# 312 lab2

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## 1 Problem 1

**1.** The first two circuits are included in the submission folder as p1a and p1b

**2.** In a real life situation I would use:

- 74LS08 2 input AND gate
- 74LS32 2 input OR gate
- 74LS16 2 input NOT gate

**3.** I will be doing the time calculations using the 74LS08 AND, delay 18ns, the 74LS16 NOT, delay 20ns, and the 74LS32 OR, delay 15ns. Circuit A would take:

$$2 * time(74LS08) + 4 * time(74LS32) = 2 * 18 + 2 * 15 = 66ns$$

Circuit B would take:

$$1*time(74LS16)+2*time(74LS08)+2*time(74LS32) = 20+2*18+2*15 = 86ns$$

**4.** I used the National Semiconductor datasheets listed on *http://rabbit.eng.miami.edu/info/datasheets/*. I used them because the lab instructions provided them and recommended that we use them for this problem. They were nicely drawn.

**5.** I could improve the delay by reducing the equations are creating a simpler equivalent circuit. The current circuits are not in their simplest form. Using gates with more than 2 inputs would reduce the number of components in the circuit and reduce latency.

**6.** The circuits in problem 1.a can be redesigned with larger input gates. I have redesigned circuit B and included it in the submission folder as p1c. The 74xx series gates used in the real world construction of circuit B are 74LS11 3 input AND, 74S16 NOT, and 74LS32 OR. The Curcuit delay is

$$time(74LS11) + time(74S16) + 2 * time(74LS32) = 30 + 20 + 2 * 15 = 86ns$$

This redesigned circuit runs 6ns faster than the original implementation with 2 input gates.

# 2 Problem 2

I completed this as part of problem 1.

# 3 Problem 3

**1.** Seven switches will be required, one for each car. The encoder will have 7 inputs and 3 outputs. The motor car encodes 000, so it isn't connected to any output in the decoder. There are 3 bits/wires in the data bus. The decoder will have three inputs and 7 outputs. The decoder translates the car code into data to be sent to the LED display.

**2.** A common cathode LED will be used. Cathode LEDs turn on in response to 1. Anode LEDs respond to 0. We will signal the LED be sending a 1.

**5.** Each car is encoded as a 3 bit number. The encodings are as follows:

- I0 -ENCODE- 000 -DECODE- ABCDEF
- I1 -ENCODE- 001 -DECODE- BC
- I2 -ENCODE- 010 -DECODE- ABGED
- I3 -ENCODE- 011 -DECODE- ABGCD
- I4 -ENCODE- 100 -DECODE- BCFG
- I5 -ENCODE- 101 -DECODE- ACDFG
- I6 -ENCODE- 110 -DECODE- ACDEFG

The non-error state is 111. This is a good design because in the event of a bus failure, the values will fall to zero and trigger an error state.

**6.** The system is not designed to handle more than one signal at once. The encoding would not happen correctly and an empty signal is sent. In order to correctly handle multiple signals, we could create a priority multiplexer. Assigning each car a priority would show the highest priority error when multiple signals are sent.