LAB #3: SUBWAY SIGNAL CONTROL LOGIC (Cadence)

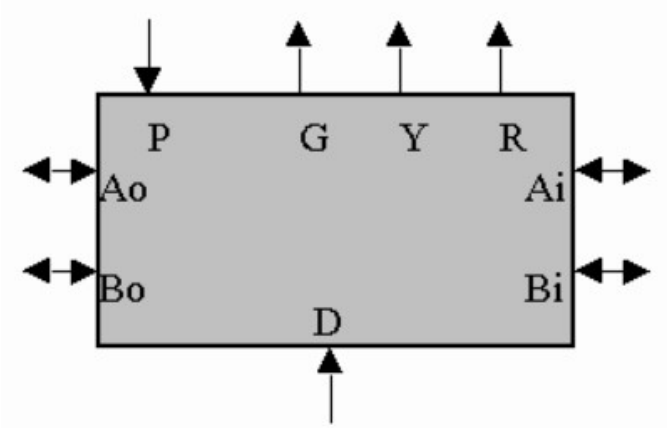
Due: at the beginning of your registered lab section between Oct 7 and Oct 11

Objective:

- The objective of this lab is to design a control logic block using Cadence.

Lab Description and Specs:

- **Function:**
  - Design a subway signal controller for each subway station. Each section of tracks in a subway station will have a sensor to determine whether there is a train in that section and a signal with red, yellow, and green lights. You want the light in the track section to show *red* if there is a train in the track section in the very next station in the direction the train is traveling, *yellow* if there is no train in the track section in the very next station but the section after that is occupied, and *green* otherwise. Design a control module shown schematically below:



Tracks allow trains move both ways from left to right and vice versa. The input D indicates the direction allowed at the time. When it is 1, the left-to-right direction is allowed; when it is 0, the right-to-left direction is allowed. The outputs G, Y, and R should be 1 to light the green, yellow, and red signals, respectively. The input P is 1 if there is a train in this section (subway station). The signals Ai, Bi, Ao and Bo are signal used to communicate from/to the station to the right and from/to the station to the left. The signals Ai and Bi are received/sent from/to the section to the right of the station, and signals Ao and Bo are received/sent from/to the section to the left of the station. You may do with these what you like, but there are only two wires available, and you may not add more. Therefore, they must have proper tri-state control. Based on your decision, specify how you will use these two wires and what their functions are.

- **Inputs:**
  - *Ai, Bi, Ao, Bo*: Inputs from the neighboring subway stations.
  - *P*: Sensor input to indicate existence of a train on the track.
  - *D*: Track direction input.

- **Outputs:**
  - *G, Y, R*: Light control signals for green, yellow, and red lights, respectively.

- *Ai, Bi, Ao, Bo*: Output signals for the neighboring stations.

Recommended Procedures:

- For this lab you will using manual schematic method to design the controller.

a. Write out the truth table for the controller and perform the logic synthesis process to obtain the Boolean equations.
b. To ensure absolute safety, eliminate all possible glitches and other hazards (static-hazard free).
c. Map the final Boolean equations to a schematic sheet using Cadence.
d. Check the sheet prior to making a symbol. Make a symbol out of your logic controller.
e. Run Cadence to verify the functionality by applying every combination of inputs like those in the truth table.

Prelab:

- Truth Table for Controller
- Boolean Equations for all outputs
- Paper Schematic layout using tri-state buffers and bi-directional ports for 1 controller station.

Questions:

- What is a static 1-hazard and a static 0-hazard?
- Discuss how you remove a static 1-hazard and a static 0-hazard.