

EE100-Electronics Homework 2

Due June 11th, 2015 @ class

Read Harris textbook, Chapter 2.

Problem 1 Write a Boolean equation in sum-of products form for each of the truth tables in Fig. 1

(a)	(b)	(c)	(d)	(e)																																																																																																																																																																																																																																																																	
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 5px;">A</th> <th style="border-right: 1px solid black; padding: 5px;">B</th> <th style="padding: 5px;">Y</th> </tr> </thead> <tbody> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> </tbody> </table>	A	B	Y	0	0	0	0	1	1	1	0	1	1	1	1	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 5px;">A</th> <th style="border-right: 1px solid black; padding: 5px;">B</th> <th style="border-right: 1px solid black; padding: 5px;">C</th> <th style="padding: 5px;">Y</th> </tr> </thead> <tbody> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> </tbody> </table>	A	B	C	Y	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1	1	0	0	1	1	0	1	0	1	1	0	1	1	1	1	0	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 5px;">A</th> <th style="border-right: 1px solid black; padding: 5px;">B</th> <th style="border-right: 1px solid black; padding: 5px;">C</th> <th style="padding: 5px;">Y</th> </tr> </thead> <tbody> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> </tbody> </table>	A	B	C	Y	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0	1	1	1	1	1	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 5px;">A</th> <th style="border-right: 1px solid black; padding: 5px;">B</th> <th style="border-right: 1px solid black; padding: 5px;">C</th> <th style="border-right: 1px solid black; padding: 5px;">D</th> <th style="padding: 5px;">Y</th> </tr> </thead> <tbody> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> </tbody> </table>	A	B	C	D	Y	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	0	0	1	0	1	0	1	0	1	1	0	1	1	0	1	1	0	0	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 5px;">A</th> <th style="border-right: 1px solid black; padding: 5px;">B</th> <th style="border-right: 1px solid black; padding: 5px;">C</th> <th style="border-right: 1px solid black; padding: 5px;">D</th> <th style="padding: 5px;">Y</th> </tr> </thead> <tbody> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">1</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">0</td><td style="padding: 5px;">0</td></tr> <tr><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="border-right: 1px solid black; padding: 5px;">1</td><td style="padding: 5px;">0</td></tr> </tbody> </table>	A	B	C	D	Y	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	1	1	1	1	0	0	0	1	1	0	0	1	1	1	0	1	0	1	1	0	1	1	1	1	1	0	0	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0
A	B	Y																																																																																																																																																																																																																																																																			
0	0	0																																																																																																																																																																																																																																																																			
0	1	1																																																																																																																																																																																																																																																																			
1	0	1																																																																																																																																																																																																																																																																			
1	1	1																																																																																																																																																																																																																																																																			
A	B	C	Y																																																																																																																																																																																																																																																																		
0	0	0	0																																																																																																																																																																																																																																																																		
0	0	1	1																																																																																																																																																																																																																																																																		
0	1	0	1																																																																																																																																																																																																																																																																		
0	1	1	1																																																																																																																																																																																																																																																																		
1	0	0	1																																																																																																																																																																																																																																																																		
1	0	1	0																																																																																																																																																																																																																																																																		
1	1	0	1																																																																																																																																																																																																																																																																		
1	1	1	0																																																																																																																																																																																																																																																																		
A	B	C	Y																																																																																																																																																																																																																																																																		
0	0	0	0																																																																																																																																																																																																																																																																		
0	0	1	1																																																																																																																																																																																																																																																																		
0	1	0	0																																																																																																																																																																																																																																																																		
0	1	1	0																																																																																																																																																																																																																																																																		
1	0	0	0																																																																																																																																																																																																																																																																		
1	0	1	0																																																																																																																																																																																																																																																																		
1	1	0	1																																																																																																																																																																																																																																																																		
1	1	1	1																																																																																																																																																																																																																																																																		
A	B	C	D	Y																																																																																																																																																																																																																																																																	
0	0	0	0	1																																																																																																																																																																																																																																																																	
0	0	0	1	0																																																																																																																																																																																																																																																																	
0	0	1	0	1																																																																																																																																																																																																																																																																	
0	0	1	1	1																																																																																																																																																																																																																																																																	
0	1	0	0	0																																																																																																																																																																																																																																																																	
0	1	0	1	0																																																																																																																																																																																																																																																																	
0	1	1	0	1																																																																																																																																																																																																																																																																	
0	1	1	1	1																																																																																																																																																																																																																																																																	
1	0	0	0	1																																																																																																																																																																																																																																																																	
1	0	0	1	0																																																																																																																																																																																																																																																																	
1	0	1	0	1																																																																																																																																																																																																																																																																	
1	0	1	1	0																																																																																																																																																																																																																																																																	
1	1	0	0	0																																																																																																																																																																																																																																																																	
1	1	0	1	0																																																																																																																																																																																																																																																																	
1	1	1	0	0																																																																																																																																																																																																																																																																	
1	1	1	1	0																																																																																																																																																																																																																																																																	
A	B	C	D	Y																																																																																																																																																																																																																																																																	
0	0	0	0	0																																																																																																																																																																																																																																																																	
0	0	0	1	0																																																																																																																																																																																																																																																																	
0	0	1	0	0																																																																																																																																																																																																																																																																	
0	0	1	1	1																																																																																																																																																																																																																																																																	
0	1	0	0	0																																																																																																																																																																																																																																																																	
0	1	0	1	0																																																																																																																																																																																																																																																																	
0	1	1	0	1																																																																																																																																																																																																																																																																	
0	1	1	1	1																																																																																																																																																																																																																																																																	
1	0	0	0	1																																																																																																																																																																																																																																																																	
1	0	0	1	1																																																																																																																																																																																																																																																																	
1	0	1	0	1																																																																																																																																																																																																																																																																	
1	0	1	1	1																																																																																																																																																																																																																																																																	
1	1	0	0	0																																																																																																																																																																																																																																																																	
1	1	0	1	0																																																																																																																																																																																																																																																																	
1	1	1	0	0																																																																																																																																																																																																																																																																	
1	1	1	1	0																																																																																																																																																																																																																																																																	

Figure 1:

Problem 2 Simplify each of the following Boolean equations. Sketch a reasonably simple combinational circuit implementing the simplified equation.

(a) $Y = \overline{A}BC + \overline{B}\overline{C} + BC$

(b) $Y = \overline{A + B + C}D + AD + B$

(c) $Y = ABCD + \overline{A}B\overline{C}D + (\overline{B + D})E$

Problem 3 Find a minimal Boolean equation for the function in Fig. 2. Remember to take advantage of the don't care entries.

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>Y</i>
0	0	0	0	X
0	0	0	1	X
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	X
0	1	1	0	0
0	1	1	1	X
1	0	0	0	1
1	0	0	1	0
1	0	1	0	X
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	X
1	1	1	1	1

Figure 2: