Solution to Q1:

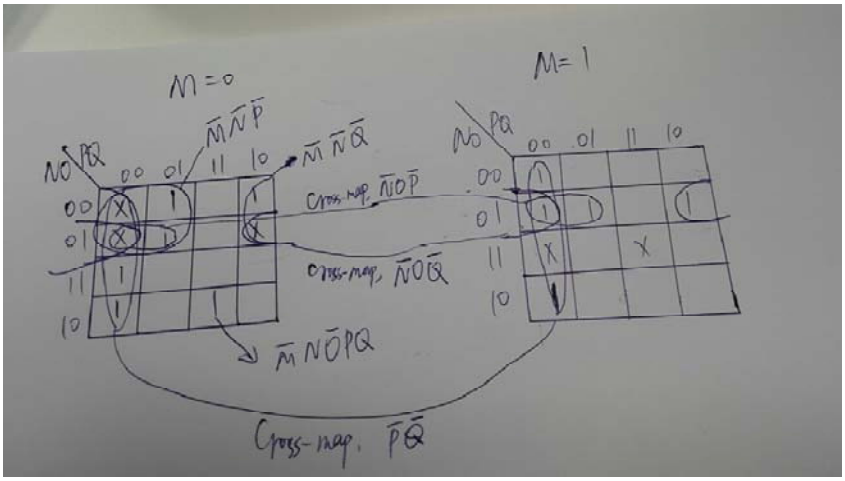
Rewrite the indices of minterms in binary representation:

$$00001, 00010, 00101, 01000, 01011, 01100, 10000, 10100, 10101, 10110, 11000$$

Rewrite the indices of don't care terms in binary representation:

$$00000, 00100, 00110, 11100, 11111$$

Fill and circle the Karnaugh Map:



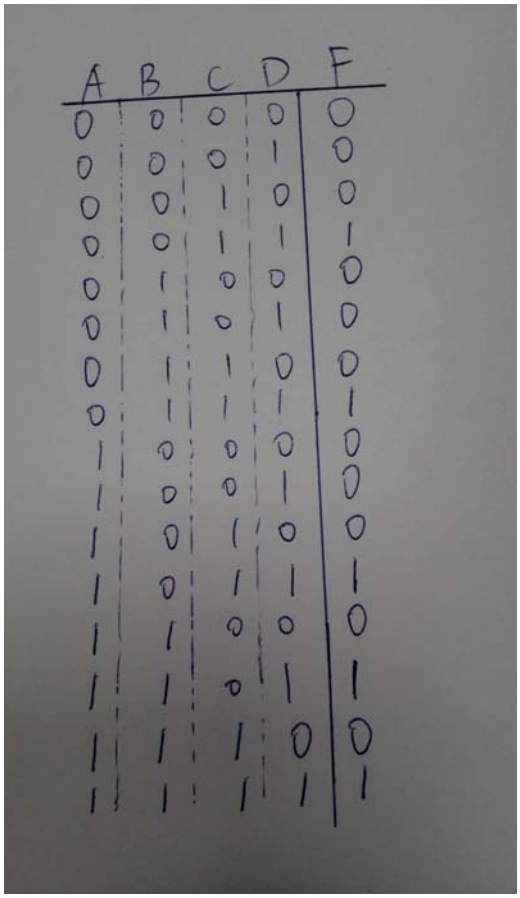
The minimal SOP is given by:

$$G(M,N,O,P,Q) = \bar{P}\bar{Q} + \bar{M}\bar{N}\bar{P} + \bar{M}\bar{N}\bar{Q} + \bar{N}O\bar{P} + \bar{N}O\bar{Q} + \bar{M}N\bar{O}PQ$$

I suggest to change the question to find the minimal SOP as the minimal POS is not covered by the slide

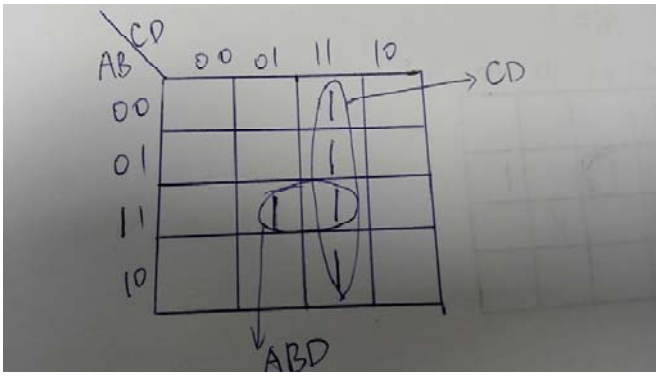
Solution to Q2:

The truth table is given by



A	B	C	D	F
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	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

Fill and circle the Karnaugh Map as:



The MSP of F is given by:

$F = ABD + CD$

Again, change the question to find the MSP, rather than MPS.

Solution to Q3:

Let us denote the following Boolean variables:

A- Status of the key (A=1: the key in ignition; A=0: otherwise.)
B- Status of the door (B=1: the door is open; B=0, otherwise.)
C- Status of the brake (C=1: the brake is on; C=0, otherwise.)
D- Status of the alarm (D=1: the alarm is working; D=0, otherwise.)

The combinations of status that lead to the sounding of the alarm are given by:

$$AB, \overline{A}\overline{C}, B\overline{C}$$

The logic equation of the alarm sounding is given by:

$$F = AB + A'C' + BC'$$

Finally, the logic equation of the alarm going off is given by

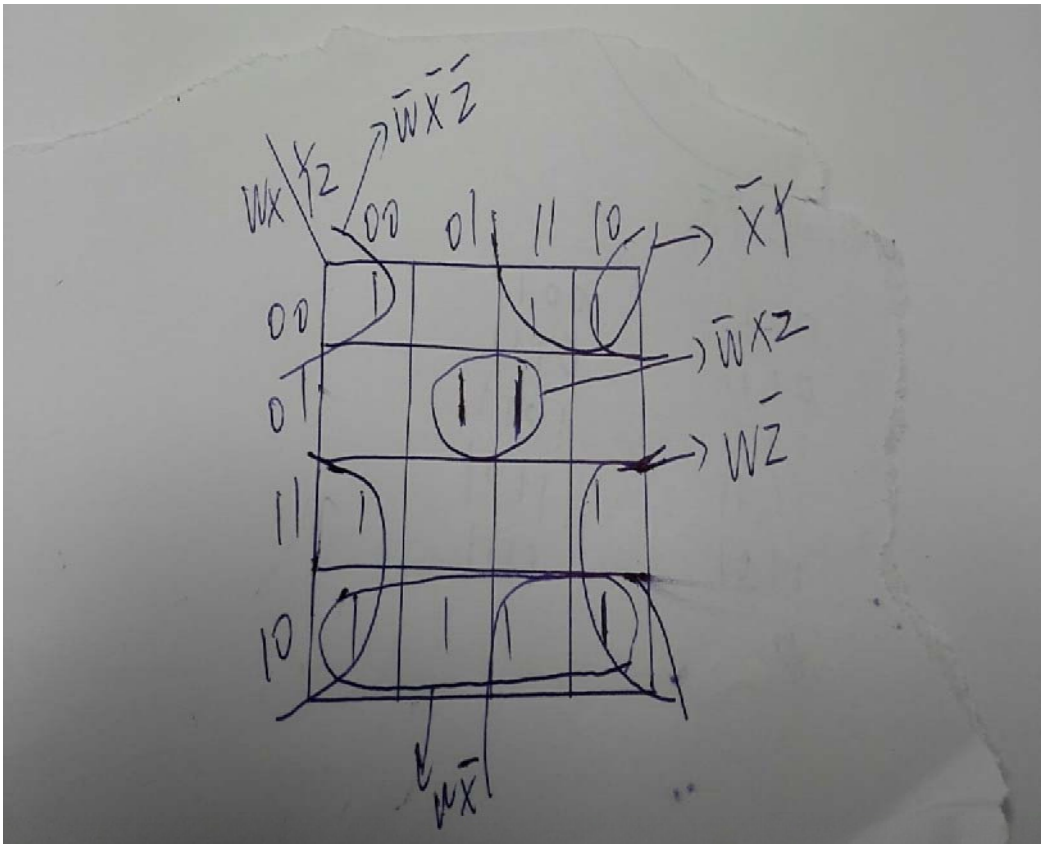
$$F' = \left(AB + A'C' + BC'\right)' = (A' + B')\left(A + C\right)\left(B' + C\right)$$

Solution to Q4:

The truth table for the segment `a' is given by

W	X	Y	Z	a
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	1
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	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

Fill and circle the Karnaugh map as follows:



The minimal SOP is given by:

$$a = \bar{W}\bar{X}\bar{Z} + \bar{X}Y + \bar{W}XZ + W\bar{Z} + W\bar{X}$$

Solution to Q5:

1) The truth table for Z is given by:

A	B	C	Z
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

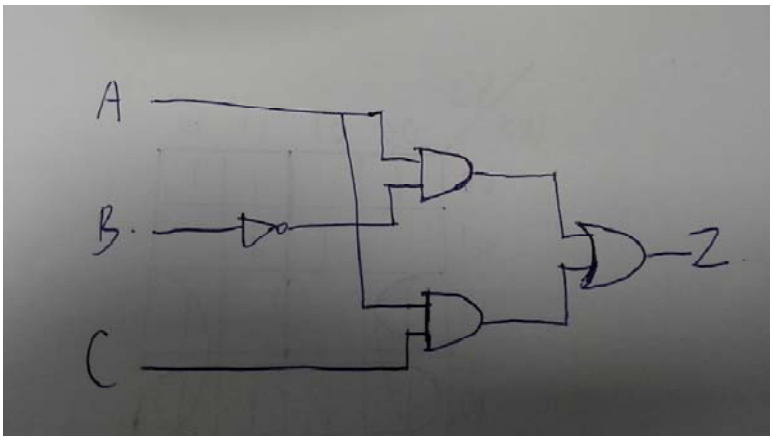
2) The minterm expansion for Z is given by:

$$Z = A\bar{B}\bar{C} + A\bar{B}C + ABC$$

The minimum SOP is given by:

$$\begin{aligned} Z &= A\left(\bar{B}\bar{C} + \bar{B}C + BC\right) \\ &= A\left(\bar{B}\bar{C} + \bar{B}C + \bar{B}C + BC\right) \\ &= A\left(\bar{B}\left(\bar{C} + C\right) + C\left(\bar{B} + B\right)\right) \\ &= A\left(\bar{B} + C\right) \\ &= A\bar{B} + AC \end{aligned}$$

3) The labelled circuit diagram is given by

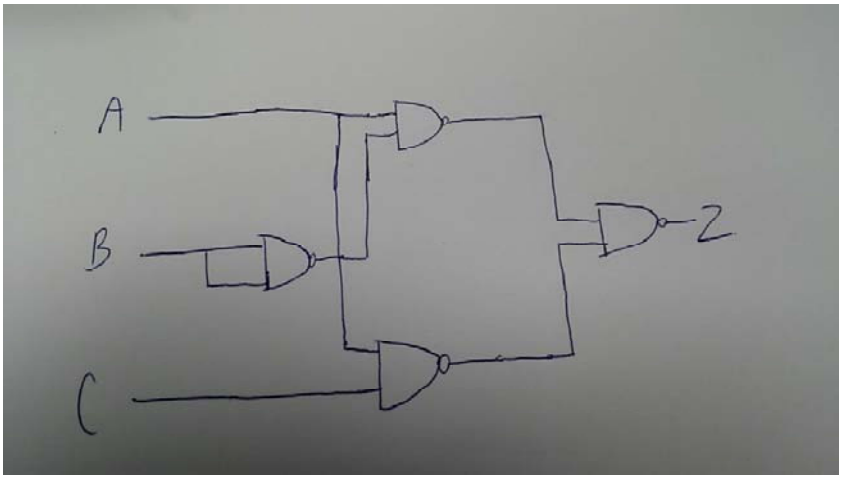


4) Using De Morgan's theorem, we have

$$Z = \left(AB' + AC\right)''$$

$$= \left(\left(AB'\right)'\left(AC\right)'\right)'$$

The circuit diagram is given by:



The number of logic gates required is four.

Solution to Q6:

1) Denote F as the detection indicator variable. It is equal to one when the input number is 1 or prime number. Denote A,B,C as the input binary expressions for the input number.

   Then, the truth table is given by

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

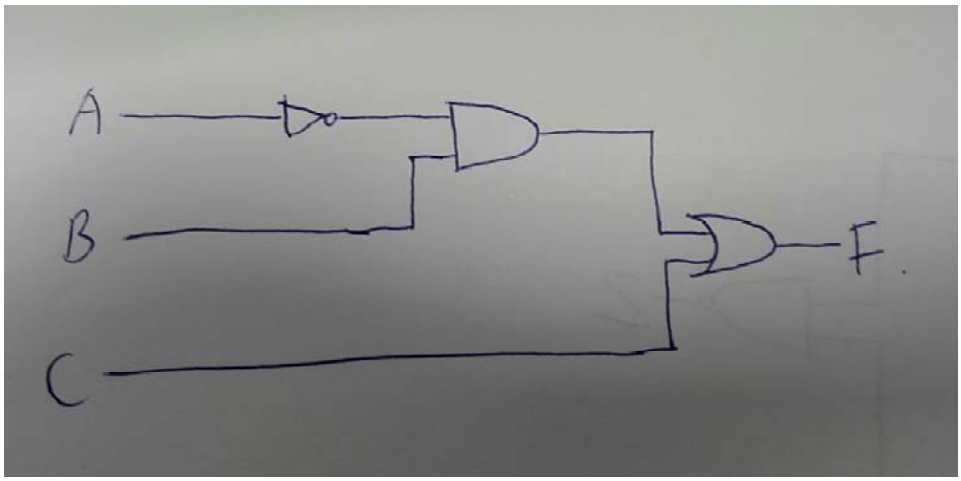
2) The Switching Algebra expression for the output F is given by

$$F = \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}C + ABC$$

It can be simplified as follows:

$$\begin{aligned} F &= \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}C + ABC \\ &= \bar{A}\bar{B}C + \bar{A}B\bar{C} + \bar{A}BC + \bar{A}BC + A\bar{B}C + ABC \\ &= \left(\bar{A}\bar{B}C + \bar{A}BC\right) + \left(\bar{A}B\bar{C} + \bar{A}BC\right) + \left(A\bar{B}C + ABC\right) \\ &= \bar{A}C\left(\bar{B} + B\right) + \bar{A}B\left(\bar{C} + C\right) + AC\left(\bar{B} + B\right) \\ &= \bar{A}C + \bar{A}B + AC \\ &= C\left(\bar{A} + A\right) + \bar{A}B \\ &= C + \bar{A}B \end{aligned}$$

3) The circuit is given by

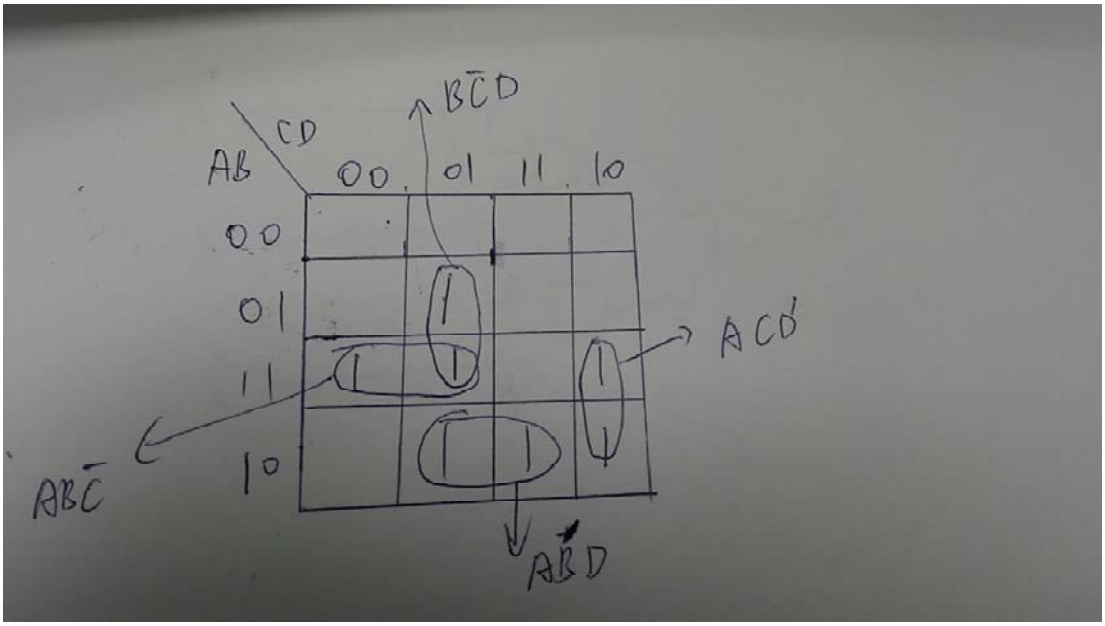

A
B
C
F.

Solution to Q7:

1) The canonical sum of minterms can be obtained as follows:

$$F(A,B,C,D) = ABC' + ACD' + AB'D + BC'D$$
$$= ABC'(D+D') + A(B+B')CD' + AB'(C+C')D + (A+A')BC'D$$
$$= ABC'D + ABC'D' + ABCD' + AB'CD' + AB'CD + AB'C'D + ABC'D + A'BC'D$$
$$= ABC'D + ABC'D' + ABCD' + AB'CD' + AB'CD + AB'C'D + A'BC'D$$

2) Fill and circle the Karnaugh map as follows:



The minimal SOP is given by

$$F(A,B,C,D) = ABC' + BC'D + ACD' + AB'D$$

Again, the minimal POS is not covered in teaching slides. I suggest to use SOP.