**1007ICT / 7611ICT Computer Systems and Networks**

**Assignment – Trimester 3, 2020**

## Due Date: 11:59pm Sunday 31 January 2021

## 1. Individual Assessment

This is an individual assignment. All work submitted must be your own work. As per the warning given in the first lecture, be careful not to use the work of others as your own nor have others use your work as their own.

## 2. Software Requirement

In this assignment, you will be using the Logisim circuit drawing software to create a circuit for the problem specified in this task sheet. You must use the **Logisim simulator version 2.7.1** to create your circuits. Assignments submitted using other programs will **NOT BE ABLE TO BE MARKED** due to incompatible file formats.

## 3. Submission Instructions

You will be required to submit **two** files electronically using the Learning@Griffith "Assessment 2: Assignment" submission point. The files will be

- A digital logic simulator circuit (created using the Logisim software)
- A written report (PDF format only)

Filenames for both your files must be prefixed with your student number, an underscore character, first name, an underscore character, last name, underscore character and then the name of the file. **PLEASE DO NOT SUBMIT ZIP (or other) ARCHIVES** as they may not be able to be marked.

**Eg.**

Your Logisim file would be named:

**s123456_FirstName_LastName_Logic_Circuit.circ**

Your written report file would be named:

**s123456_FirstName_LastName_Report.pdf**

Files with filenames that does not adhere to this requirement may **NOT** be marked or may attract a mark penalty.

## 4. Task Description

For this assignment you are required to implement a simple simulation of a gearbox in a car. The gearbox has two inputs:

- Input 1 (G) represents the current gear (0-7).
- Input 2 (S) represents the gear that the driver wants to change to (0-7).

The gear change is successful if S = G, or if S = G – 1, or if S = G + 1. Any other value for S outside of this range will result in an unsuccessful gear change.

> **Example 1:** The current gear (G) is 2 and the gear we want to change to (S) is 3. In this case the requirement S = G + 1 is met and the gear change is successful.
>
> **Example 2:** The current gear (G) is 2 and the gear we want to change to (S) is 4. In this case S is outside the allowed range and the gear change is unsuccessful.
>
> **Example 3:** The current gear (G) is 0 and the gear we want to change to (S) is 0. In this case the requirement S = G is met and the gear change is successful.

> **Note:** These are just a few examples. There are (many) more cases that result in successful or unsuccessful gear changes. Your circuit must correctly show a successful or unsuccessful gear change for each possible case.

For this assignment, the current gear (G) will be represented by three inputs (3 bits). The three G inputs are named as G1, G2, and G3. The table below shows the assignment of bits to each G value for G1, G2, and G3.

For this assignment, the gear that we want to change to (S) will be represented by three inputs (3 bits). The three S inputs are named as S1, S2, and S3. The table below shows the assignment of bits to each S value for S1, S2, and S3.

**G and S Inputs**

| G value | G1 | G2 | G3 |
|---|---|---|---|
| **0** | 0 | 0 | 0 |
| **1** | 0 | 0 | 1 |
| **2** | 0 | 1 | 0 |
| **3** | 0 | 1 | 1 |
| **4** | 1 | 0 | 0 |
| **5** | 1 | 0 | 1 |
| **6** | 1 | 1 | 0 |
| **7** | 1 | 1 | 1 |

| S value | S1 | S2 | S3 |
|---|---|---|---|
| **0** | 0 | 0 | 0 |
| **1** | 0 | 0 | 1 |
| **2** | 0 | 1 | 0 |
| **3** | 0 | 1 | 1 |
| **4** | 1 | 0 | 0 |
| **5** | 1 | 0 | 1 |
| **6** | 1 | 1 | 0 |
| **7** | 1 | 1 | 1 |

## *Part A*:

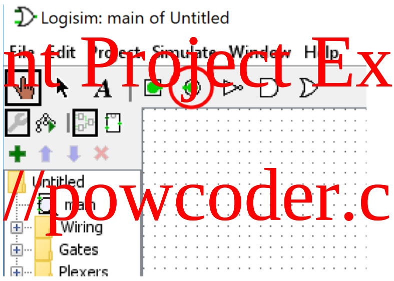
The implementation for this part must use **only the three basic logic gates** (AND, OR, NOT).

- Each AND gate and each OR gate can have **only 2 inputs**.
- Each NOT gate can have only 1 input.
- No other logic gates or circuits are permitted to be used in your circuit for Part A.

You are required to implement a circuit where the user (you) can input a value for the current gear (G) using value (G1, G2, and G3) and a gear to change to (S) using value (S1, S2, and S3).

The circuit decodes the G1, G2, G3 and S1, S2, S3 values using a **decoder (see lecture notes)** made up of only the permitted logic gates to determine if S = G, or if S = G – 1, or if S = G + 1.

The output is via a single output pin (green circle in Logisim):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File Edit Project Simulate Window Help
Untitled
main
Wiring
Gates
Plexers

The output pin must be labelled, **Successful** which is lit if S = G, or if S = G – 1, or if S = G + 1. The output pin is not lit for any other combination of S and G values.

## *Part B*:

For this part, the car has a gearbox that can withstand up to a number of unsuccessful gear changes (N) and it will break if that number is reached. The number ***N*** ranges from **1 to 7** and must be set via a combination of three separate inputs: ***N1***, ***N2,*** and ***N3***. An ***N*** value of **0 is not allowed** and the gearbox state is undefined for this case. This means that you will have to set ***N*** to be non-zero (1..7) before starting the engine engaging the gearbox. **Note:** In Logisim, you can combine the 3 inputs for ***N*** into a single 3 bit input.

Using the same circuit file containing Part A, add additional circuitry to count how many successful and unsuccessful gear changes have been made. Each time an unsuccessful gear change is made, add 1 to the number of unsuccessful gear changes. Each time a successful gear change is made, add 1 to the number of successful gear changes.

**Gearbox broken (car no longer able to be driven):**
If the number of unsuccessful gear changes is equal to ***N***, then an LED labelled "Gearbox broken" is lit, and the circuit is **permanently locked**. No matter the changes to the input after this happens, the "Gearbox broken" LED will remain lit and cannot be turned off.

### 1007ICT ONLY (This is not part of the 7611ICT assignment)

If the number of successful gear changes reaches the maximum value of 7 (for a 3-bit counter) then the simulation will also stop because the count can no longer increase. In this case you can assume that the user will no longer try to interact with the simulation. The "Gearbox broken" LED will remain off if it is off, or will remain lit if it is already lit.

### 7611ICT ONLY (This is not part of the 1007ICT assignment)

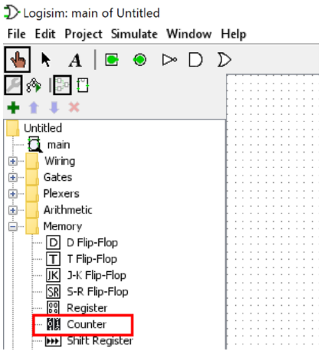
**Successful gear changes:**
The gearbox is able to do a small amount of self-repair.
If 3 successful gear changes are made,

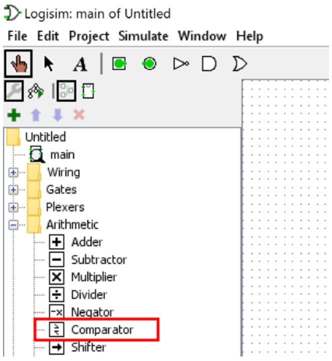
- the total number of unsuccessful gear changes is reset to 0
- the total number of successful gear changes is reset to 0

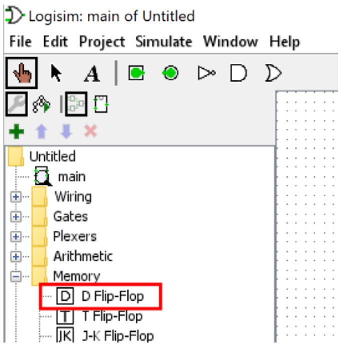
**Note:**
For Part B you will need to add a button that is pressed by you after the current gear (G) and gear to change to (S) values have been entered. This is to avoid counting while you are adjusting the input pins for the G and S input pins (G1, G2, G3, S1, S2, and S3).

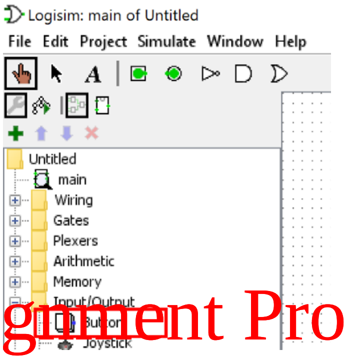
For Part B you may use only the following:

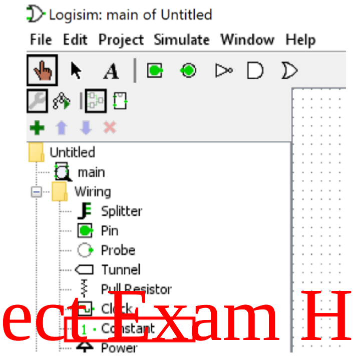
- **The three basic logic gates** (AND, OR, NOT). Each AND gate and each OR gate can have only 2 inputs. Each NOT gate can have only 1 input.
- The counter (3 bit, no wrap around) circuit from the Logisim circuit library.
- The comparator (3 bit, unsigned) circuit from the Logisim circuit library.
- The D FLIP-FLOP circuit from the Logisim circuit library. The prebuilt D FLIP-FLOP circuit can be used to 'remember' some information.
- Buttons
- Constant (7611ICT students can use a constant to compare against successful gear changes).











## 5. Labelling

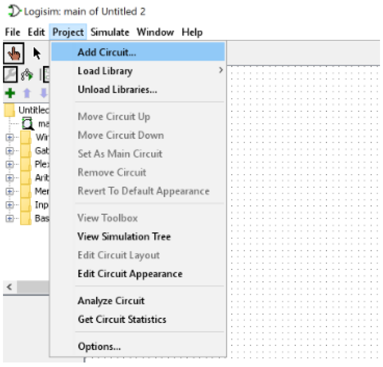
You **must label each circuit and template** that you construct with the Logisim Annotation tool and ensure that all the inputs are labelled as instructed in this task sheet. Each circuit page and subcircuit/template must be labelled with:

1. Your name
2. Your student number
3. An appropriate label for each input
4. An appropriate label for each output
5. An appropriate label for each subcircuit/template

## 6. Templates/Subcircuits

You will be required to use templates (Logisim calls these subcircuits) to simplify the overall circuit design. Instructions for using templates/subcircuits are available on Learning@Griffith in the Assessment 2 folder where you downloaded this assignment.

Note that when you create the template/subcircuit you must keep them within your single circuit file. Templates that are linked as separate files may not be able to be marked. To create a new template/subcircuit within your current file, use the Project menu and the Add Circuit menu item.



You are required to create a working and connected template/subcircuit for the following components:

- Each decoder
- The gearbox logic
- Part A circuit (for connecting into the Part B circuit)

## 7. Report

Your report **2 pages maximum** must contain the following sections:

1. **Your details:** Name and student number

2. **Screenshots of your circuit diagrams:**

   1. A screenshot of your whole circuit including both Part A and Part B. This screenshot may include subcircuits/templates.

   2. A screenshot of your Part A circuit that shows the decoder and gearbox logic sections. This screenshot may include subcircuits/templates.

   3. A screenshot of the inner circuitry of one of your decoders. The inner circuitry refers to the actual logic gates and not the subcircuit/template drawing.

   4. A screenshot of the inner circuitry of your gearbox logic. The inner circuitry refers to the actual logic gates and not the subcircuit/template drawing.

      If you have broken your gearbox logic up into smaller subcircuits show the inner circuitry for these also.

3. **Circuit Function:** A brief (maximum 300 word) description of your circuit describing concisely and correctly in your own words how the circuit operates.

**Note:** Submissions with more than 2 pages, illegible screenshots, and/or more than 300 words for the description may not receive the full marks available.

## 8. Interview

To be held during the workshop sessions on Day 11 and Day 12. You will be asked to clearly demonstrate your understanding of your circuit and of its operation to your workshop demonstrator.