Class:	CPE 100L – Digital Logic Design 1	Semester:	Summer 2021

Points		Document author:	Angel Garcia J
		Author's email:	garciaj@unlv.nevada.edu
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Instructor's comments:

1. Topic – Shift Light

The circuit being created is for a shift light which is a light typically located by the cluster gauge of a manual car in order to know when to shift gears. The light will turn on depending on the RPM value from the cluster gauge as well as the set value for when the light should turn on. The value set will also be a RPM value but it will range from 0-15k RPM.

2. The Goal

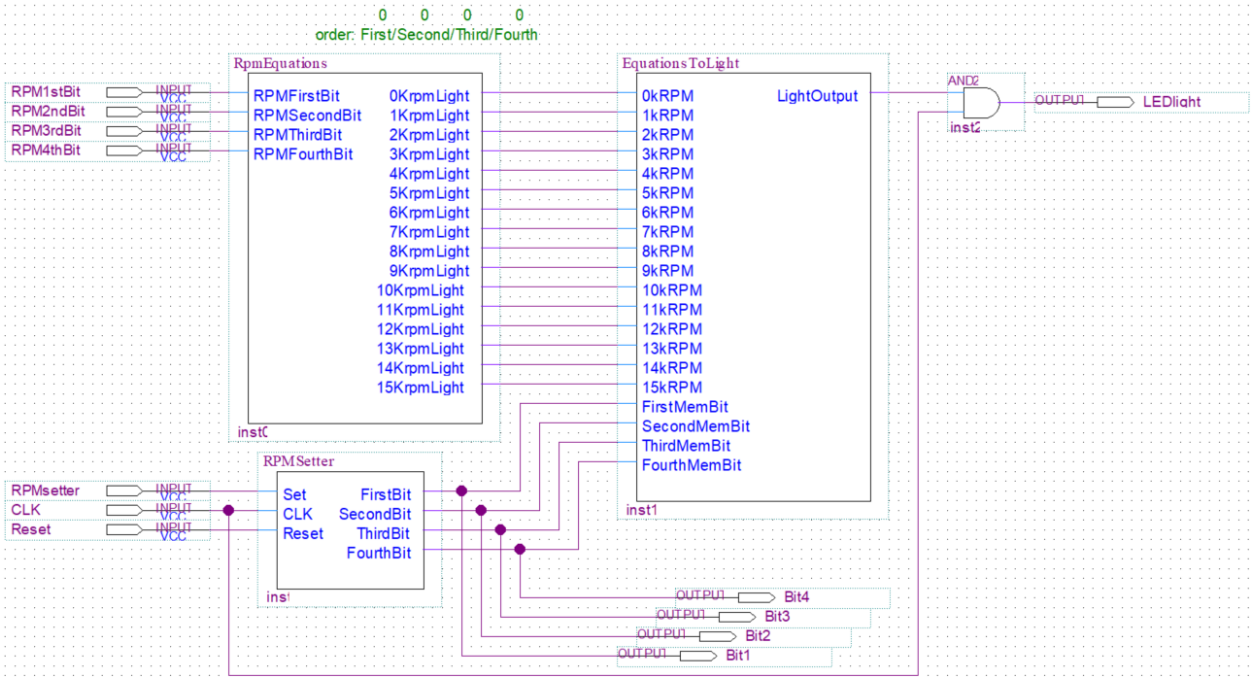
The motive behind making this device was to create something that I found interest in which is racing and from there I thought of my current build(Mazda Protege). I have been thinking of buying a shift light for my own car and as soon as I realized I needed to make a final project for this class I realized it would be a pretty good idea to make this shift light on my own in order to later use it on my own car to allow it to be modified in any shape or form that I want as I would plan to combine this circuit with the car's ECU(Electronic Control Unit aka Car Computer).

3. Background Theory

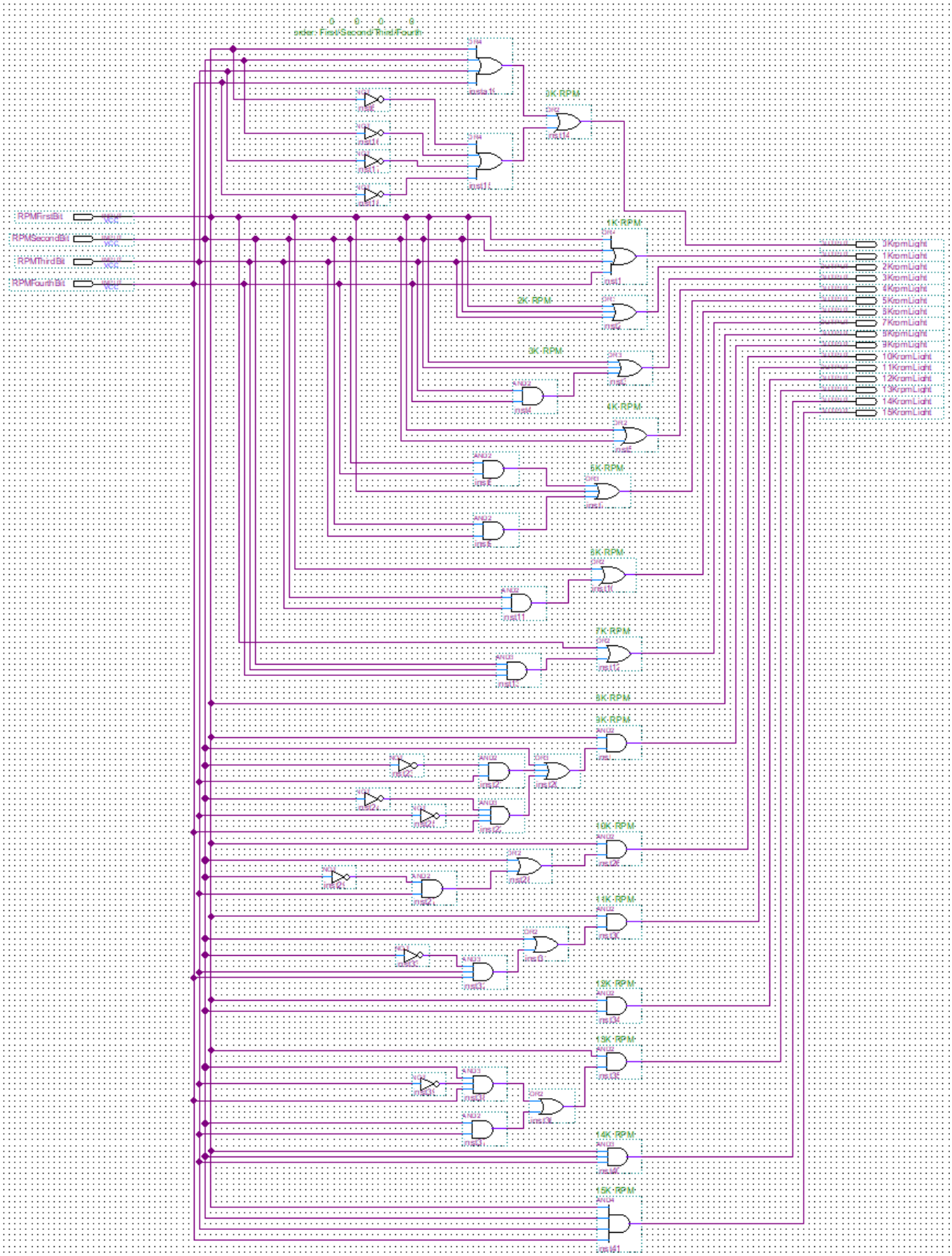
In order for this circuit to work there will need to be 4 inputs coming in from an Arduino that are translated from the car's ECU that provides a voltage reading into 4 bits that represent a RPM(Revolutions per Minute) value from 0-15k. Once the 4 bits representing the car's RPM value are introduced into the circuit there will then be 16 equations that represent every scenario where a certain RPM needs to be hit by the car's cluster gauge. The 16 equations then go into a 16:1 mux that outputs a 1 value which would turn on the Shift Light(red light). The way that the equation is selected by the mux is by having a 4-Bit Memory Cell that holds a RPM value represented by 4 bits that will be the minimum for when the RPM should be on. The 4-Bit Memory Cell will be able to set a value through a set button(input) by incrementing by 1k rpm until 15k rpm by which then it will reset back to 0k rpm as it is a 4-bit counter and this counter can also be reset by clicking the reset button(input of 1) to make the RPM value 0k.

4. Schematics

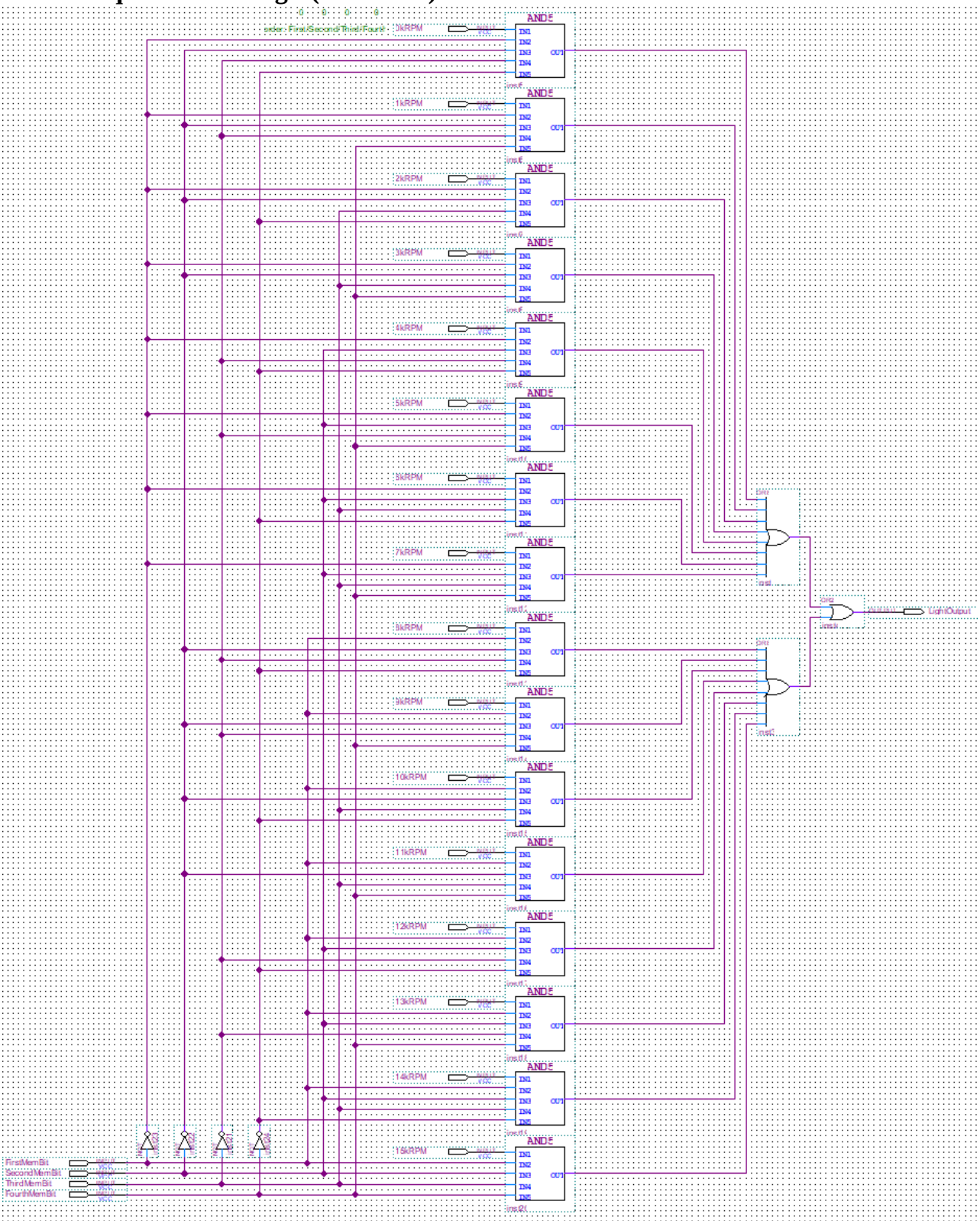
- Main Schematic



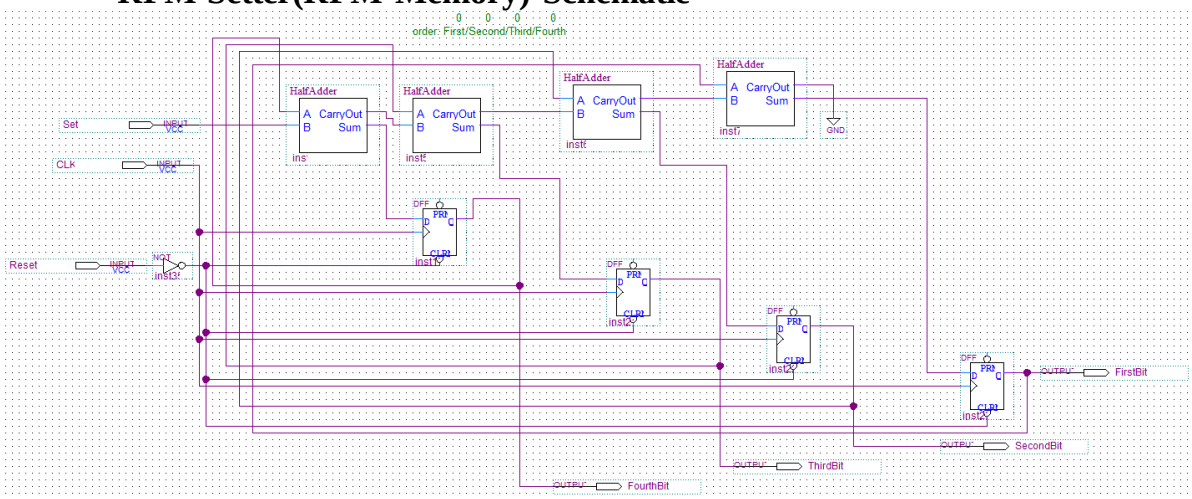
- RPM Equations Schematic



- Equations To Light(16:1 Mux) Schematic



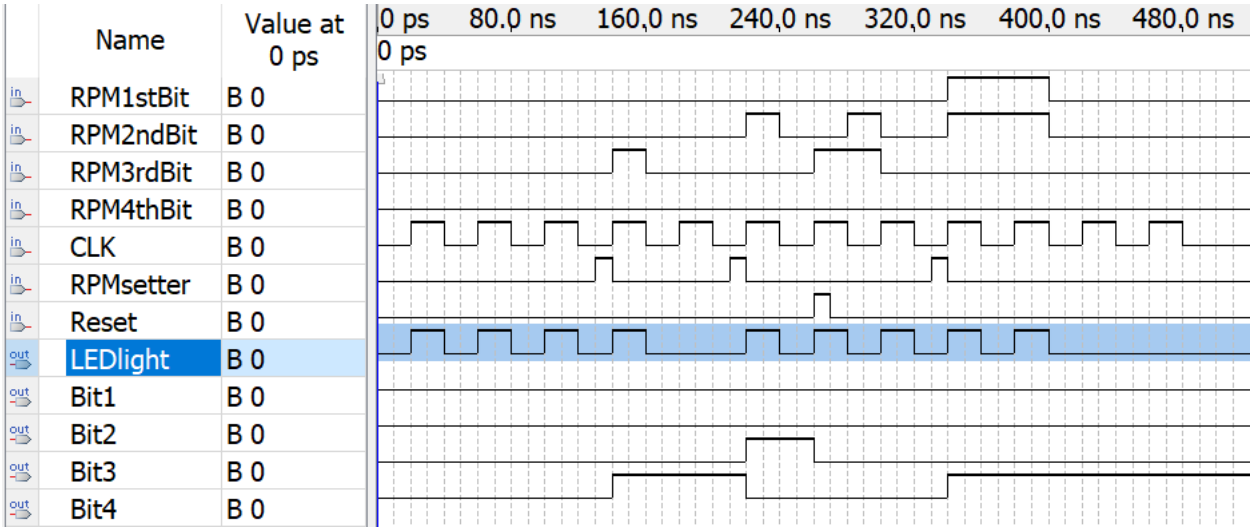
- RPM Setter(RPM Memory) Schematic



5. Circuit Operation

Operation of the circuit can be seen below as from 0ns to 140ns the memory is set to 0000 which means the light will turn on whenever the CLK has a 1 value and when the RPM has a value of at least 0k RPM which is represented the top 4 bits(RPM#bit). The light continues to stay on from 140ns to 160ns even though the RPM setter set the memory to only turn on the circuit when there is a value of at least 1k RPM since the RPM being produced by the is 2k RPM(0010). Other scenarios are also shown but an important one to notice is when the reset button is hit(value of 1) and the memory is set to 0000 and continues to keep the light on since the minimum RPM was set to 0k RPM(0000, as mentioned before). The simulation then ends with the light off since after the reset the RPMsetter set the memory to 1K RPM(0001) which means if the car produces 0k RPM the light would not turn on.

6. Simulation Results



7. Encounter Problems

Some of the issues ran into during the creation of the Shift Light would be the memory not holding the RPM values correctly which led us to find out that the 4-Bit Memory Cell I created/used from LAB #11 had the outputs flipped which was the reason why our light would only turn on sometimes. Another small issue that added to the memory problem was the fact that during the creation of the circuit there was a huge mix-up of files once testing and adding our parts to the big project. The way the mix-ups were cleared up was by having certain sections assigned and having the other individual with assigned work screenshare their progress to ensure all files were sent as needed.

8. Fun Facts

The circuit is a quite simple implementation of the shifter light, newer devices such as racing steering wheels have the ability to have multiple lights turn on before the actual RPM is hit such as this:

The device shown above could be implemented by having two more multiplexers representing the two other colored lights(green and yellow)

The implementation by my team only represents the Red light and a real life example of

our circuit would be this:

https://youtu.be/NW6Ysq3tUZE

9. Conclusions

This final project allowed me to demonstrate my interest in racing technology and allowed me to create a circuit that could serve purpose in my current car build. Another lesson learned from this final project was that rough drafts/sketches of circuits are a MUST when working on a big team project which is why I am glad I was able to create this sketch for my team: