

# CSE260 K-Map Related Problems

## Question 1:

In planet Z, there have been two new outbreaks of Disease X and Disease Y. You have been tasked with creating a system which will detect the presence of Diseases X and Y. A person may have no disease or any one of the diseases or both. The presence of the diseases will depend on the following symptoms:

### 1. Inputs (Symptoms) :

A: Breathing Difficulties. (A=1 if you have breathing difficulties, A=0 otherwise)

B: Normal Body Temperature (B=1 if you have a normal body temperature, B=0 otherwise)

C: Fatigue (C=1 if you have fatigue, C=0 otherwise)

D :Loss of smell (D= 1 if the person has lost his ability of smell, D=0 otherwise)

Outputs: X : Disease X

Y : Disease Y

### 1. You have Disease X if your **fatigue** is accompanied by

- i) **breathing difficulties with normal body temperature** or
- ii) **no loss of smell.**

### 2. If you **don't have fatigue** then you will have Disease X if you have

- i) **an abnormal body temperature** or
- ii) **you have loss of smell with no breathing difficulties**

### 3. If you **don't have a normal body temperature** or **you have lost your sense of smell with no breathing difficulties** then you have Disease Y.

Devise a truth table for the system above which will detect the presence of the diseases based on the given symptoms. **In your truth table, the input columns should be in the order ABCD, where A is the MSB and D is the LSB.**

Draw K-map (s) based on the scenario above and derive simplified output (s).

## Question 2:

A new bizarre coffee machine has two LED lights, RED and GREEN which light up based on certain inputs. You are asked to derive the internal circuit of the machine which enables the

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lights to glow. Depending on the inputs, both the lights, any one of the lights or none of the lights may glow.

These two lights light up based on the following conditions:

## 1. Inputs (Conditions) :

A: Coffee beans. (A=1 if coffee beans are absent, A=0 otherwise)

B: Water Temperature (B=1 if water temperature is suitable, B=0 otherwise)

C: Milk (C=1 if milk is present, C=0 otherwise)

D :Sugar (D= 1 if sugar is running low, D=0 otherwise)

If the temperature is too hot/cold then the temperature is considered unsuitable.

Outputs: R : RED LED

G : GREEN LED

1. The RED LED will light up if there is **adequate amount of milk** and there is
  - i) **sufficient sugar** or
  - ii) **no coffee beans left for use with a suitable water temperature**
2. If there is **no milk** then the RED LED will still glow up if
  - i) **there are adequate coffee beans but no sugar.** or
  - ii) **the water temperature is very cold.**
3. The GREEN LED will light up if the **water temperature is too high** or **when there is a scarcity of sugar in the machine with enough coffee beans present.**

Devise a truth table for the system above which will detect the presence of the diseases based on the given symptoms. **In your truth table, the input columns should be in the order ABCD, where A is the MSB and D is the LSB.**

Draw K-map (s) based on the scenario above and derive simplified output (s).

## Question 3:

An elevator has the following sensors:

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$G = 1$ , if the gate is closed, 0 otherwise

$L = 0$ , if the elevator is not loaded (has no people or material on it)

$D = 1$ , if the elevator is in demand (someone has called the elevator to a floor)

$M = 0$ , if the elevator is not moving

The outputs to the system will be as follows:

$A=1$ , Alarm will be turned on if

- I. The gate is not closed and the elevator is moving
- II. The elevator is moving but not in demand or loaded
- III. The gate is not closed and the elevator is loaded and moving
- IV. The elevator is not loaded, not moving, and in demand

a) Using the description of the circuit above, construct the truth table for the system.

b) Use k-maps to obtain simplified equations for the outputs.

c) Using the equations found in part (b), draw the circuit.

## Question 4:

The ongoing Covid pandemic in the world has scared the authorities at Hazrat Shahjalal International Airport in Dhaka and they have asked the CSE department of BRACU to design a system that would help them to decide what to do with people coming in from African countries that are at risk. The Airport authorities have approved the following specifications for the system:

### Input (4 variables)

$F = 1$  indicates the passenger HAS FEVER.

$H = 0$  indicates the passenger DOES NOT HAVE a SEVERE HEADACHE.  $M = 1$  indicates the passenger HAS MUSCLE PAIN.

$A = 0$  indicates the passenger DOES NOT HAVE ABDOMINAL (STOMACH) PAIN.

### Output (3 variables)

$Q = 1$  indicates the passenger should be quarantined (Kept locked up in a separate area and not let anyone come in contact with him or her so as to prevent COVID from spreading).

$T = 1$  indicates the passenger is at RISK and needs to be tested.

$G = 1$  indicates the passenger is free to go.

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The Airport authorities has asked us to consider the following points when designing the system:

- I. A passenger who has FEVER and MUSCLE PAIN and any one of the other two symptoms (STOMACH PAIN or SEVERE HEADACHE) should be QUARANTINED.
- II. A passenger who has TWO OR MORE symptoms out of the four should be sent for testing.
- III. A passenger who does not fall in any of the above criteria is free to go.

**PLEASE NOTE THAT THIS POINTS ARE GIVEN IN ORDER OF PRIORITY ... so 1 HAS THE HIGHEST PRIORITY AND 3 HAS THE LOWEST.**

- a. Using the above specification, prepare a truth table for the system.
- b. Using 4 variable Karnaugh-Map methods, derive SOP expressions for all of the three outputs.

## Question 5:

Minimize the following boolean function K map:

$$F(A, B, C, D) = \sum m(0, 2, 8, 10, 14) + \sum d(5, 15)$$