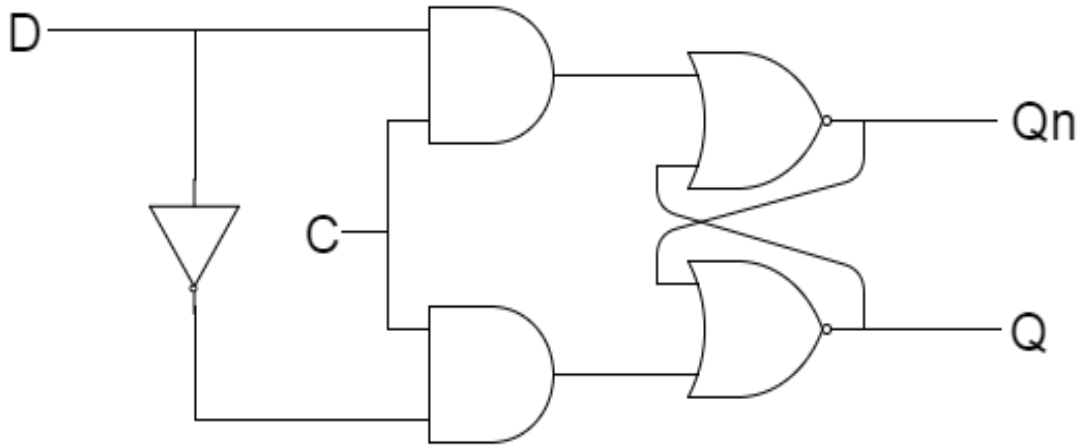
b) S-R Latch



S-R Latch with Enable (C)

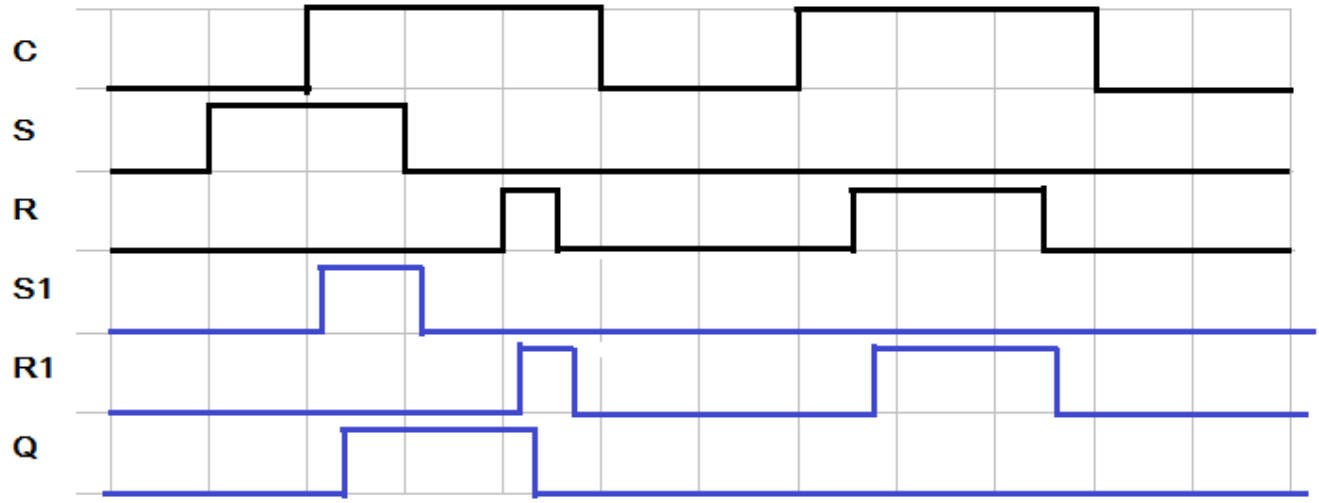


D Latch with Enable



Problem 4)

Vahid 3.7



when C = 0

Q = last Q

when C = 1

Q = 1 when S = 1 and R = 0

Q = 0 when S = 0 and R = 1 or when S = 1 and R = 1

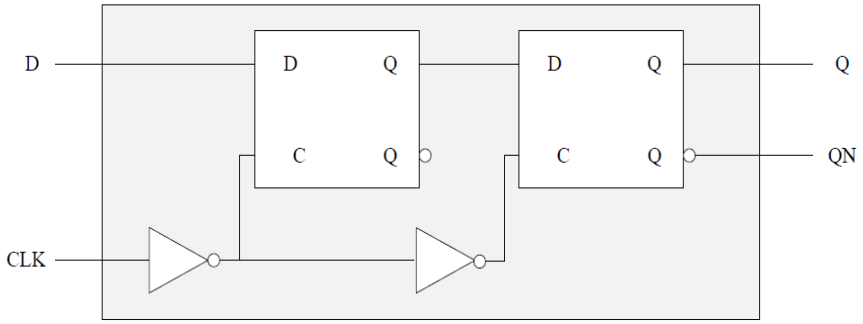
S1 follows S, R1 follows R

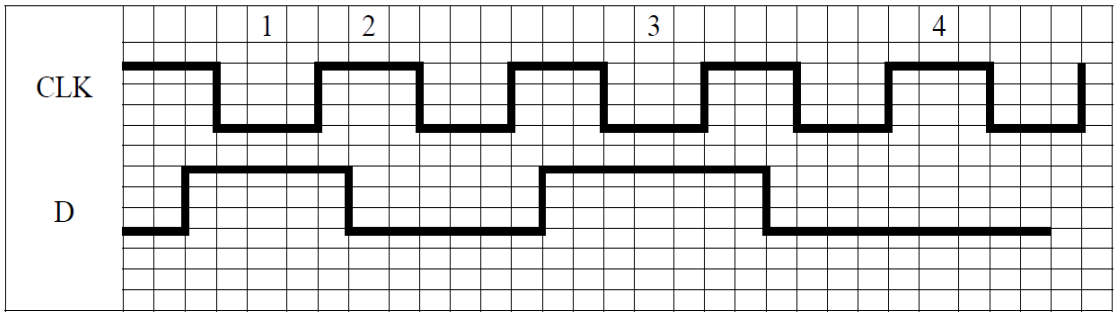
Q does not transition until after S1 and R1 transition

C	S	R	S1	R1	Q	QN
0	*	*	0	0	Last	Last
1	0	0	0	0	Last	Last
1	0	1	0	1	0	1
1	1	0	1	0	1	0
1	1	1	1	1	0	0

Problem 5 - 10 points total

The sequential logic component shown below is a positive edge triggered D flip-flop, and contains two D-latches. The timing diagram shows a series of events on the positive-edge triggered flip-flop. Fill in the logic values for Q and QN for the times specified on the diagram with numbered bubbles. The initial value of Q is 0, and QN is 1. (Ignoring the propagation delay)

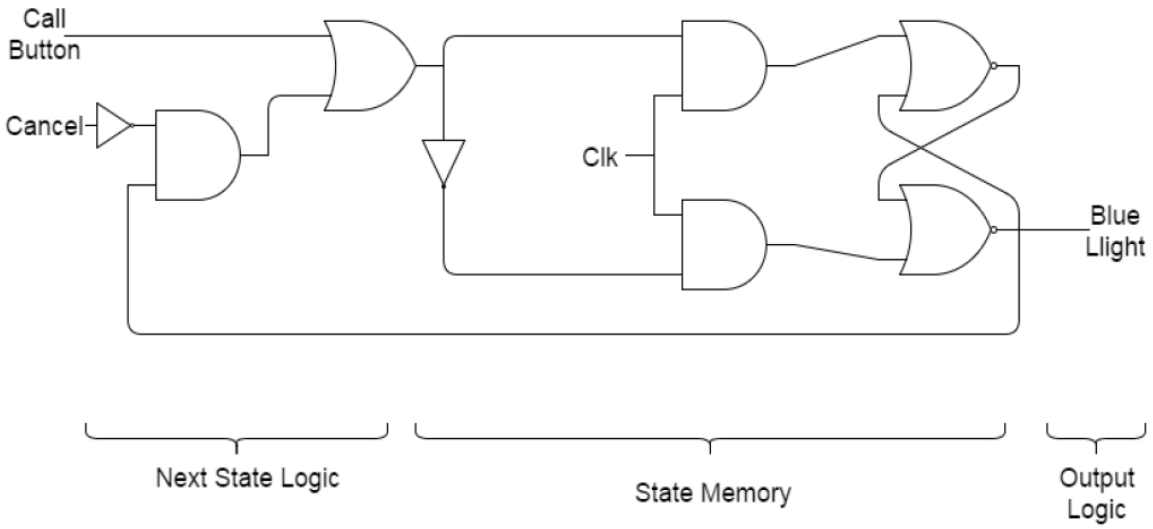




	Q	QN
Time 1	0	1
Time 2	1	0
Time 3	0	1
Time 4	0	1

Problem 6 - 20 points total

1) Using D-Latch



2) Next State Logic:

$D = Call + Cancel'Q$

$Q^* = C_0 + C_1'Q$ (Where $Q^* = D$, $C_0 = Call$, and $C_1 = Cancel$)

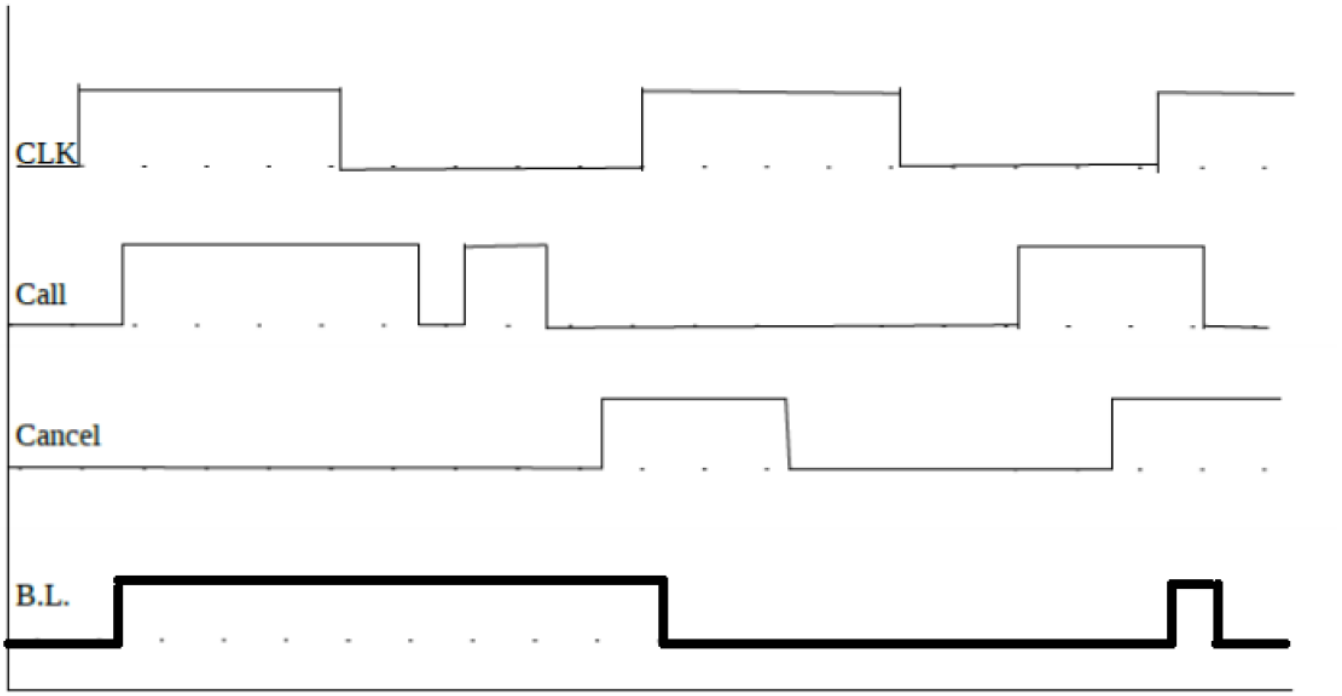
Output:

$Y = Q$

3)

Call	Cancel	Q	D	
0	0	0	0	
0	1	0	0	No Change, Memory
1	0	1	1	Set
1	1	0 1	1	Reset

4)



Problem 7 – 10 points