INDRAPRASTHA INSTITUTE *of*
INFORMATION TECHNOLOGY
DELHI

Department
of
Electronics & Communication Engineering

ECE111|Digital Circuits
Section: A

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Lab_5:

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A) Problem 1:

1) Aim:

Problem Statement:

Ejector seats are designed to rescue the crew of an aircraft during an emergency. To reduce the risk of injury to the occupants during ejection, several ejection modes are available depending on the environmental conditions. For example, one ejector seat selects from three modes based on the orientation of the aircraft and the air pressure:

- **Mode 1 – Used while the aircraft is upright and air pressure is high**
- **Mode 2 – Used while the aircraft is upright and air pressure is low**
- **Mode 3 - Used while the aircraft is upside-down regardless of air pressure**

A condition sensor measures the orientation and air pressure and sends this information to a mode selector. The mode selector then selects the appropriate mode and activates subsystems, such as rockets and parachutes, for that mode.

Design the logic circuit required to select the mode, modeling the orientation, air pressure and mode selector as follows:

- **Orientation (Input J):**

0 – Aircraft upright
1 – Aircraft upside down

- **Air Pressure (Input K):**

0 – High pressure
1 – Low pressure

- **MODES (output X,Y, Z):**

X at logic 1 – Mode 1
Y at logic 1 – Mode 2
Z at logic 1 – Mode 3
(Other outputs in each mode are logic 0)

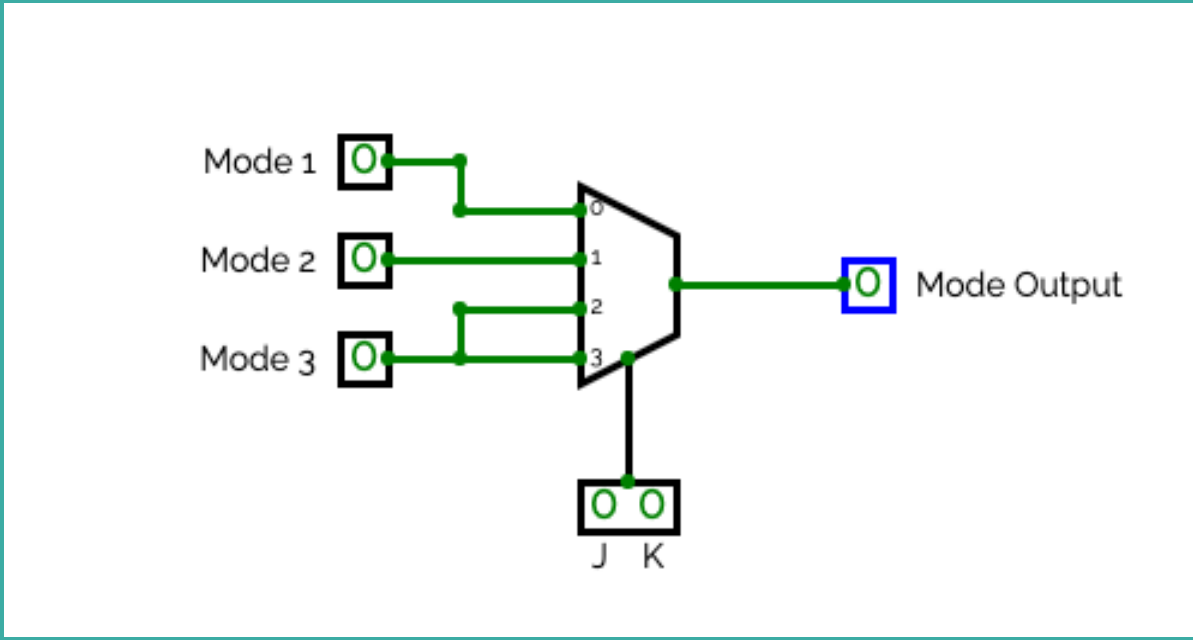
2) Components Used:

- Input Switches
- 2 - Bit Input
- 4x1 Multiplexer
- Output
- Wires

3) Link of Circuitverse Workspace:

- https://circuitverse.org/users/116189/projects/dc-lab-5-part-a-arnav-goel-2021519

4) Neat Circuit Diagram (Screenshot of Circuitverse Workspace):



5) Truth Table and Boolean Expressions:

We can derive the following truth table from the problem statement given above:

J	K	Output
0	0	Mode 1 = X
0	1	Mode 2 = Y
1	0	Mode 3 = Z

1	1	Mode 3 = Z

The expression which is derived from the following truth table is:

Output = (X. J'. K') + (Y. J'. K) + (Z. J)

This expression is the Boolean Expression for a 4x1 Multiplexer which has 2 same inputs at 2 input positions and has J and K as its two select lines.

6) Observation and Results:

As we can see the Boolean expression derived from the truth table is perfectly implemented using a 4x1 Multiplexer and for different combinations of select lines, we get different modes as outputs. Thus we have modeled the Seat Ejector for the various modes which exist.

B) Problem 2:

1) Aim:

Problem Statement:

A local council has received numerous reports of congestion occurring at a roundabout. In order to confirm these reports and determine the severity of the issue, a monitoring system has been proposed to analyze traffic coming from the three entrances to the roundabout. At each entrance, a sensor has been set up to detect whether traffic is waiting at that entrance. A logging device is then activated when at least two of these sensors have been triggered, allowing the council to evaluate how often and how long traffic is waiting, and whether any improvements to the roads are required.

Design the logic circuit required for this congestion detection system, modeling the sensors and logging device as follows:

- **Sensors (Input J, K, L):**

0 – Entrance Clear (No traffic congestion)

1 – Traffic Congestion

- **Logic Device (output X):**

0 – No congestion (Inactive)

1 – Congestion Detected (Logging)

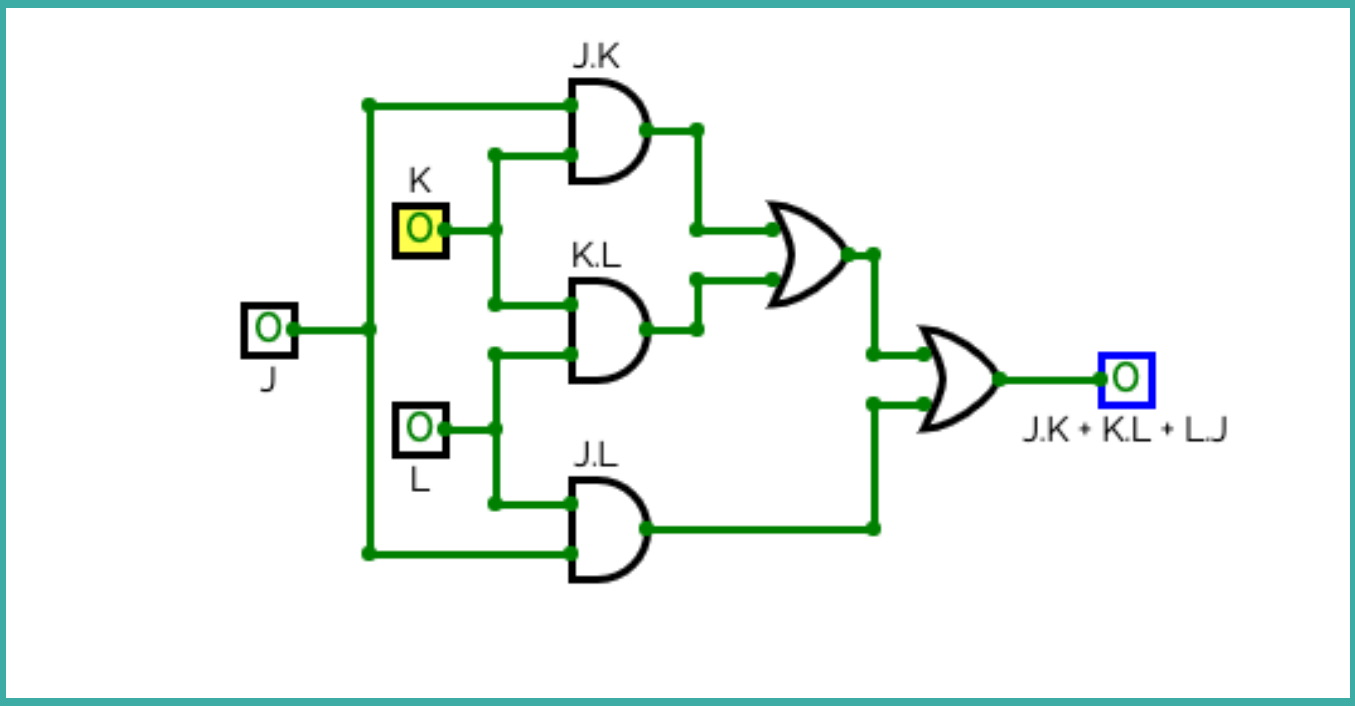
2) Components Used:

- Input Switches
- 2-input AND Gate
- 2-input OR Gate
- Output
- Wires

3) Link of Circuitverse Workspace:

- https://circuitverse.org/users/116189/projects/lab-5-part-b-arnav-goel-2021519

4) Neat Circuit Diagram (Screenshot of Circuitverse Workspace):



5) Truth Table and Boolean Expressions:

Since we know from the problem statement, the signals are activated when there is traffic at atleast 2 junctions.

We can derive the following truth table from the problem statement given above:

J	K	L	Output (X)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$$X = m3 + m5 + m6 + m7$$

K-Map:

KL	00	01	11	10
J 0	0	0	1	0
1	0	1	1	1

By pairing up the 1's in 3 duplets we get the final expression as:

X = J. K + K. L + L. J

6) Observation and Results:

As we can see the Boolean expression derived from the truth table is perfectly implemented using OR and AND gates in the circuit diagram shown above in Circuitverse and hence we have modeled the Congestion Detection System using very simple K-Map analysis of the truth table derived from the question.