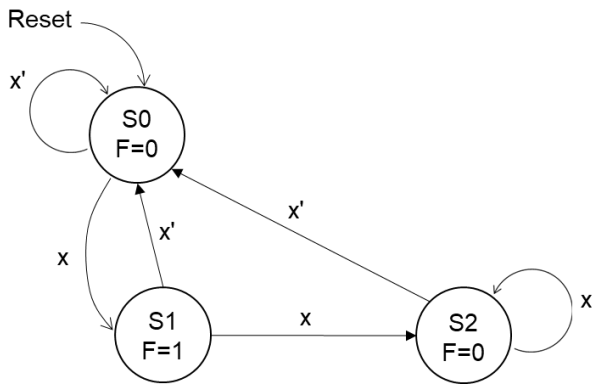
CSC 137 Section 02 MIDTERM 2

Show your work clearly to earn points. Work not shown will not earn any points.
Date: April 7, 2022 Instructor: Dr. Ilkan Çokgör Total: 20 points

Student Name: Student Number:

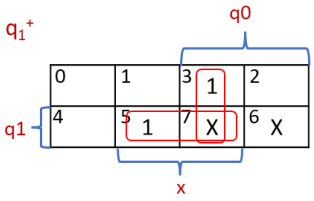
1) Given the state transition diagram below:



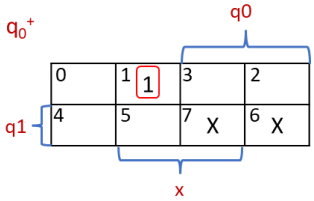
a) Construct the state transition table. (2 points)

q_1	q_0	x	q_1^+	q_0^+
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	0
1	1	0	X	X
1	1	1	X	X

b) Use K-maps to derive the simplest Boolean equations for the state variables. Take don't care cases into account. (2 points)



$q_1^+ = q_1 x + q_0 x$



$q_0^+ = q_1' q_0' x$

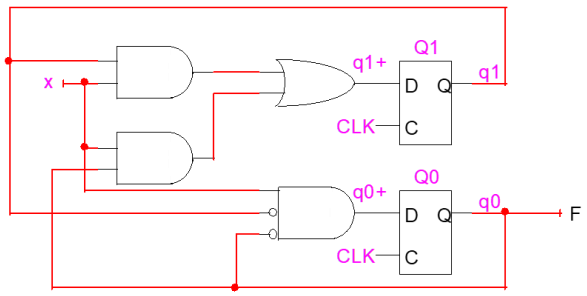
c) Construct the Output table. (1 point)

q_1	q_0	F
0	0	0
0	1	1
1	0	0
1	1	X

d) Derive the simplest Boolean equation for the output. (1 point)

$F = q_0$

e) Draw the Moore machine circuit. (2 points)

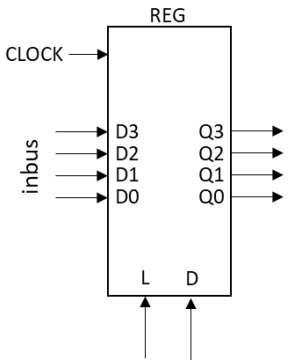


RESET Omitted

2) You are tasked with designing a control unit for a 4-bit operation which is using signed integers. This operation is divided into microoperations and the register transfer language (RTL) description for each micro-operation is given below:

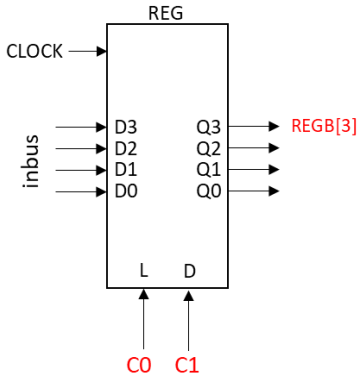
```
Start:  REG <- inbus;
        If REG < 0 then goto Stop;
Loop:   REG <- R1 – 1;
        If REG >= 0 then goto Loop;
Stop:   goto Stop;
```

The processing hardware is a single register as shown below (Q3 is the most significant bit and Q0 is the least significant bit), and its function table is given as follows:



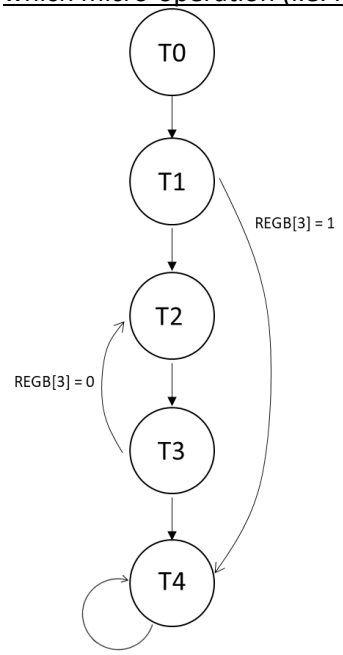
Function Table		
L	**D**	**Function**
0	1	Decrement
1	0	Load external inputs
0	0	No change

a) Establish the control and condition signals (if necessary), and show where they are connected on the processing circuit. Show in a table which control signal will be generated at each RTL step. (3 points)



Start:	REG <- inbus;	T0	C0
	If REG < 0 then goto Stop;	T1	None
Loop:	REG <- R1 – 1;	T2	C1
	If REG >= 0 then goto Loop;	T3	None
Stop:	goto Stop;	T4	None

b) Construct the state transition diagram of the control unit. Show which state corresponds to which micro-operation (i.e. RTL step) in a table. (3 points)

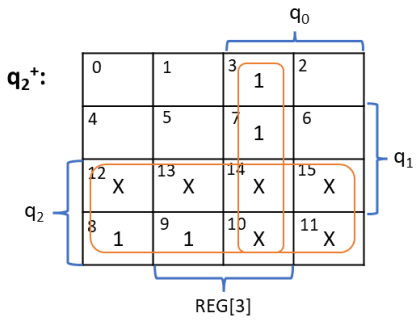



```
Start:  REG <- inbus;                   T0      C0
        If REG < 0 then goto Stop;      T1      None
Loop:   REG <- R1 – 1;                  T2      C1
        If REG >= 0 then goto Loop;     T3      None
Stop:   goto Stop;                      T4      None
```

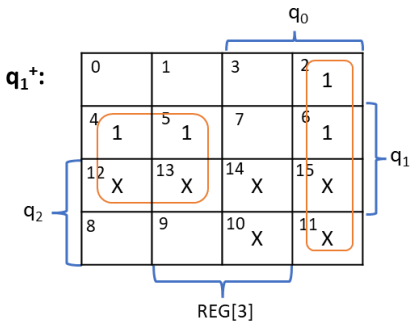
c) Construct the state transition table for the control unit. (3 points)

q_2	q_1	q_0	REG[3]	q_2^+	q_1^+	q_0^+
0	0	0	0 (X)	0	0	1
0	0	0	1 (X)	0	0	1
0	0	1	0	0	1	0
0	0	1	1	1	0	0
0	1	0	0 (X)	0	1	1
0	1	0	1 (X)	0	1	1
0	1	1	0	0	1	0
0	1	1	1	1	0	0
1	0	0	0 (X)	1	0	0
1	0	0	1 (X)	1	0	0
1	0	1	0	X	X	X
1	0	1	1	X	X	X
1	1	0	0	X	X	X
1	1	0	1	X	X	X
1	1	1	0	X	X	X
1	1	1	1	X	X	X

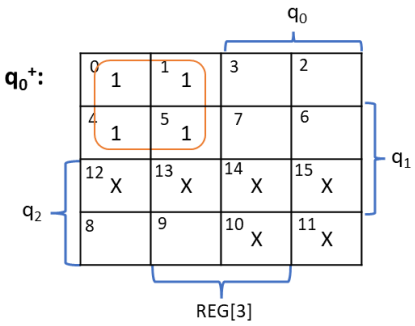
d) Derive the simplest Boolean equations for the state variables. (3 points)



q_2^+: $q_2 + q_0\,REG[3]$



q_1^+: $q_1\,q_0' + q_0\,REG[3]'$



q_0^+: $q_2'\,q_0'$