Solutions for Practice Sheet - 3

Combinational and Sequential Circuits

Question 1

Take each of the conditions as signals as suggested in the hint.

1. A_3 is HIGH only when the time of day is 5 o'clock or later.
2. A_2 is HIGH only when the production run for the day is complete.
3. A_1 is HIGH only when all machines are shut down.
4. A_0 is HIGH only when it's Friday.

We can then use them to formulate our expression for the logic circuit.

The horn should be activated when either of the following conditions is met:

1. It's after 5 o'clock and all machines are shut down. $\implies A_3 A_1$
2. It's Friday, the production run for the day is complete, and all machines are shut down. $\implies A_0 A_2 A_1$

The final expression is then:

$$A_3 A_1 + A_0 A_2 A_1$$

This can then be implemented as a logic circuit. Note that this question can also be done using a Karnaugh map, and if this is specifically asked for, then you should do it that way. That would involve making a 4 variable Karnaugh map and filling the appropriate cells, and grouping them to get the minimized expression.

Question 2

The binary number is greater than 0010 and less than 1000. This means that the number is in the range 0011 to 0111. Assume that we are excluding 0010 and 1000. At this point, we can make a Karnaugh map and solve the question. We can also write the expression directly.

We can see that in the range 0011 to 0111, the MSB is always 0. This means that we must include the complement of that bit. We also notice that whenever

A_2 is 1, we must return HIGH, in conjunction with the previous condition. The expression then becomes:

$$\overline{A_3}A_2$$

We must now include one case that we are missing, which is 0011. For that, we can or the current expression with $\overline{A_3}\overline{A_2}A_1A_0$. This gives us our final expression as

$$\overline{A_3}A_2 + \overline{A_3}\overline{A_2}A_1A_0$$

This can then be made into a logic circuit. Note that the K map approach is also valid, and if asked for, you should do it that way. This approach is only to help you find patterns to make circuits that follow certain conditions.

Question 3

The state diagram for the given conditions and the state machine is shown in Fig 1.

This state diagram can be used to make the state table. The main takeaway here is that we have two branches, one for the off condition and one for the detction condition, and we move to a new state when we observe a portiopn of a pattern we are looking for.

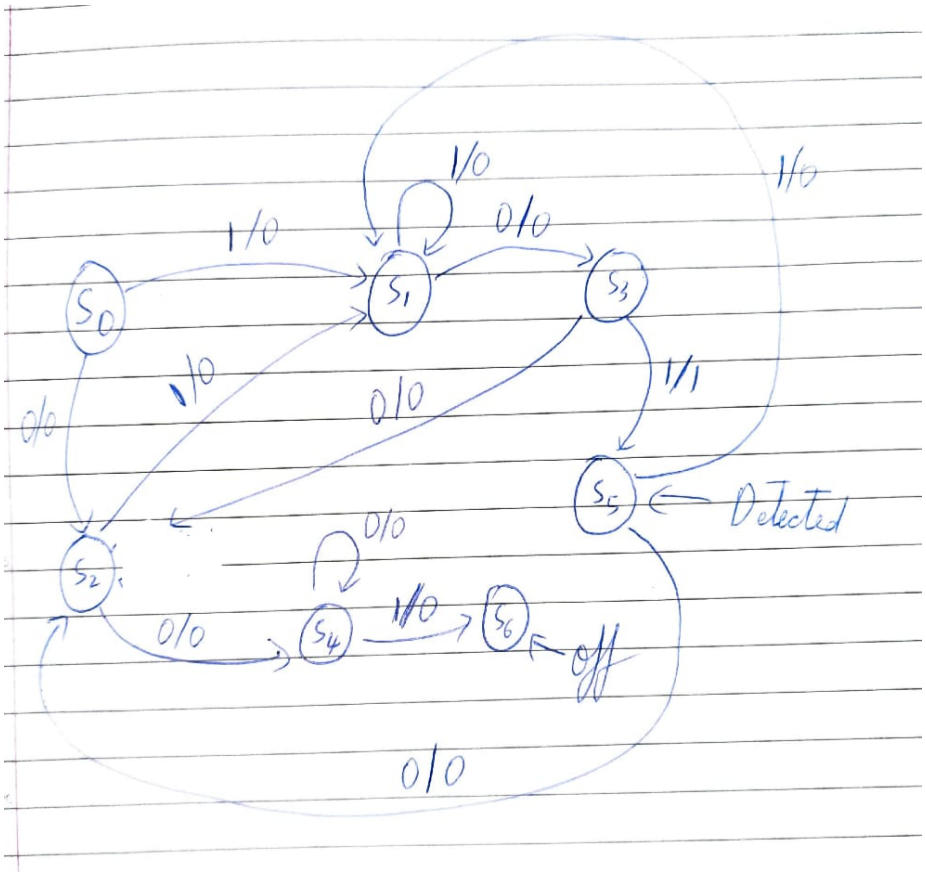

Figure 1: State diagram for 101 detector with 001 off condition

Question 4

From the circuit, we get the following expressions

$$T = x$$
$$J = Q_1\overline{Q_0}$$
$$K = \overline{Q_1} + \overline{Q_0}$$
$$y = Q_1 + Q_0$$

We can then make the state table as shown in Fig 2, using the expressions we have above.

Q_1 Q_0	T	Q_1(t+1)	J	K	Q_0(t+1)
00	0	0	**0**	**1**	0
00	1	1	**0**	**1**	0
01	0	0	**0**	**1**	0
01	1	1	**0**	**1**	0
10	0	1	**1**	**1**	1
10	1	0	**1**	**1**	1
11	0	1	**0**	**0**	1
11	1	0	**0**	**0**	1

Figure 2: State table for the given sequential circuit
