

Name of the Student: _____

Max. Marks : 25 Marks

Time : 25 Minutes

Q1.

A fridge is fitted with a temperature-sensing unit to indicate whether the temperature inside the fridge is too high, too low, or at a safe temperature.

The system consists of a temperature sensor that produces a 2-bit binary output, a logic circuit and a low current, common cathode 7-segment display.

Figure 1 shows a block diagram of the system.

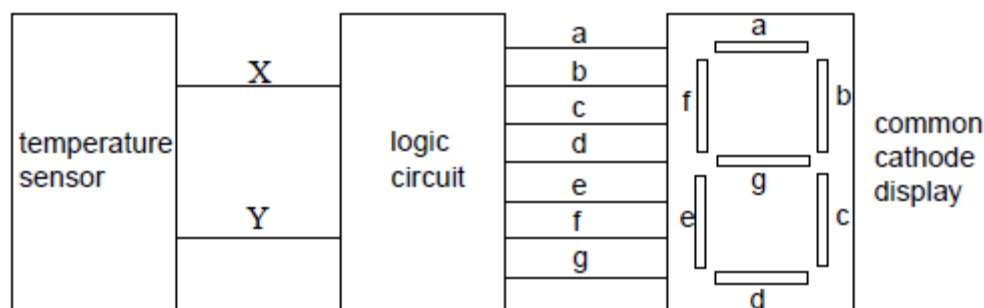
Figure 1

Table 1 shows the operation of the system.

Table 1

Fridge temperature	Temperature sensor output		7-segment display output
	X	Y	
$< 3^{\circ}\text{C}$	0	0	L
3°C to 4°C	0	1	S
4°C to 5°C	1	0	S
$> 5^{\circ}\text{C}$	1	1	H

Key

L = low

S = safe

H = high

- (a) Complete **Table 2** to show the logic signals required on lines a to g to display the specified characters.

Table 2

X	Y	a	b	c	d	e	f	g	Display
0	0								L
0	1								S
1	0								S
1	1								H

(3)

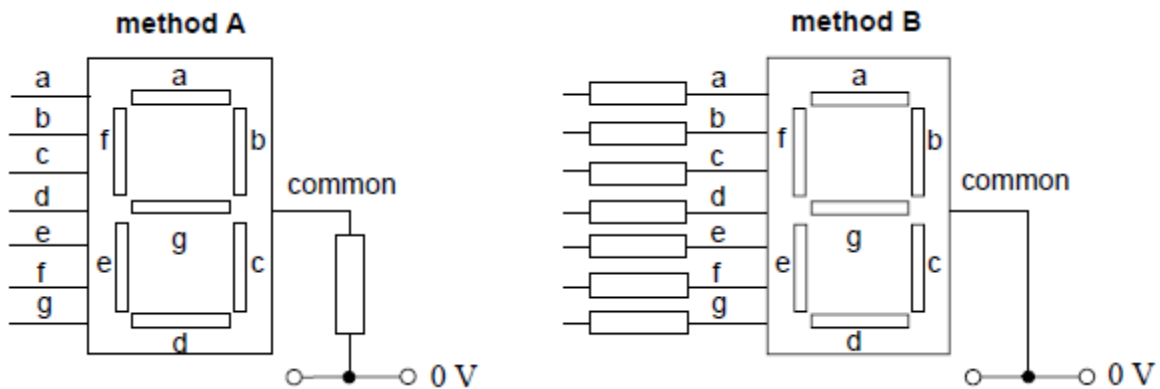
- (b) Circle the single logic gate which would generate the required signal for segment **a**.

AND EXOR OR NAND NOR NOT

(1)

- (c) The LEDs in the 7-segment display must be protected by current limiting resistors. **Figure 2** shows two methods, **A** and **B**, of connecting current limiting resistors.

Figure 2



- (i) State **one** disadvantage of **method A**.

(1)

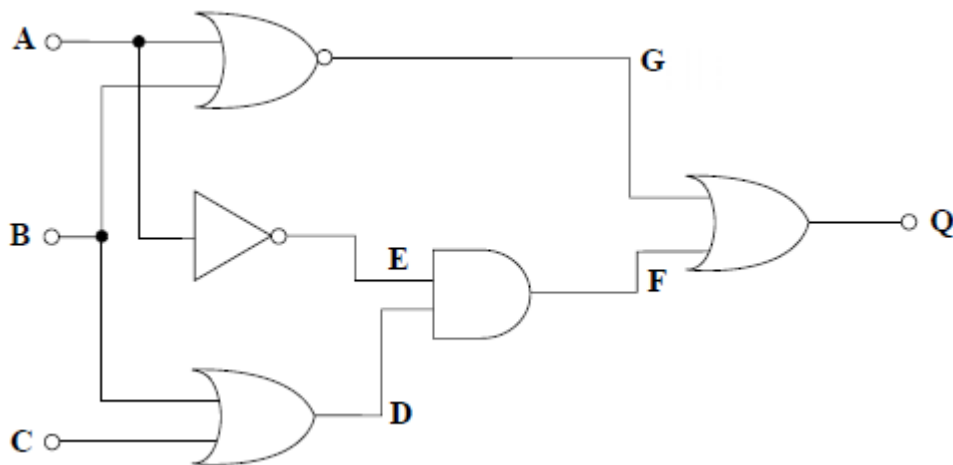
- (ii) Calculate the value of the current limiting resistors required in **method B** to limit the current in each segment to 20 mA. Assume the voltage from the logic circuit is 5 V and the forward voltage drop across each LED in the 7-segment display is 2.2 V.

(2)

- (iii) Circle the appropriate value for these resistors from the following list of E24 resistors.

Q2.

The diagram shows a logic circuit with three inputs **A**, **B** and **C**.



- (a) Write the Boolean expressions for the signals at the intermediate points **D**, **E**, and **G** in terms of the inputs **A**, **B** and **C** only.

D _____

E _____

G _____

(3)

- (b) Complete the truth table below for the logic signals at the intermediate points **D**, **E** and **G**.

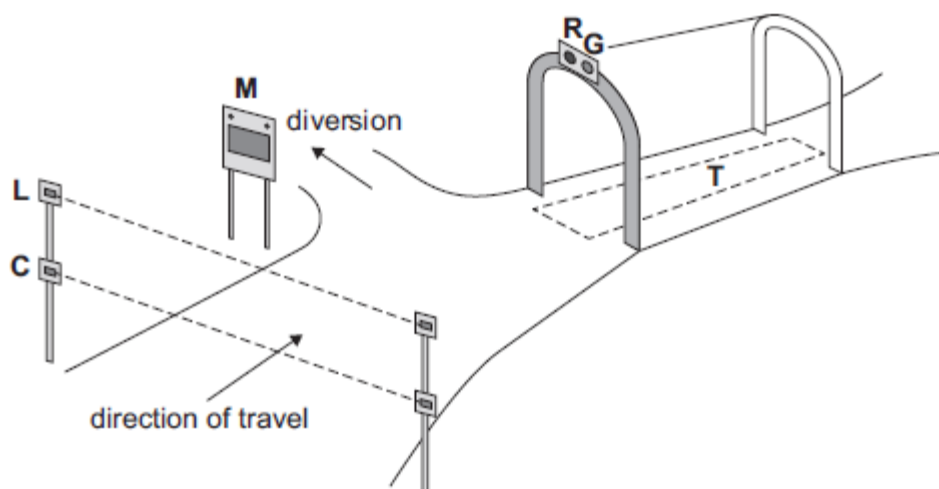
Inputs			Intermediate points		
C	B	A	D	E	G
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

(5)

Q3.

Figure 1 shows a simplified diagram of a road safety system for traffic travelling towards a road tunnel. The tunnel is too narrow for two-way traffic and too low for lorries.

Figure 1



C and **L** are laser beam sensors placed at different heights on the road just before the tunnel. When a beam is broken, the sensor produces a logic 1.

Cars will break the beam at sensor **C only**. Lorries will break the beams at both sensor **L** and sensor **C**.

M is an electronic message display that tells lorries to take a diversion. The message display lights up when it receives a logic 1.

T is a sensor buried in the road inside the tunnel. It produces a logic 1 when an oncoming car is in the tunnel.

The red stop light **R** comes on when a lorry is detected or when there is an oncoming car in the tunnel. **R** will light up when it receives a logic 1.

The green go light **G** comes on when a car is detected and there are no oncoming cars in the tunnel. **G** will light up when it receives a logic 1.

- (a) Complete the truth table.
Some of the data has already been entered for you.

Input			Output		
Sensor T	Sensor C	Sensor L	Message display M	Red stop light R	Green go light G
0	0	0	0	0	1
0	0	1	0	0	1
0	1	0		0	

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

(4)

- (b) Write the simplest Boolean expression for the red stop light **R** in terms of **T**, **C** and **L**.

(2)

- (c) The expression for the green go light **G** could be written as $G = \overline{T} \cdot (\overline{C} + \overline{L})$

Draw on **Figure 2** the logic diagram for this expression using only NOT, AND and OR gates.

Figure 2

T 

C 

L 



(3)

(Total 9 marks)