Lab 5 Homework Vending Machine

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Vending Machine

- A vending machine is an automated machine that provides items such as snacks, beverages, cigarettes and lottery tickets to consumers after cash, a credit card, or a specially designed card is inserted into the machine.
- The first modern vending machines were developed in England in the early 1880s and dispensed postcards.
- Mechanisms
  1. Insert enough money to the machine.
  2. Selects available product to buy.
  3. Machine will generate the product and the customer can take out the product and get their changes back if there is any.

Exercise 1 – Basic Vending Machine

- When the vending machine is power-on, it is required to setup merchandise price. In this case we have to setup 3 kind of merchandises.
- After setting up, customer can start using the vending machine. If the customer insert enough money for the selected product, the customer should get the product and get their changes back if there is any.
- This machine have infinite number of products.
- This machine support inserting coin and selecting product at the same time.
- The change giving mechanism only work when the product is coming out.
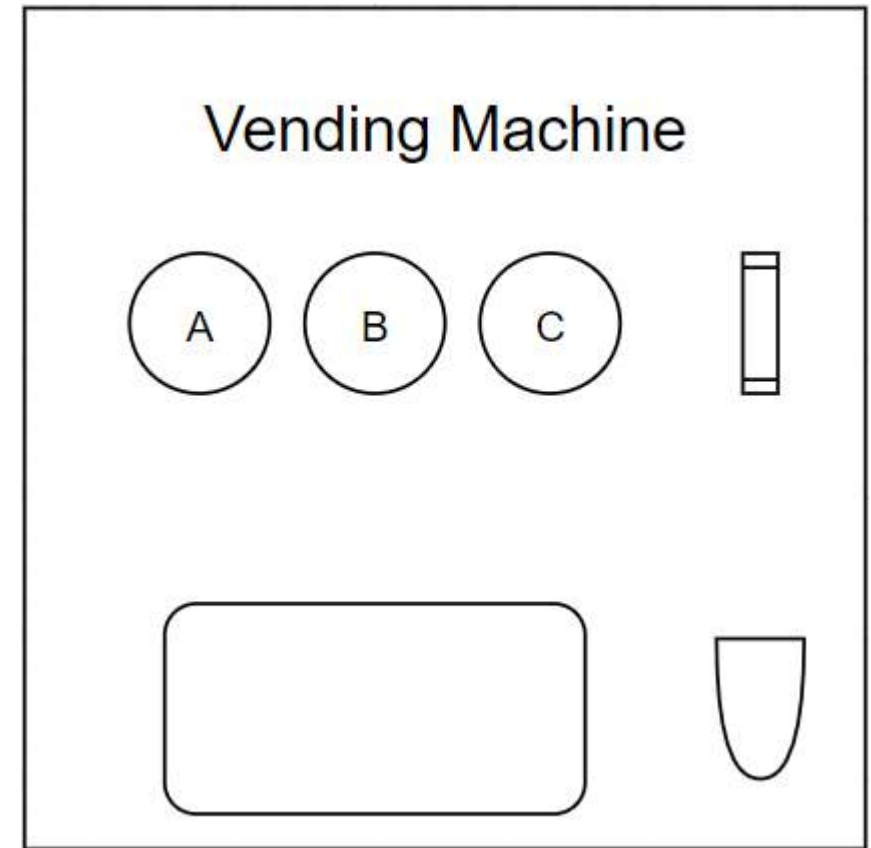
Vending Machine

Exercise 1 – Basic Vending Machine

- I/O Interface

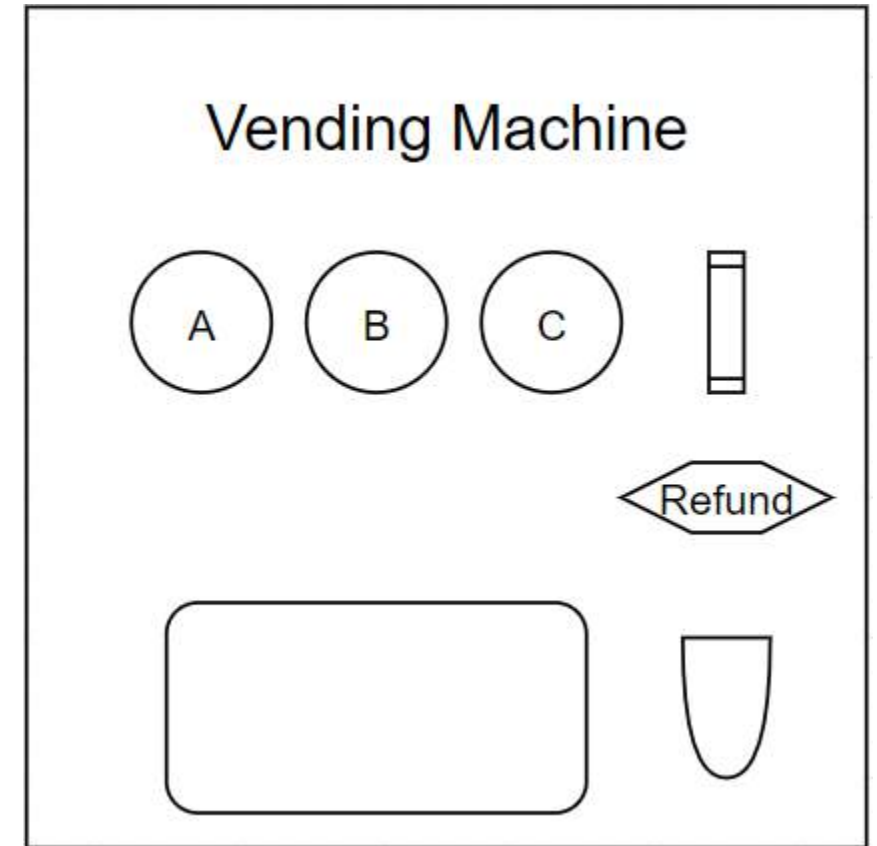| Name	I/O	Width	Description
clk	I	1	System clock signal. This system is synchronized with the positive edge of the clock.
rst	I	1	Active-high asynchronous reset signal.
DI	I	8	Price setting signal.
MI	I	8	Coin slot.
sel	I	2	Selection buttons. Default = 2'b00, A = 2'b01, B = 2'b10, C = 2'b11
MO	O	8	Change giving.
PO	O	2	Product collector.

Exercise 1 – Basic Vending Machine

- Waveform
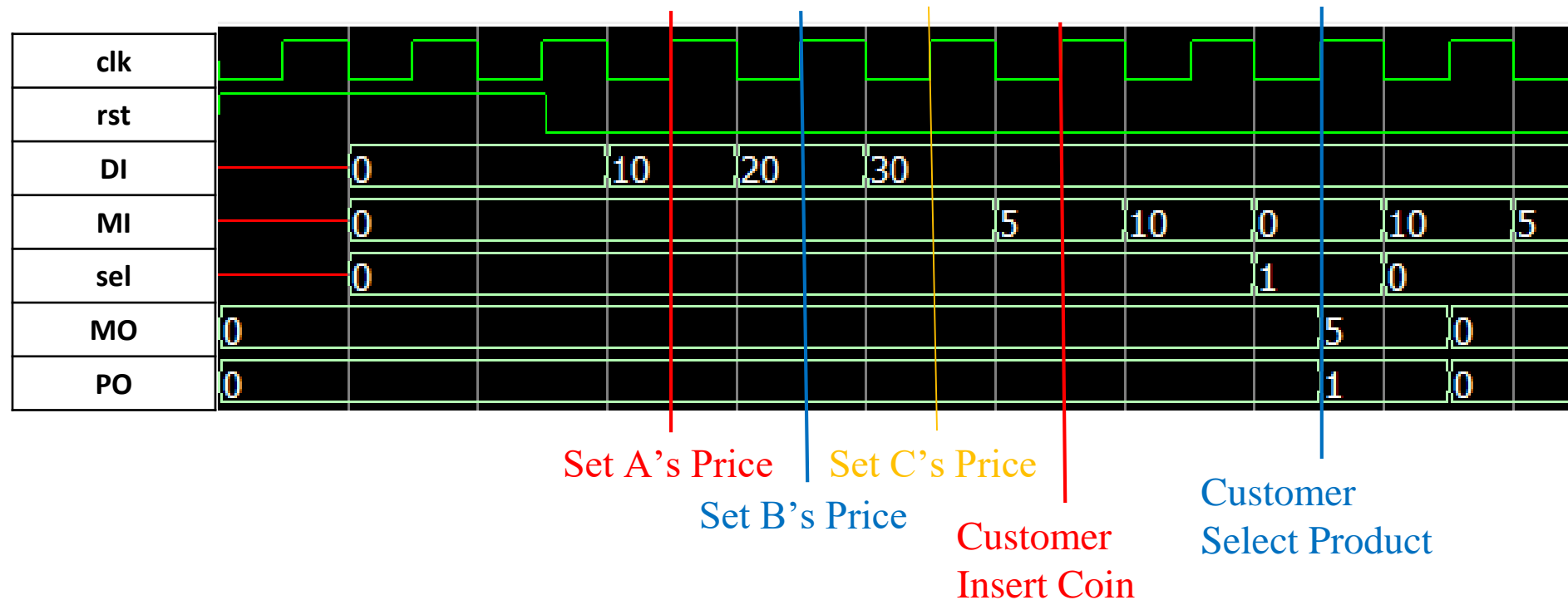
Exercise 2 – Vending Machine with Refund

- The vending machine in exercise 1 will only give the change when customer buy a product, which means the only way to get money back is to buy a product even though you don't want anything from this machine. This is so-called a hard sell.
- In this exercise, we add a button called refund which can let customer terminate the transaction whenever they want.
- The refund button will only be activated after merchandise price setup. The refund is given through change giving box.

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Exercise 2 – Vending Machine with Refund

- I/O Interface

Name	I/O	Width	Description
clk	I	1	System clock signal. This system is synchronized with the positive edge of the clock.
rst	I	1	Active-high asynchronous reset signal.
DI	I	8	Price setting signal.
MI	I	8	Coin slot.
sel	I	2	Selection buttons. Default = 2'b00, A = 2'b01, B = 2'b10, C = 2'b11
re	I	1	Active-high refund button.
MO	O	8	Change giving.
PO	O	2	Product collector.

Exercise 2 – Vending Machine with Refund

- Waveform

Set A's Price   Set C's Price   Customer Refund

Set B's Price   Customer
Insert Coin

Bonus

Exercise 3 – Vending Machine with Limited Product

- In reality, the number of products cannot be unlimited, so it required to setup the quantity of merchandises. When the vending machine is power-on, it is required to setup merchandise's price and quantity.
- In this exercise, we add a index called empty to show all of merchandises are soled out. If empty is high, the money given by customer will directly drop into change giving box.
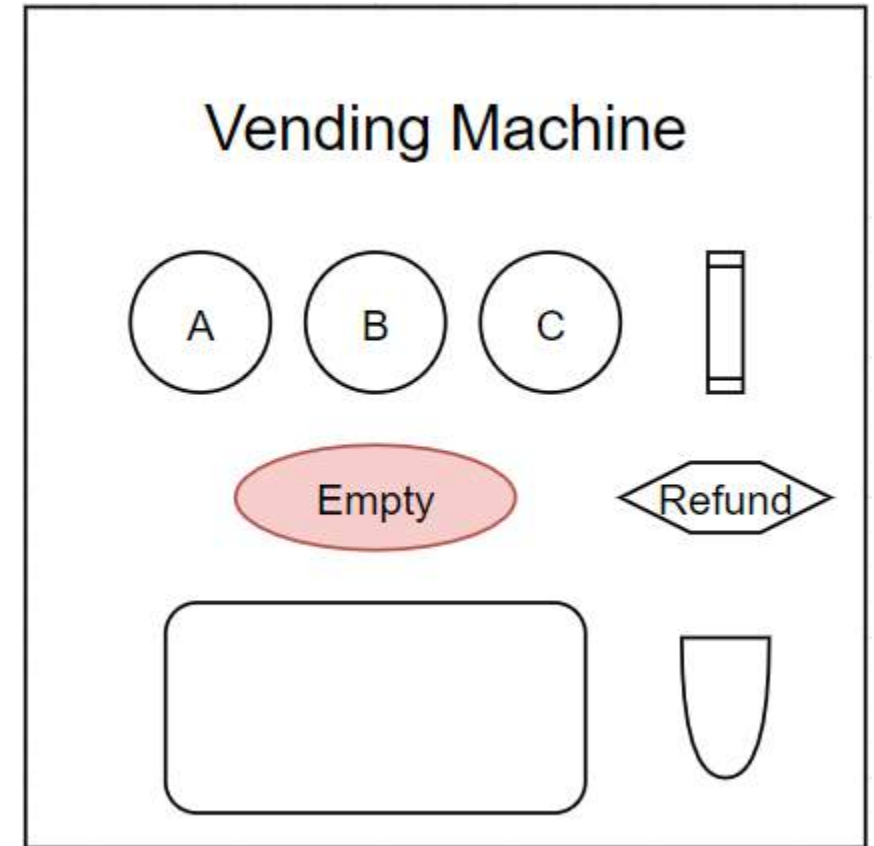
Bonus

Exercise 3 – Vending Machine with Limited Product

- I/O Interface

Name	I/O	Width	Description
clk	I	1	System clock signal. This system is synchronized with the positive edge of the clock.
rst	I	1	Active-high asynchronous reset signal.
DI	I	8	Price setting signal.
MI	I	8	Coin slot.
sel	I	2	Selection buttons. Default = 2'b00, A = 2'b01, B = 2'b10, C = 2'b11
re	I	1	Active-high refund button.
MO	O	8	Change giving.
PO	O	2	Product collector.
empty	O	1	Active-high empty index.

Bonus

Exercise 3 – Vending Machine with Limited Product

- Waveform
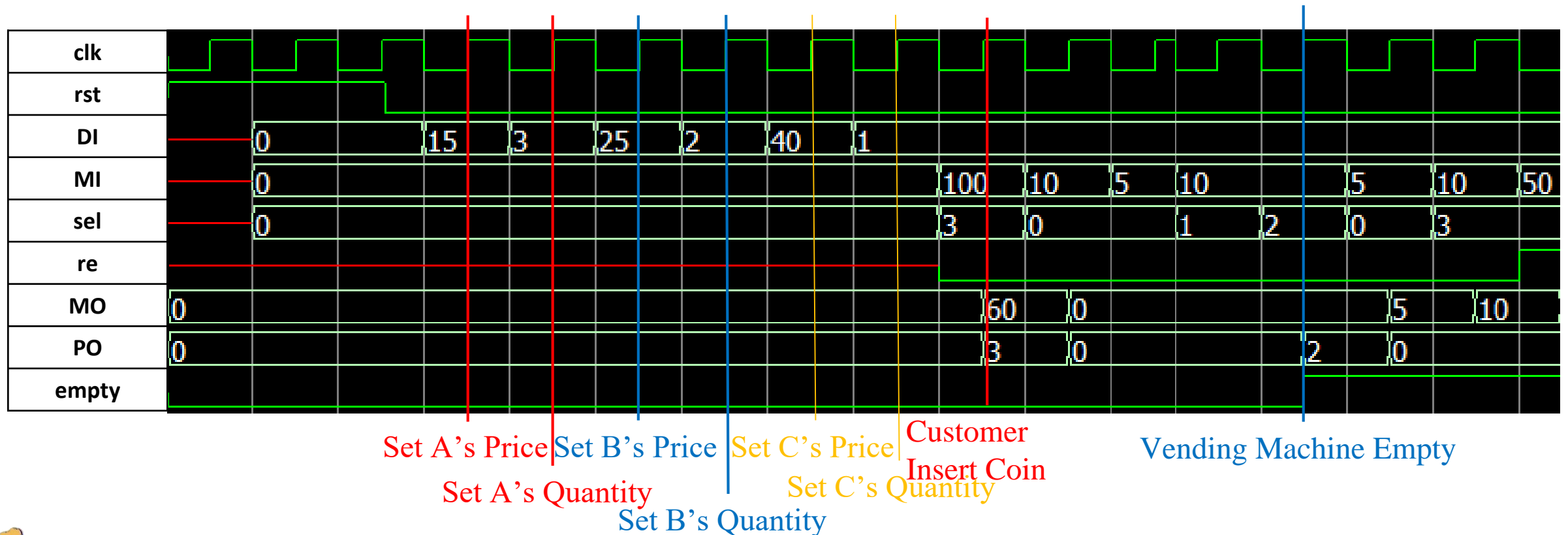
Error Example

```
[Test 13 line  1]
        Output Change =  50, Product = 0, Empty = 1
        Expect Change =  50, Product = 0, Empty = 0


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**   OOPS!!               **  |       ____|        ( KILL ALL HUMANS! )
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**   Simulation3 Failed!! **  |  '.-+-+-+|     -'
**                        **  |    """""" |
*****************************  '-.__   __.-'
 Totally has          1 errors
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Correct Example

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**   Congratulations !!    **                (_`    `--'':(      | What did  |
**                         **                 \    _,-_|`       /   you      |
**   Simulation3 PASS!!    **                  L <--,-'     -'-----------'
**                         **                   J   (
***************************                   __,'    \---..
```
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# Report Format

- Report should contain:
1. Level1 pass picture or
   Level1 fail picture and wavcform
2. Level2 pass picture or
   Level2 fail picture and wavcform
3. Level3 pass picture or
   Level3 fail picture and wavcform



Bonus