FARJANA YESMIN OPI
22-47018-1

(i) Outline for designing the alarm circuit:

Steps:

1. Analyzing the problem statement.
2. Finding the i/p's and o/p's of the system.
3. Relating the inputs and outputs.
4. Creating a truth table.
5. Forming a standard expression from the truth table.
6. Simplifiying the expression using K-MAP.
7. Designing the system circuit by logic gates.
8. Implementing the system with CMOS logic.

Step 1:

There are four sensor in car. The ignition activation system of this car is attached to a digital system. If the driver seat is occupied and the driver seatbelt is fastened or the driver seat is occupied and the driver seatbelt is fasten, and the passenger seat is occupied and the passenger seatbelt is fastened then the activation system turns on. There are appropiate sensor present for detecting the above.

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Step 2:

There are appropidte sensors present for detecting the activation. which are the inputs of the system.

Where, A = Sensor for driver seat

B = Sensor for driver seatbelt

C = Sensor for passenger seat

D = sensor for passenger seatbelt

An output Y will be generated for given conditions.

Step 3:

When A and B is high or A and B, and C and D is high, the output will be high otherwise the output will be low.

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Step 4:

	A	B	C	D	Y
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

Step 5:

$$Y = \Sigma(12, 13, 14, 15)$$
$$= AB\overline{C}\overline{D} + AB\overline{C}D + ABC\overline{D} + ABCD$$

Step 6:

AB \ CD	00	01	11	10
00	0: 0	1: 0	3: 0	2: 0
01	4: 0	5: 0	7: 0	6: 0
11	12: 1	13: 1	15: 1	14: 1
10	8: 0	9: 0	11: 0	10: 0

A	B	C	D
1	1	0	0
1	1	0	1
1	1	1	1
1	1	1	0
A	B	X	X

$$Y = AB$$

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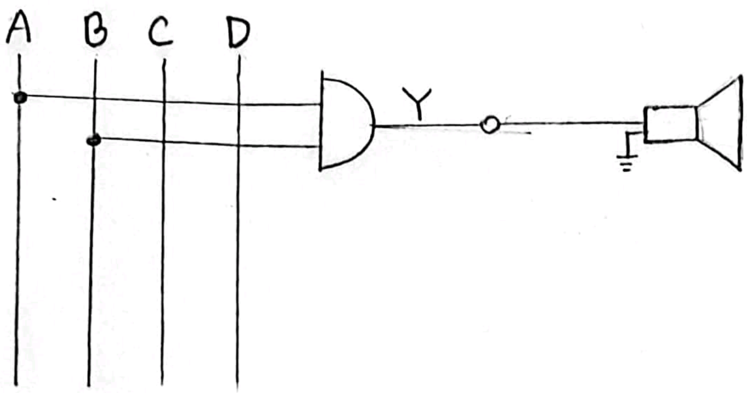
Step 7:



Design of the system using basic gates

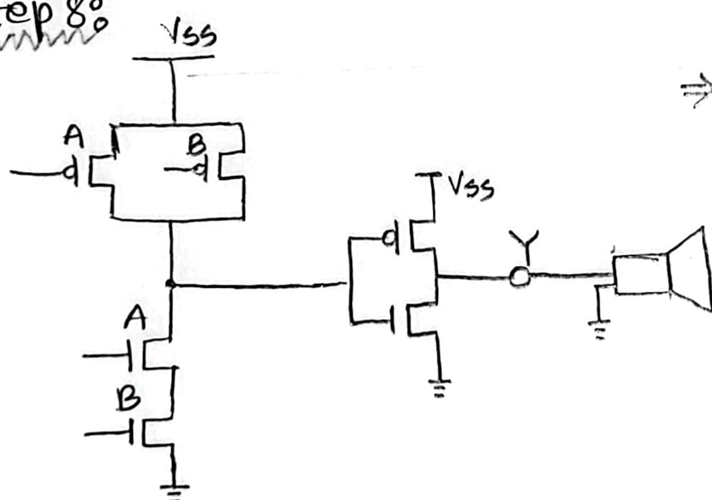
Here, When both A and B sensor inputs are high(1), the the output of the system will be high and the alarm speaker will get enough voltage to make sound. Thus, in this way the alarm will be triggered.

Step 8:

$Y = AB$

$\Rightarrow \overline{Y} = \overline{AB} \rightarrow$ NMOS

$= \overline{A} + \overline{B} \rightarrow$ PMOS



Implemention of the system using CMOS logic

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Given,

$P = N + O + I + S + E$

$= 4+7+0+1+8$

$= 20$

$\therefore P*20\ Hz = 20 \times 20$

$= 400\ Hz$ [Within the soothing hearing limits]

$\therefore$ ~~Frequency~~, $f = 400\ Hz$

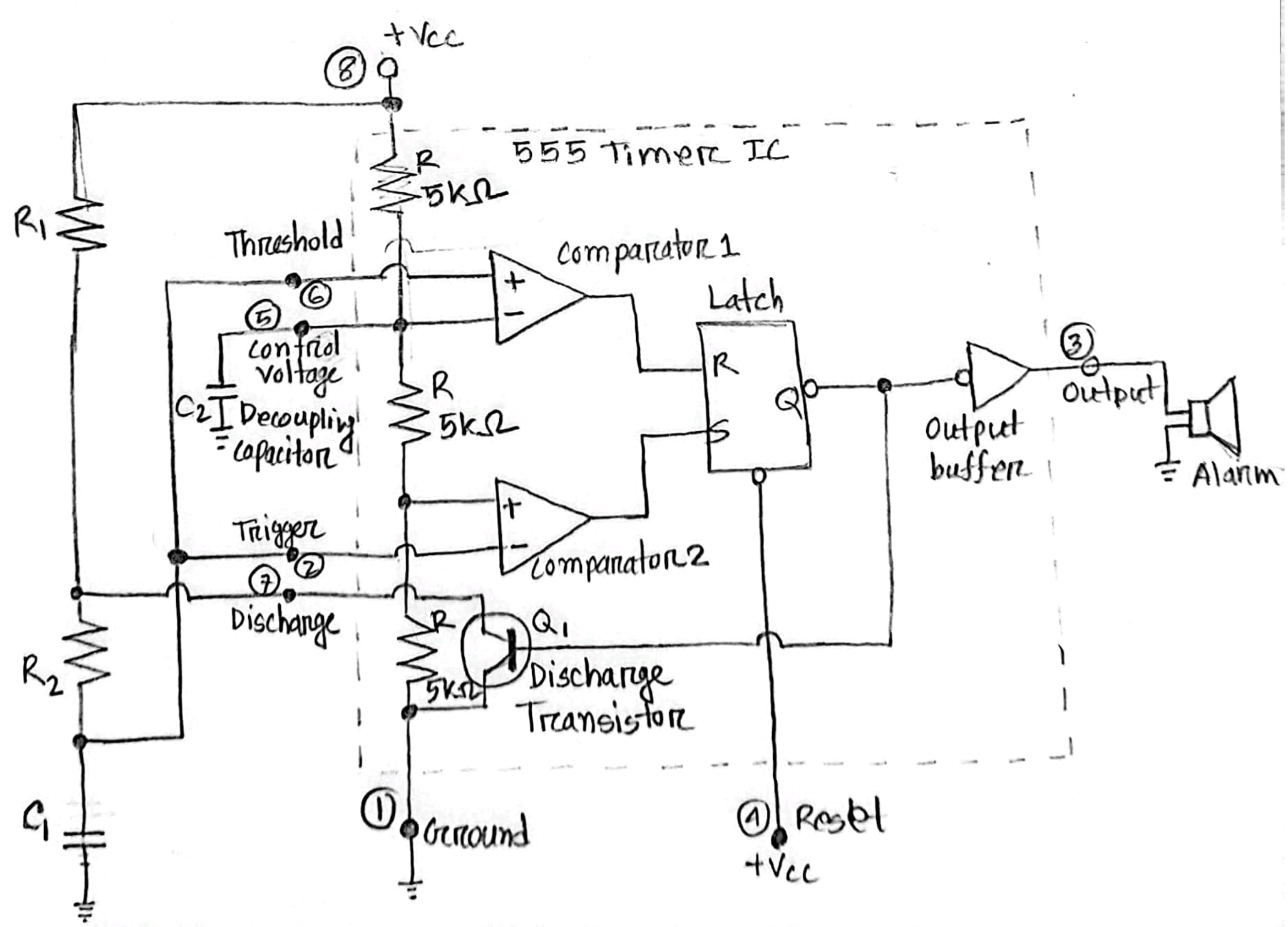
Here, $Q = 100 - P$

$= 100 - 20$

$= 80$

$\therefore$ Duty cycle, $Q\% = 80\%$

Now, we can design the alarm timer circuit with 555 timer IC in Astable mode.



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Here, 400 Hz is not a very high frequency So, we need a $250\mu F (C_1)$ and a $50\mu F (C_2)$ as a decoupling capacitor.

Now, Time period, $T = \frac{1}{f} = \frac{1}{400} = 0.0025 s$

We know,

Duty Cycle, $Q\% = \frac{T_H}{T}$

$\Rightarrow T_H = Q\% \times T$

$= 0.8 \times 0.0025$

$= 0.002 s$

$T_L = T - T_H$

$= 0.0025 - 0.002$

$= 0.0005 s$

And, $T_L = 0.693 R_2 C_1$

$\Rightarrow R_2 = \frac{T_L}{0.693 \times C_1} = \frac{0.0005}{0.693 \times 250 \times 10^{-6}}$

$= 2.886 \Omega$

$T = 0.693 C_1 (R_1 + 2R_2)$

$\Rightarrow R_1 = \frac{T}{0.693 \times C_1} - 2R_2$

$= \frac{0.0025}{0.693 \times 250 \times 10^{-6}} - (2 \times 2.886)$

$= 8.658 \Omega$

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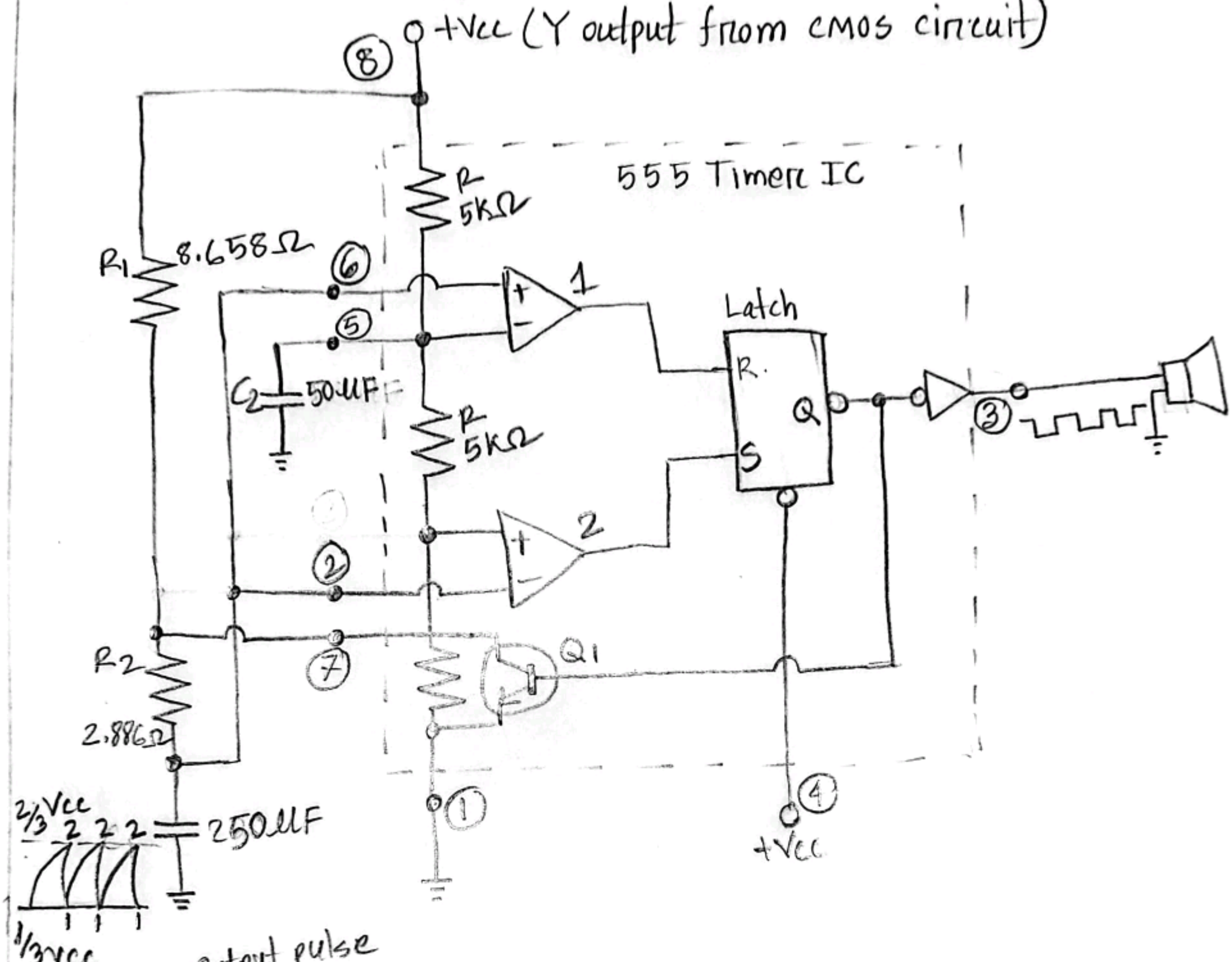
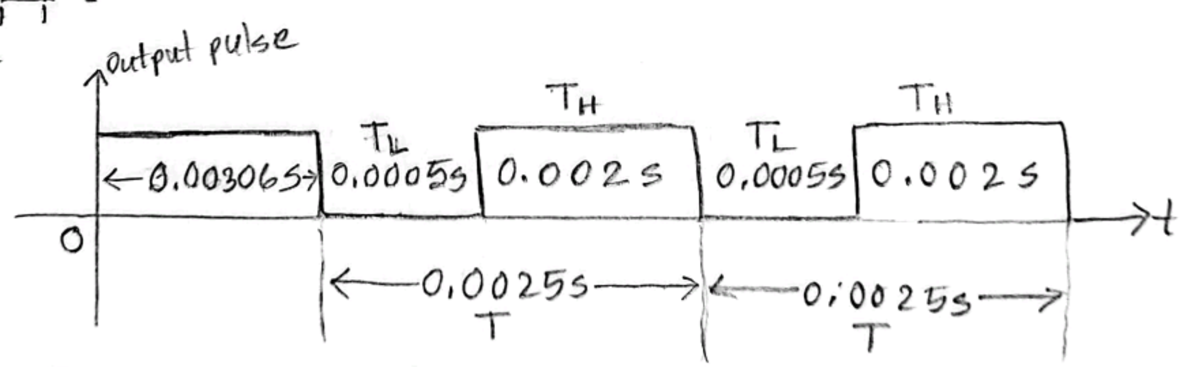
Final circuit diagram with values:





Initially, the capacitor takes 0.00306 s to charge from 0 to ~~3~~ 2/3 Vcc.
So, we get output time period of 0.0025s after the initial 0.00306 s. ~~So~~ That's why the alarm will buzz ~~at~~ for 0.002s and stop for 0.0005s and it will maintain 400 Hz frequency

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(iii) Limitations:

① The system heavily relies on accuracy and reliability of sensors. Any inaccuracies in these sensors can lead to false readings and incorrect activation of ignition.

② It may generate false alarms if sensors detect incorrect information.

③ It's functionality is limited to detecting driver and passenger seat occupancy and seatbelt status. It does not account for other factors that that could influence safe driving conditions, such as the condition of the driver, vehicle speed or road conditions.

④ Any failure in the car's electrical system, such as a dead battery or other component failure could affect the function of the system.

Effect of increasing frequency above 4500 Hz:

① Frequencies above 4500 Hz are considered disturbingly high pitched. Increasing the alarm frequency beyond this limit could lead to discomfort, unpleasent or even potential harm to individuals' hearing.

② At higher frequency, problem can occur with the 555 timer IC