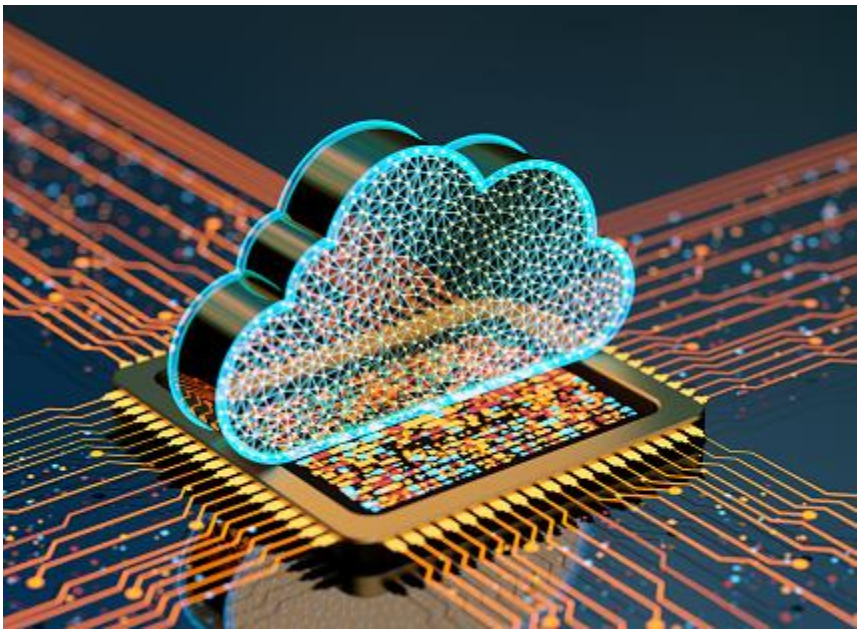

COS10004 – COMPUTER SYSTEM

Lab Session: Monday 17:30 – 19:30 | Assignment 1 – Alarm Clock

ABSTRACT

This report consists of an alarm clock divided into subsections (up to stage 4), explaining how logic gates and wirings are used to construct a digital clock.

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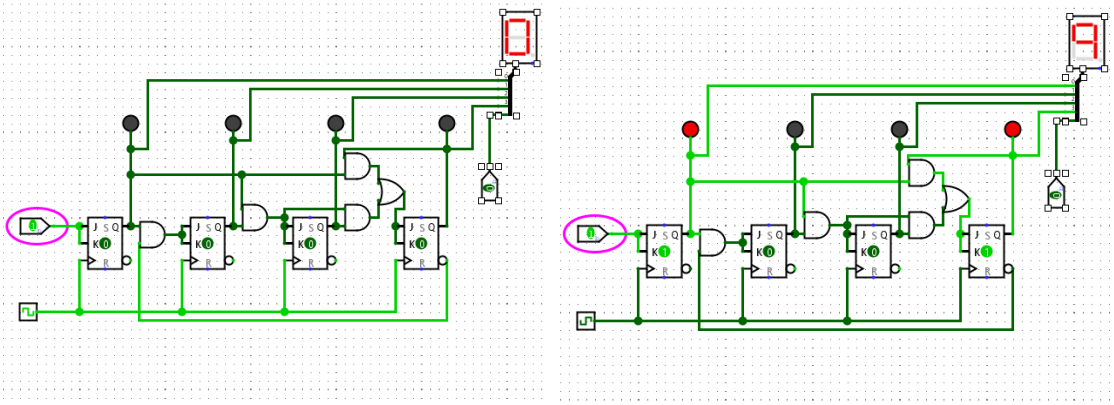
Student ID: 103818390

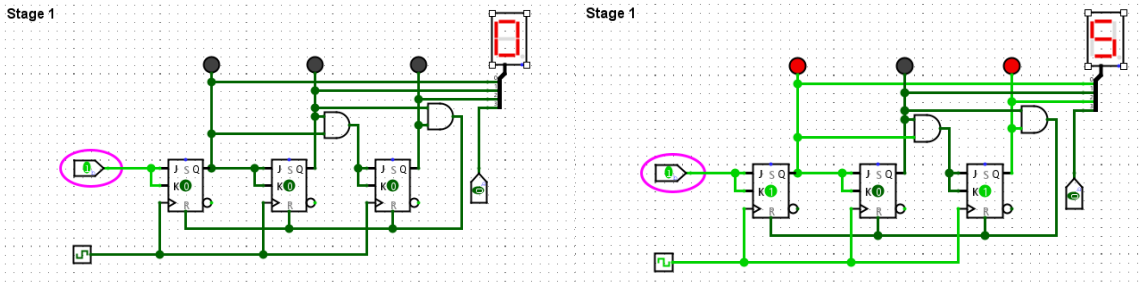
Alarm Clock – Stage 1

Minute Counter and Display

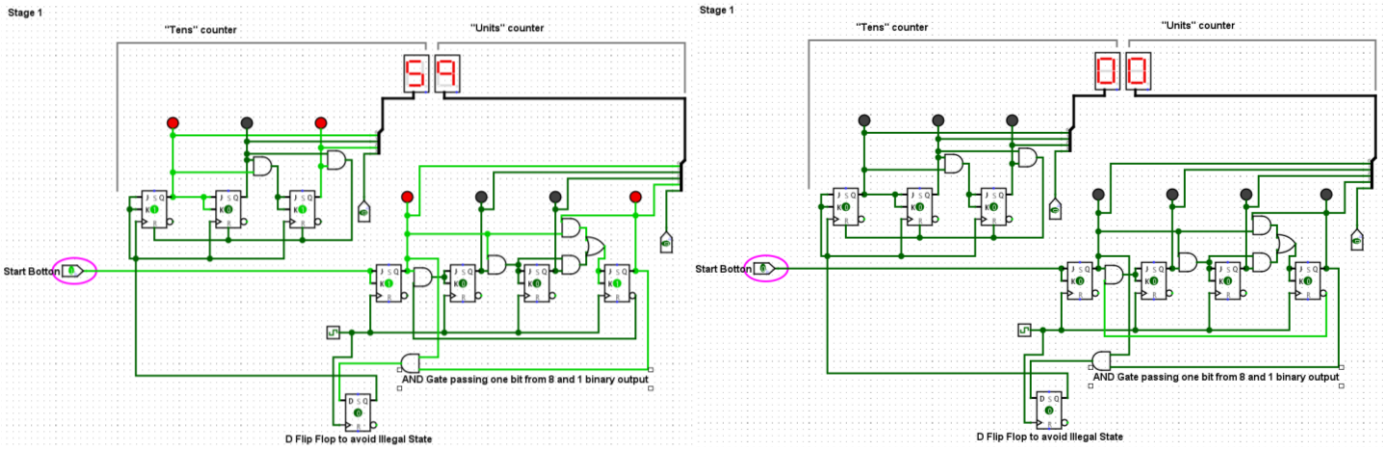
1. **Counter for the "units" that range from 0 – 9:**



2. **Counter for the "tens" that range from 0 – 5:**



3. **Minute Counter wrapping back to 00 after displaying 59:**

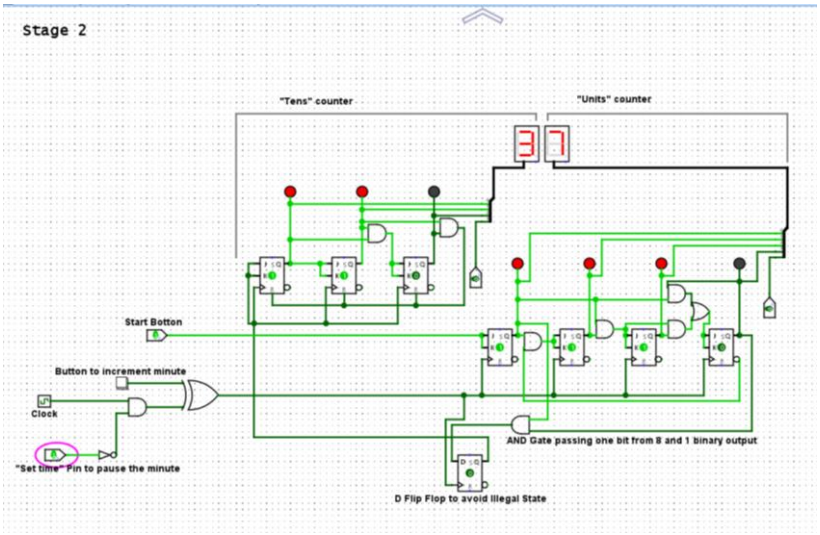


When both "units" and "tens" counters have been put together, there have been various wiring connections to make each individual counter form a real minute counter which will display 00 right after 59. To do this, one bit from binary 9 should pass to the clock input and J-K inputs of the "tens" counter. For this, one bit from output 8 and one bit from output 1, [8+1=9] has been passed to an AND Gate to pass one bit to the mentioned input in the "tens" counter. To eliminate illegal state, a D Flip Flop has been used. When the whole circuit is complete, the bits are passed on successfully, creating the desired minute counter as soon as the clock and the start button are switched on.

Alarm Clock – Stage 2

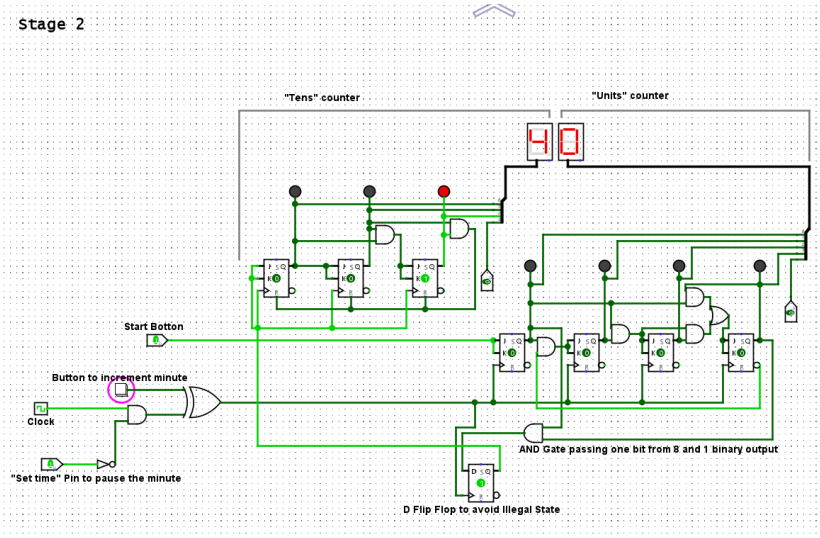
Set Time Modality

1. **Pin to switch the clock to "set time" mode:**



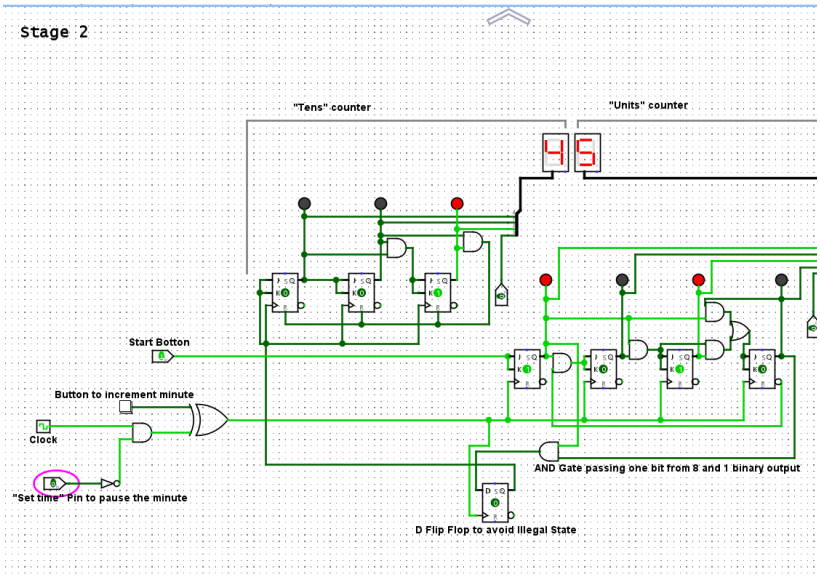
The "set time" pin connected to a NOT gate, then to one input of an AND gate will pass on a zero bit, and hence, the AND gate too will output a zero bit to one of the inputs of the NOR gate which will also output a zero bit, turning off the clock pulse and hence, pausing the minute display.

2. **m+ button to manually increment minute:**



As soon as the circuit is paused, we can increment the minute. To do so, an m+ button will be clicked, passing on one bit to the NOR gate and hence, acting like one clock pulse and thus, increasing the clock by one minute.

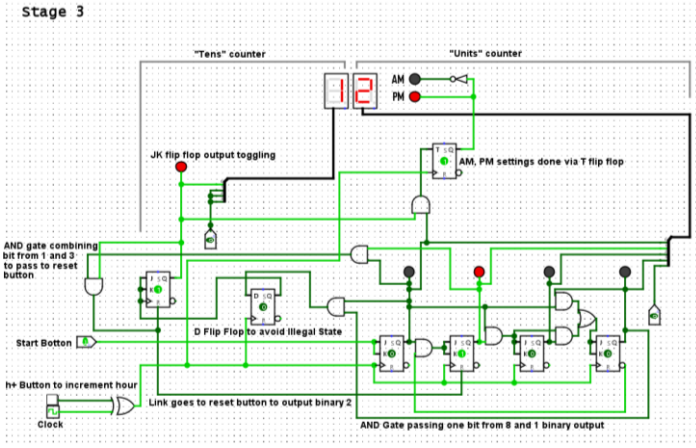
3. **Clock ticking is resumed once "set time" mode is disabled:**

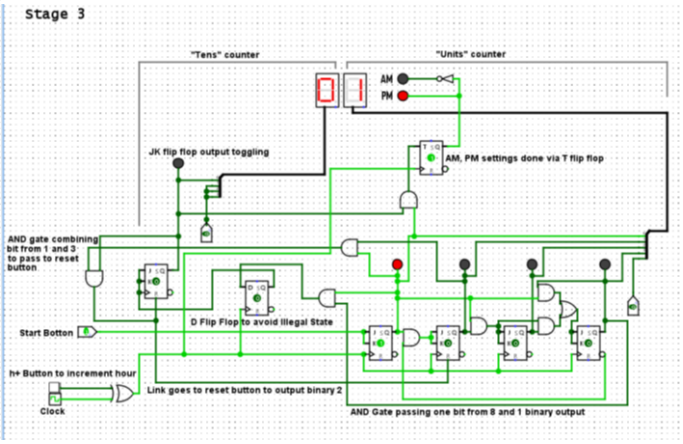


As the required minute is set by clicking the m+ button, it can be resumed by disabling the "set time" pin. That is, we need to press the pin and it will pass zero bit to the NOT gate. The opposite process of step 1 will happen and thus, switching the clock back to its normal state.

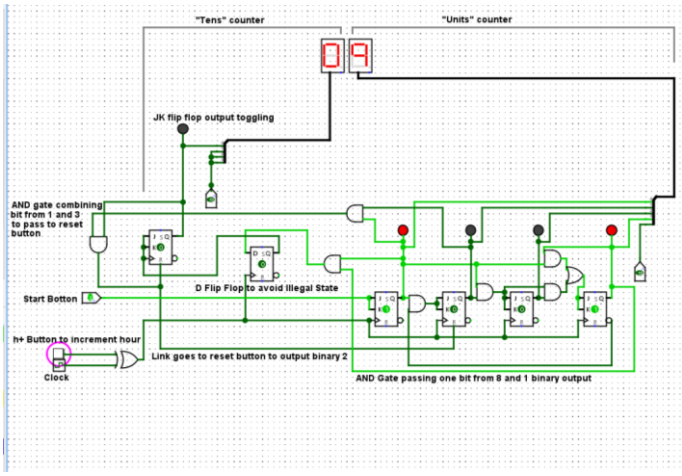
Alarm Clock – Stage 3

1. **Hour display and Set Time Functionality:**



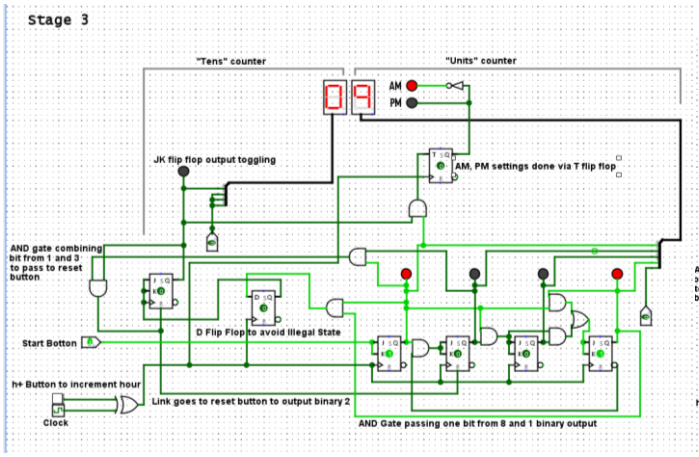


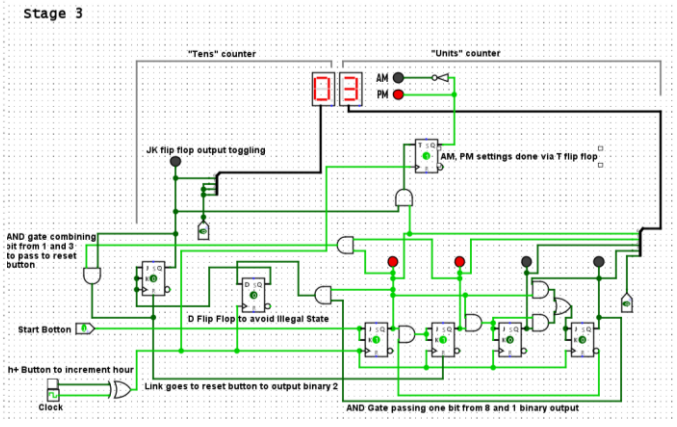
2. **h+ button to manually increment hour:**



Just like in stage 2, the same technique was used to add an h+ button to increment the counter by one hour. As soon as the button is clicked, a bit is passed through the OR gate, giving a positive output to the clock input in the JK flip flop, speeding the process of passing bit and hence, incrementing the hour.

3. **AM/PM LED toggling between "off" and "on":**



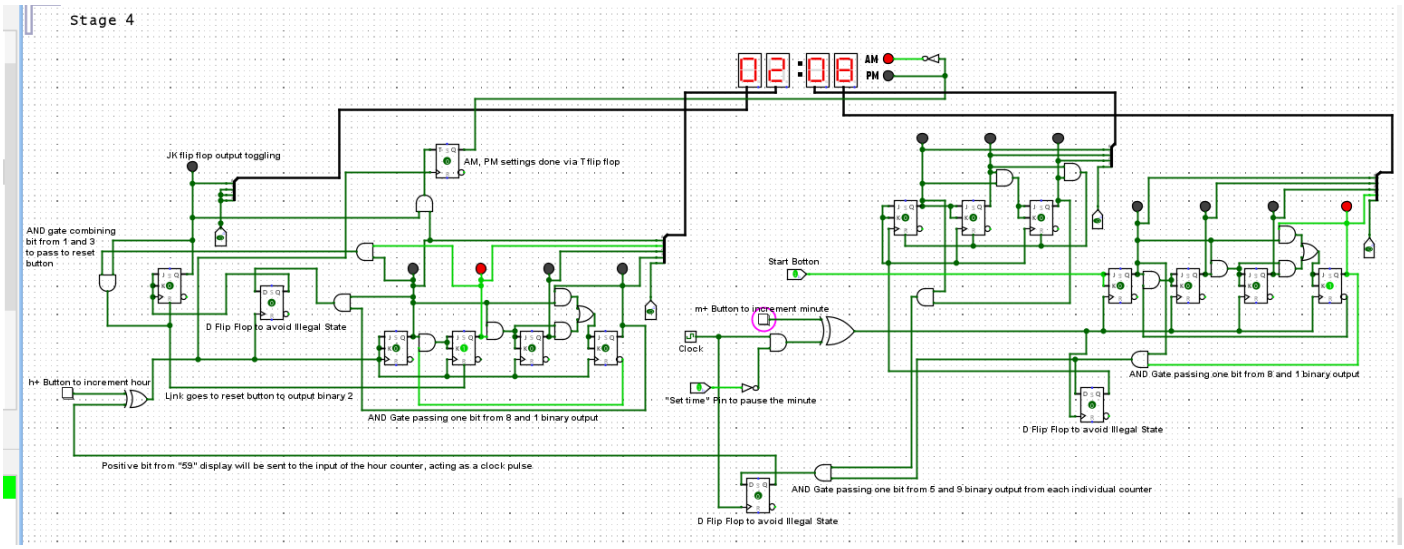


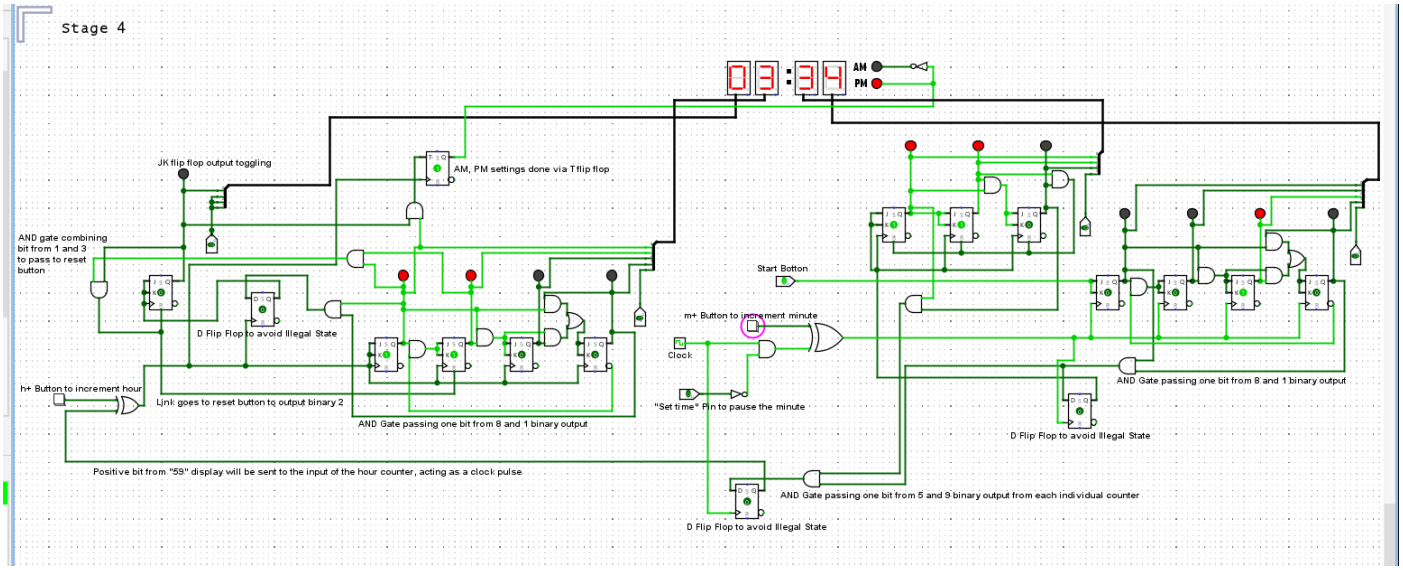
Just like in stage 1, the "units" and "tens" are linked. That is, as binary 9 is reached, the output will be changed to one in the "tens" counter. Also, the positive output is connected to the reset button in the "tens" JK flip flop and to the "units" binary 2 JK flip flop. Then, as the clock reaches 12, it will wrap to 01. For the AM/PM, the binary 1 from each counter, forming, display "11" is linked to a T flip flop to allow the LED to toggle hence passing a bit or a zero to both LEDs. One LED is followed by a NOT gate and thus, turning AM or PM LED respectively.

Alarm Clock – Stage 4

Hours and minutes counter ticking with the system clock

1. **Connection of the "minutes" counter to the "hours" counter:**
2. **AM/PM LED toggling as expected:**
3. **No illegal values appearing on display:**





The "minutes" and the "hours" are connected successfully. That is, one bit via AND gate connecting binary "5" from minutes ("tens" counter) and binary "9" from minutes ("units" counter) will pass on a bit to the hour ("units" counter), acting as a clock pulse as soon as the minute counter display "59". The D flip flop followed after the AND gate between the hours and minutes counters will eliminate illegal display. The "Set time" button, m+ (incrementing minutes) and h+ (incrementing hours) work smoothly as the connections are made from the appropriate output to the appropriate input. Also, the AM/PM LEDs function as expected. In short, the whole circuit ticks like a standard clock.