ECE 27000 Spring-22
Practice Problems 5 - Solution

Solve the following problems considering the function
$F(X1, X2, X3, X4, X5, X6, X7, X8) =$
$= X1 \cdot X2 + X1 \cdot X3 + X4 \cdot X5 + X4' \cdot X6 + X7 \cdot X8$

1. The function is implemented as an AND-OR circuit with AND gates corresponding to the product terms given above. Find all the static hazards of the function.

2. Find a sum-of-products expression whose corresponding AND-OR circuit does not have any static hazards.

Solution:
The K-map method is not practical in this case.
It is possible to use the consensus theorem to identify hazards caused by
$X4 \cdot X5 + X4' \cdot X6$.
Another method, which was shown in one of the lectures, is to compare all the pairs of product terms, and search for adjacent minterms that are not covered by a single term. Several examples follow, including the one that identifies the hazards.

$X1 \cdot X2$	1	1	-	-	-	-	-	-
$X1 \cdot X3$	1	-	1	-	-	-	-	-
	1	1	1	-	-	-	-	-

All the adjacent minterms covered by these terms are contained in one of the terms, and do not cause hazards.

$X1 \cdot X2$	1	1	-	-	-	-	-	-
$X4 \cdot X5$	-	-	-	1	1	-	-	-
	1	1	-	1	1	-	-	-

Same as above, there are no hazards.

$X4 \cdot X5$	-	-	-	1	1	-	-	-
$X4' \cdot X6$	-	-	-	0	-	1	-	-
	-	-	-	0,1	1	1	-	-

The pairs of minterms covered by the following terms result in hazards.

-	-	-	0	1	1	-	-
-	-	-	1	1	1	-	-

Specifically, hazards are caused by the following adjacent minterms.

0	0	0	0	1	1	0	0
0	0	0	1	1	1	0	0
0	0	0	0	1	1	0	1
0	0	0	1	1	1	0	1
0	0	0	0	1	1	1	0
0	0	0	1	1	1	1	0

...

1	1	1	0	1	1	1	1
1	1	1	1	1	1	1	1

To eliminate the hazards, it is possible to add a term that covers the following pair of terms.

-	-	-	0	1	1	-	-
-	-	-	1	1	1	-	-
-	-	-	-	1	1	-	-

The term is $X5 \cdot X6$. The same result is obtained by applying the consensus theorem.