EENG284: Introduction to Digital Design

Spring 2021

Homework Assignment #11

Due: 11:59pm, Wednesday, May 5th, 2021.

1. Design a digital circuit to control access to an automated parking garage containing 828 parking spaces. Drivers pull up to the garages gate and insert their pass card into a card reader. The card reader sends the pass card ID number to the digital circuit. If their pass card has a valid code then the gate opens. There is a pressure sensor just inside the entry way which sends a signal to the circuit whenever a significant load is present (over 150 lbs). The exit procedure is similar, the users have to insert their pass card into a card reader. The digital circuit then raises the exit gate bar, a pressure sensor at the exit tells the circuit when it is OK to close the exit gate. See Figure 1.

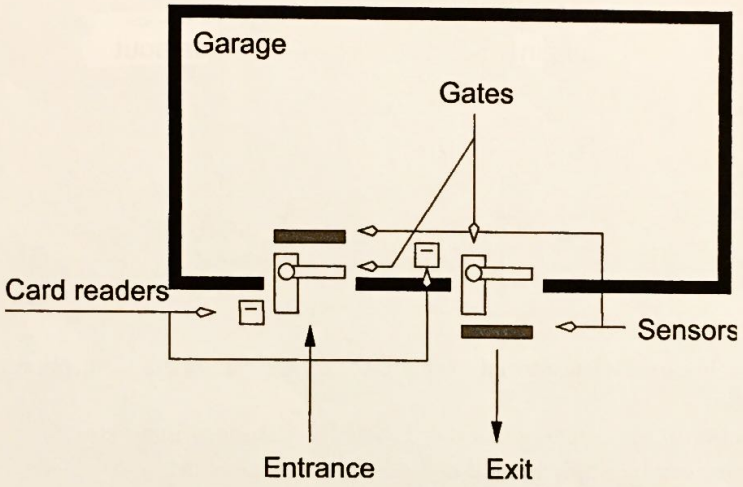


Figure 1: The layout of an automated garage.

The signal names are defined in the following table:

Entrance gate	InGate	0 Close gate	1 Open gate
Entrance sensor	InSen	0 No weight	1 Weight present
Entrance REQ	InREQ	0 No card read data	1 Card reader has data
Entrance ACK	InACK	Circuit control	
Entrance ID	InID	Card ID	
Exit gate	OutGate	0 Close gate	1 Open gate
Exit sensor	OutSen	0 No weight	1 Weight present
Exit REQ	OutREQ	0 No card read data	1 Card reader has data
Exit ACK	OutACK	Circuit control	
Exit ID	OutID	Card ID	

orange = inputs
blue = output

The gate requires a logic 1 to start and to stay open. The sensor will generate a logic 1 while there is more than 150 lbs. on the sensor. Only close the gate when the rear wheels of the car activate the sensor (hope no unicycle use the garage). The entrance card reader will provide InID or OutID using a two-line handshake, where the circuit is the passive consumer. Assume that at any point in time only one car is entering or leaving the garage. That is, deal with only one direction at a time.

In addition to controlling access to the garage, the clients would also like to keep track track of how many times a pass ID has been used to gain access in-to and out-of the garage. The count will be checked and reset once a month. Cars pass into and out of the garage at most 4 times a day.

To implement this circuit use a *single* RAM. Each word of the RAM must be divided into three fields; ID, Ins and Outs corresponding to the pass ID number, number of times into the garage and number of times out of the garage respectively. The digital circuit will scan successive IDs in the RAM looking for a match. If a match is found then either increment the Ins or Outs field then store this item back into the RAM. A major issue in this design is determining the sizes of the data items. Use the information in the word statement to make the design as space efficient as possible. Turn in; an algorithm the

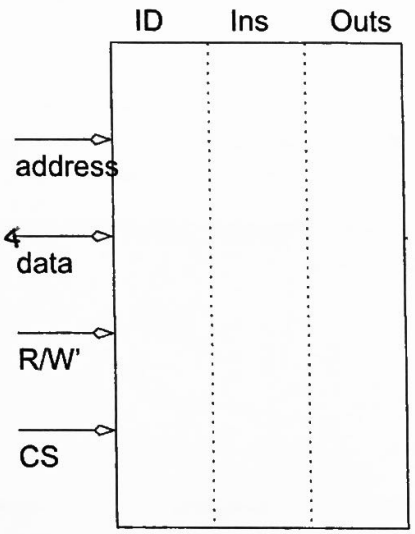
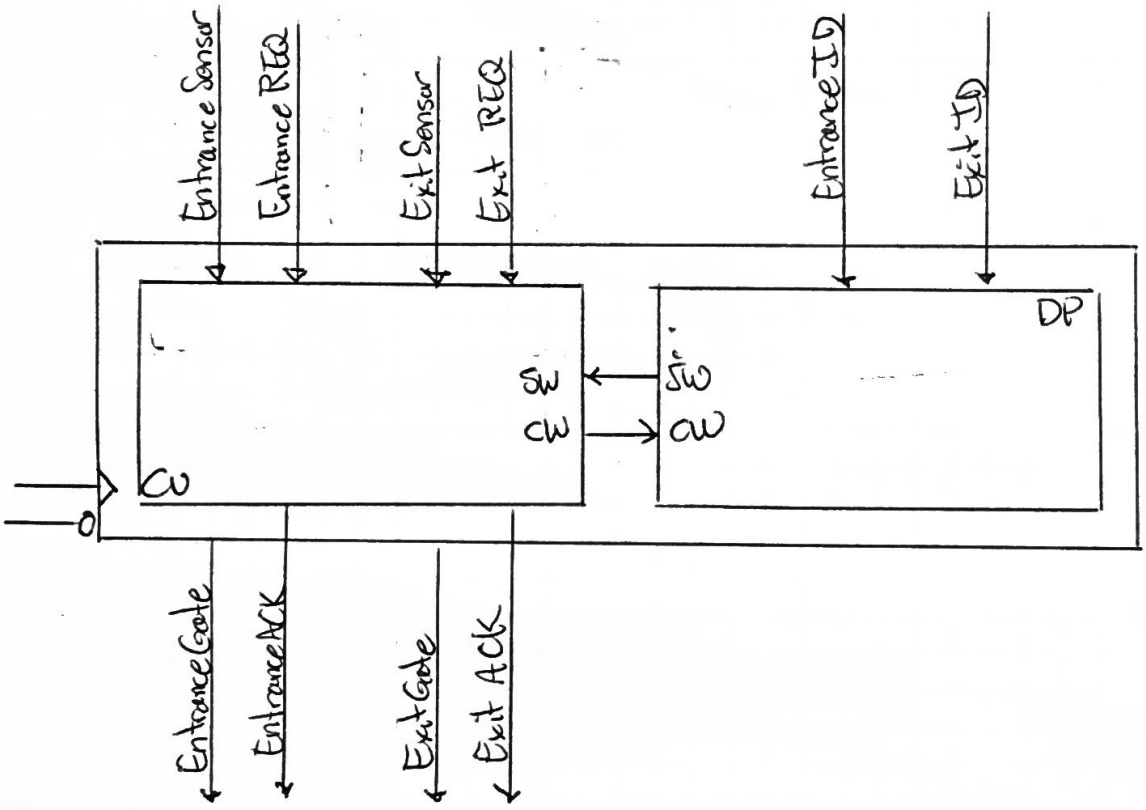


Figure 2: The format of the RAM in the garage circuit problem.

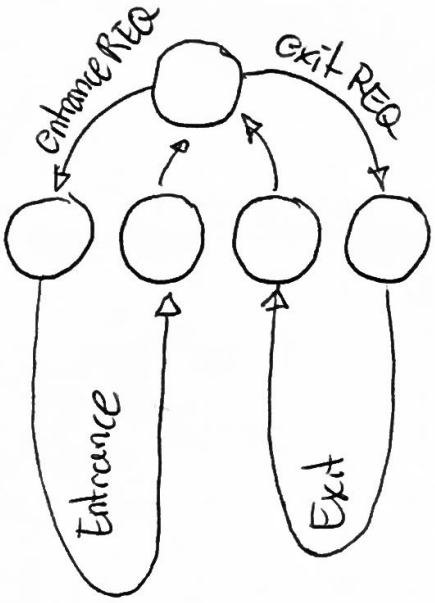
datapath and control unit, the control word table, the memory input equations, and output equations. The control unit is to be implemented using a ones hot encoding.



Algorithm

```
for(;;) {
    if (entranceREQ == 1) {
        <2-line handshake>
        Key = entranceID;
        <loop through RAM looking for key>
        if(Key == MBR_Key) {
            MBR_NumJas += 1;
            <write Key back to RAM at address you found at>
            entranceGate = 1;
            <while cars rear wheels have not passed entrance sensor>
            entranceGate = 0;
        }
    }
    if (exitREQ == 1) {
```

Control Unit



Datapath