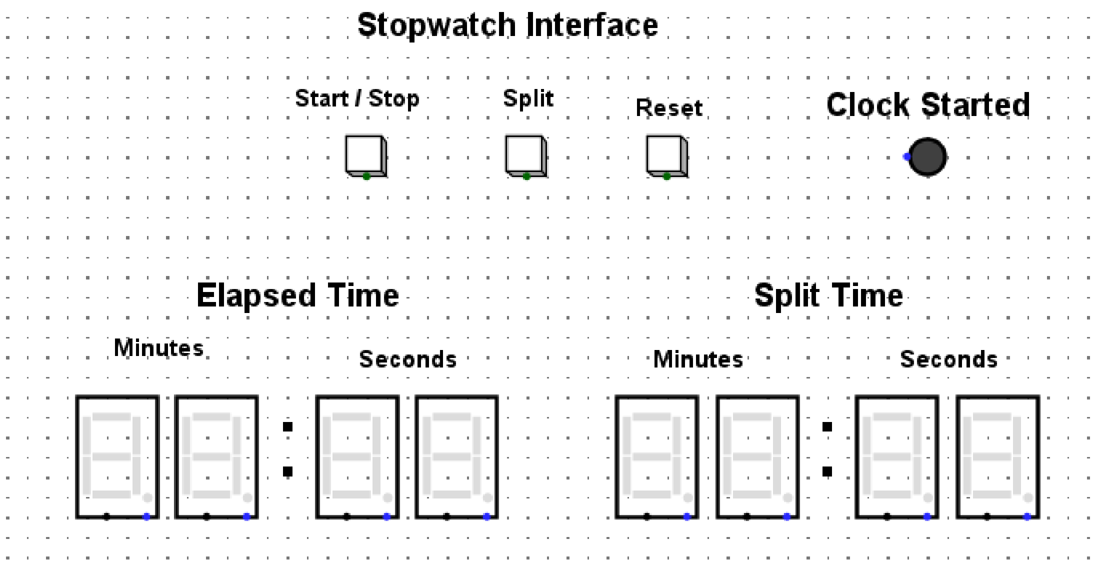
Assignment 1 - Digital Stopwatch



For this assignment, you are going to implement the functionality for a simple stopwatch interface as shown above. The interface itself is already provided as a Logisim file named main.circ .

Your assignment must be built using this file as the interface. Failure to do so will result in no marks for Completeness of Solution (worth 70% of total marks!)

You are encouraged to use multiple circuits to implement specific components however your whole circuit must be operable and displayed using the buttons and display components in this file.   That is, your solution should not require any additional interface components (e.g., buttons, displays, pins etc) in order to test the functionality of your circuit.

Logisim Version

Your assignment must be implemented using Logisim Evolution 3.8.0, which can be downloaded from: https://github.com/logisim-evolution/logisim-evolution/releases

This is the version we will test with, and we will not be using any other version, or making special accommodations. If your solution is incompatible with ours, it will not be able to be tested and thus will be ineligible for most marks on offer.

 You can verify that your version is correct by loading the provided main.circ file with the interface as shown above.

Allowable Logisim Components

Only the following components may be used to develop your solution:

- Logic Gates: any
- Flip Flops: JK, D, S-R, T
- LEDs
- Clock (only one)
- Hex Digit Display (already provided in interface)
- Buttons (already provided in interface)

- Pins (for connecting circuits)
- Constants (for setting inputs that will not change)
- Splitter (everywhere, please)

The use of any other components *will be penalised* – in particular, you must not use any pre-built circuits such as registers, shift registers, etc).

Implementation Stages

To break the problem down, you will implement the functionality of the stopwatch in stages. Each stage has a percentage weighting of marks contributing to the overall total of 100% You should implement each stage in order, and upon completion of each stage, save your file using the naming convention: stageX.circ.

This assignment will take a long time to complete in full. You should start early and work methodically through each stage. Note however that a good mark for this assignment does not require all stages being complete. In particular, Stages 5 and 6 are considered more advanced,

Stage 1: Implement the Start/Stop button

Using the Start/Stop button provided in main.circ, wire up a simple circuit that toggles between the *Start* and *Stop* states every time the button is clicked. Your solution should:

- Use the "Clock Started" LED and ensure it is turned on when the Stopwatch is in the Start state, and off when in the Stop state,
- Make use of a Flip Flop to keep track of the current state.

Stage 2: Implement a single digit "Seconds" display

This stopwatch will provide 1 second precision, and so needs to display the number of seconds that have elapsed since the Start button was pressed. As such, this will require the implementation of a counter. You will start by implementing a single digit "Seconds" counter for the units column of the "Seconds" display. That is, a counter that increments the "Seconds" display by 1s every clock tick, between "0" and "9". Specifically:

- Replace your flashing LED in Stage 1 with a counter that keeps track of the number of "seconds" (in increments of 1s, between 0s and 9s).
- The "Seconds" display should start from "00" when the Start/Stop button is first pressed
- The "Seconds" display should Stop when the Start/Stop button is pressed in the Start state.
- The "Seconds" display should resume counting when the Start/Stop button is pressed in the Stop state
- Your circuit should explicitly ensure no illegal values are displayed (e.g., no hex values displayed)

For this stage you can assume a single clock pulse equals 1s, and the display will only show the units column in seconds. As such, your "Seconds" display should only show values: "00, 01, 02, 03, 04, 05 …09", and then wrap back to "00".

Stage 3: Implement the full two-digit "Seconds" display

You're now going to implement full "Seconds" display for your stopwatch. Modify your circuit so that:

- the seconds display now shows "Seconds" in 1s increments using both the units and tens column. That is, the display will now show values: "00, 01, 02 …. 57, 58, 59", and then wrap back to "00".
- the display resets to all zeros whenever the Reset button is clicked, and enters the Stop state (i.e., the Elapsed Time remains 00:00).
- Your circuit should explicitly ensure no illegal values are displayed (e.g., no hex values displayed or digits above "5" in the tens column, etc).

Stage 4: Implement the "Minutes" display

In this stage you will implement the remaining time display components (i.e., "Minutes"). These are described in two sub-stages below. Implement a "Minutes" display using the *two hex digit displays* labelled "Minutes". Specifically, your "Minutes" display should:

- display ***decimal*** values only from "00:00" to "99:59", and then wrap back to "00:00" (no hex values should appear)
- only increment when the "Seconds" display is wrapping back to "00" (and this should be at the same time).
- ensure the Start/Stop and Reset buttons work for the "Minutes" display as they do for the "Seconds" display.

Stage 5: Implement the "Split" button

Most stop watches provide a "Split" button that allows intermediate times (i.e., lap times) to be recorded and displayed. In this stage you will implement the "Split" display. For this you will use the second "Split Time" display as shown on the Interface above to show the stopwatch time at the time the "Split" button is pressed.

Specifically, your circuit should:

- display the elapsed time on the "Split Time" display at the moment when the "Split" button is pressed, *and only when the stopwatch is not in the Stop state*
- Ensure the displayed "Split" time remains displayed and unchanged until the next time "Split" is pressed, or the "Reset" button is pressed.
- If the Reset button is pressed, the "Split" Time display should read "00:00"

Note that the "Split" button should not impact the "Elapsed Time" display. It should continue to count as normal.

Stage 6: Implement multi-"Split" time recording

It is often useful to be able to see each "Split" time recorded (e.g., the time of each lap completed) upon completion of a timed activity. In this stage you will implement the logic required to record *up to 5 separate "Split" times* during a single timed activity.

When the stopwatch *is active* (i.e., not in the Stop state), your circuit should:

- record the current "Split" time when the "Split" button is pressed
- ensure up to the last 5 split times remain recorded (if more than 5 split times are recorded, it should forget the earliest split time to make room).
- It must use Flip Flops to implement the storage.
- Ensure the most recent split time is displayed on the "Split Time" display at all times
- Set all recorded split times to 0 when the Reset button is pressed

- Provide Hex Digit Displays to verify the contents of each time being stored (this should be separate from the main interface but obvious for markers to find).

When the stopwatch *is in the Stop state* (i.e., not currently timing an activity:

- Ensure the most recent split time is displayed in the "Split Time" display at the moment the Stop state is entered.

Assessment Criteria:

- Completeness of Solution: (**70% of total mark**)
    - Completion of Stage 1: (up to 10 of the 70 marks available)
    - Completion of Stage 2: (up to 20 of the 70 marks available)
    - Completion of Stage 3: (up to 35 of the 70 marks available)
    - Completion of Stage 4: (up to 50 of the 70 marks available)
    - Completion of Stage 5: (up to 60 of the 70 marks available)
    - Completion of Stage 6: (up to 70 of the 70 marks available)
- Quality of the solution (**15% of total mark**)
    - Clarity and modularity of design (including appropriate use of subcircuits)
    - Efficient layout and use of components
    - Readability: use of labels and easy to find/use UI components.
    - Innovation/elegance of solution
- 5-minute video demonstration and reflection (**15% of total mark**)
    - Quality and clarity of the video
    - depth of understanding and critical reflection on the design and implementation

    Note that your video should be well planned and structured, and be strictly no longer than 5 minutes. **A one mark deduction for every 10 seconds over 5 minutes will be applied.** It should make succinct, well thought out points about your design, and without this, will attract few (if any) marks. You are encouraged to discuss its contents with your tutor.

Submission

Your completed submission must be made through Canvas - (Go to Assignment 1 under "Assignments" before the due date/time).

Everyday day late will incur a *10% deduction*.

Each *submission must be zip file containing*:

- the actual Logisim files (.circ source files) for testing. Each file MUST be labelled stageX.circ, where X is the stage completed.

- The video file or a file providing a link the file online. Please make sure of you are providing your video as a link, *that the file is not made publicly accessible (i.e.., it should only be accessible to those with the link)*

Academic Integrity

This is an individual assessment task and it is required that you work alone on your solution for assignment. This means you *must not share your solution with any other student*, *or make any part of your solution publicly available available online*. Markers will be cross-checking work, and will expect to see progress being made on assignments during the dedicated lab classes.

Any breaches of academic integrity will immediately attract a mark of 0 for the assignment, and probable further disciplinary actions in accordance with Swinburne's Academic Integrity policies and procedures.