CS 310 Project

1.Designing the truth table based on the description given in the PDF format:

Filling up the truth table based on the non-erratic input values [Input(ABCDE)];Output(QRSTU)]

A	B	C	D	E		Q	R	S	T	U
0	0	0	0	0		0	0	0	0	0
0	0	0	0	1		0	0	0	0	0
0	0	0	1	0		0	0	0	1	0
0	0	0	1	1		0	0	0	1	0
0	0	1	0	0		0	0	1	0	0
0	0	1	0	1		0	0	1	0	0
0	0	1	1	0		0	0	1	1	0
0	0	1	1	1		0	0	1	1	0
0	1	0	0	0		0	1	0	0	0
0	1	0	0	1		1	0	0	0	0
0	1	0	1	0		1	0	0	0	0
0	1	0	1	1		1	0	0	1	0
0	1	1	0	0		1	0	0	1	0
0	1	1	0	1		1	1	0	0	0
0	1	1	1	0		1	0	1	0	0
0	1	1	1	1		1	1	0	1	0
1	0	0	0	0		1	0	1	1	0
1	0	0	0	1		1	1	1	0	0
1	0	0	1	0		1	1	0	0	0
1	0	0	1	1		1	1	1	1	0

Filling up the truth table based on the erratic input values [Input(ABCDE)];Output(QRSTU)]

A	B	C	D	E		Q	R	S	T	U
1	0	1	0	0		X	X	X	X	1
1	0	1	0	1		X	X	X	X	1
1	0	1	1	0		X	X	X	X	1
1	0	1	1	1		X	X	X	X	1
1	1	0	0	0		X	X	X	X	1
1	1	0	0	1		X	X	X	X	1
1	1	0	1	0		X	X	X	X	1
1	1	0	1	1		X	X	X	X	1
1	1	1	0	0		X	X	X	X	1
1	1	1	0	1		X	X	X	X	1
1	1	1	1	0		X	X	X	X	1
1	1	1	1	1		X	X	X	X	1

2. Creating Karnaugh Maps based on our truth tables:

 *Creating Karnaugh Map for output Q and finding the optimized expression:

AB/CD	00	01	11	10
00	0	0	0	0
01	0	1	1	1
11	X	X	X	X
10	1	1	X	X

AB/CD	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	X	X	X	X
10	1	1	X	X

E=0   E=1

Optimized Boolean Expression From Karnaugh Map: $Q = A + BE + BD + BC$

More optimization: $Q = A + B * (E + D + C)$

*Creating Karnaugh Map for output R and finding the optimized expression:

AB/CD	00	01	11	10
00	0	0	0	0
01	1	0	0	0
11	X	X	X	X
10	0	1	X	X

AB/CD	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	X	X	X	X
10	1	1	X	X

E=0   E=1

Optimized Boolean Expression From Karnaugh Map: $R = AE + AD + BCE + B\bar{C}\bar{D}\bar{E}$

More optimization: $R = A * (E + D) + B * (CE + \bar{C}\bar{D}\bar{E})$

*Creating Karnaugh Map for output S and finding the optimized expression:

AB/CD	00	01	11	10
00	0	0	1	1
01	0	0	1	0
11	X	X	X	X
10	1	0	X	X

E=0

AB/CD	00	01	11	10
00	0	0	1	1
01	0	0	0	0
11	X	X	X	X
10	1	1	X	X

E=1

Optimized Boolean Expression From Karnaugh Map: $S = \bar{B}C + AE + CD\bar{E} + A\bar{D}$

More optimization: $S = A * (E + \bar{D}) + C * (\bar{B} + D\bar{E})$

*Creating Karnaugh Map for output T and finding the optimized expression:

AB/CD	00	01	11	10
00	0	1	1	0
01	0	0	0	1
11	X	X	X	X
10	1	0	X	X

E=0

AB/CD	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	X	X	X	X
10	0	1	X	X

E=1

Optimized Boolean Expression From Karnaugh Map: $T = DE + \bar{A}\,\bar{B}D + BC\bar{D}\bar{E} + A\overline{DE}$

More optimization: $T = D * (E + \bar{A}\,\bar{B}) + \bar{D}\,\bar{E} * (BC + A)$

*Creating Karnaugh Map for erratic output indicator U and finding the optimized expression:

U stands the same for E=0 and E=1

AB/CD	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	0	1	1

Optimized Boolean Expression From Karnaugh Map: $U = AB + AC$

More optimization: A*(B+C)

3.Notes about the Logisim circuits:

Based on the optimized Boolean expressions taken from the Karnaugh maps, I built the first circuit. It worked fine but it was too messy. For that reason, I built another one where I put the inputs in parallel and because of that, the circuit was easier to understand since cables did not form "spaghetti" crosses between them like in the first one. Also, since the improved circuit was less cluttered, I was able to remove some of the not gates from the circle without affecting the final outputs. In the end, I counted the number of transistors for the first circuit and the second one to compare their optimization. The first circuit had 214 transistors whereas the second one (the improved one) had 206 transistors, so the second can be a better choice regarding the cost of the materials that we spend for building it.