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# Project Digital Logic

## Lift Electronic Controller System
## (Simulation Using Deeds Software)

**Prepared by Dr Foad**
**2023/2024-1**

FACULTY OF COMPUTING

This project is to implement knowledge from this course by simulating the real case outside from class.

Strategies used:

- Group self explore
- Creative problem solution and design
- Good presentation, reporting & demo session

# Project Componet

- This project is done in a group of 3 or 4 students
- Combinational Circuit
  - Combinational Logic (Comparator, Pattern Detector, Decoder, Mux/DeMux, etc.)
  - Advanced/Accessories – depend on creativities
- Sequential Circuit
  - Sequential Logic (Counter Design)
  - Clock Enabler
  - Advanced/Accessories – depend on creativities
- Integration
  - Combinational logic
  - Sequential Logic
  - Advanced/Accessories – depend on creativities

**Part 1**: Basic Controller (example 2 bit)
**Part 2**: Advanced Controller (Deeds)

Example of System Controller in Real Life
- Lift/Elevator Building
- Photostat Machine
- Car Park
- Washing Machine
- ATM machine (Bank)
- Vending

**Design System Controller**
- Choose a real system from the list, and study how the system's work.
- Determine
  - Input
  - Process
  - Output
- Categories which part of the system fall under Combinational Logic or Sequential Logic
- Each member of the group, think of an advanced feature that you want to add into your existing circuit to produce an advanced controller system.

# Lift Operational Scenario (behavioral):

You may choose any system that you want to design the controller and studies how the system's work.
Example System Chosen: To Control Lift Building UP or DOWN

`A hotel visitor want to use a building lift to go up from one level to another. The requirements are put in the desired level to go, tag the visitor room card, closed the lift door, and push UP button. Then, the lift will goes up by counting up one level to another until its reaches to the desired level. The door will open and at the same time alert will be given to the visitors. Similarly, the reverse process happen when the visitor want to go down. The counting sequence will decrease until it reaches to the desired floor.

- Lift UP
  - Key in level up
  - Tag in card hotel
  - Door Close
  - Lift goes up to destination
  - Lift stop at destination
  - Sound notification
  - Door Open

- Lift DOWN
  - Key in level down
  - Tag in card hotel
  - Door Close
  - Lift goes down to destination
  - Lift stop at destination
  - Sound notification
  - Door Open

# Example of Circuit Controller (8 level building)

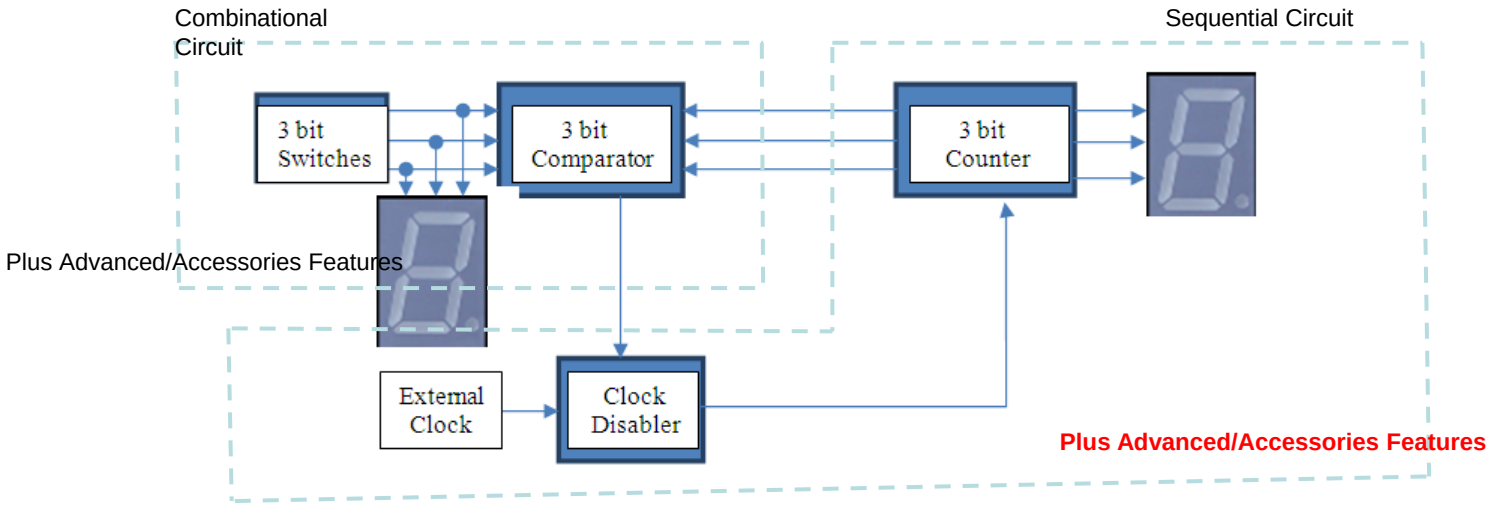



Figure1. A block diagram of a complete system

**Clock Disabler (Pattern Detector)**

When counter value NOT EQUAL TO Input Switch value, Then Clock is Active
When counter value is EQUAL TO Input Switch value, Then Clock is NOT Active

# Project Idea & Implementation

- Determine
  - Input
  - Process (Component)
  - Output
- Categories which part of the system fall under **Basic** Lift Controller and **Advanced** Lift Controller

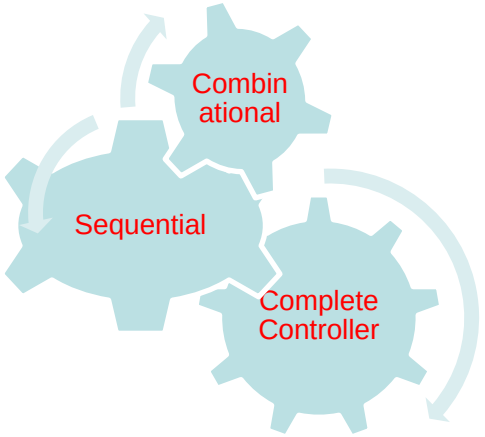
Options of System Controller in real life
- Lift/Elevator Building
- Photostat Machine
- Car Park
- Washing Machine
- ATM machine (Bank)
- Vending Machine

Combinational Circuit

- MSI Function
  - Comparator
  - Mux
  - Demux
  - Decoder
  - Encoder
- Basic Gates

Sequential Circuit

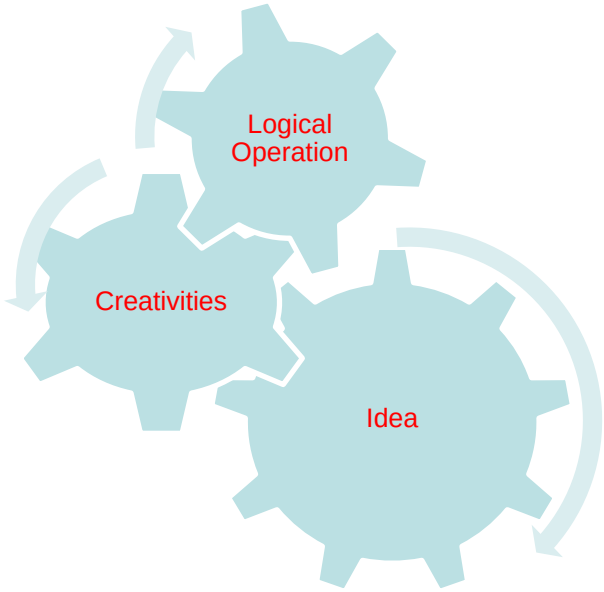
- Counter/Memory
  - Counter Design
- Clock Enabler




Add ON Accessories / Advanced Features
- E.g. Welcoming Notes, Security, Interactive Display System, Etc

# Project Idea & Implementation

- Determine component function that can be categorized as Combinational and Sequential Circuit
- Example features to be considered:
  - Compare Value
  - Pattern Detector
  - Authentication
  - Controlled input
- Design the component circuit
- Integrate combinational and sequential components to produce a complete controller system
- Simulate the circuit
  - Operate base on the required operation




**Part 1**: Basic Controller (example 2 bit)
**Part 2**: Advanced Controller (Deeds)

# Activities Part 2: Advanced Lift Controller System

- Design advanced lift controller system

`A hotel visitor want to use a building lift to go up from one level to another. The requirements are put in the desired level to go, tag the visitor room card, closed the lift door, and push UP button. Then, the lift will goes up by counting up one level to another until its reaches to the desired level. The door will open and at the same time alert will be given to the visitors. Similarly, the reverse process happen when the visitor want to go down. The counting sequence will decrease until it reaches to the desired floor.

## Example features

- Lift Going UP
  - Welcoming Note
  - Key in level up
  - Tag in card hotel
  - Door Close
  - Enter Password
  - Lift goes up to destination
  - Lift stop at destination
  - Sound notification
  - Door Open

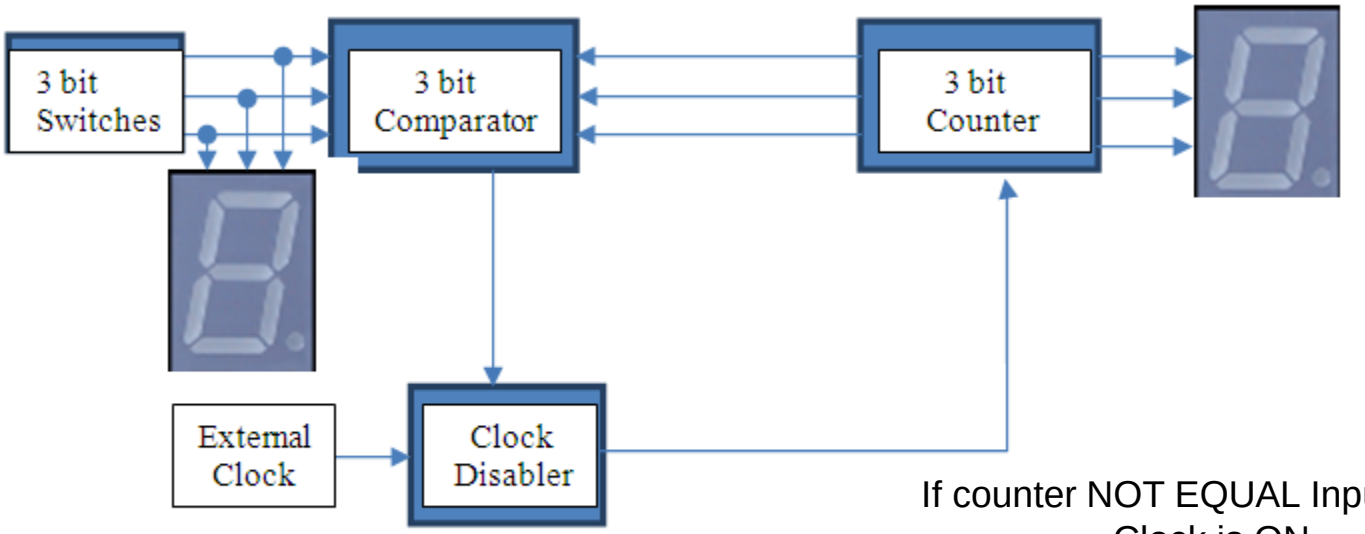
- Lift Going DOWN
  - Welcoming Note
  - Key in level down
  - Tag in card hotel
  - Door Close
  - Enter Password
  - Lift goes down to destination
  - Lift stop at destination
  - Sound notification
  - Door Open

# Basic Design Controller

Basic controller will use 3 different components on a single GAL device, those components are

1. Count Up Counter
2. Comparator
3. Decoder (Pattern Detector) – Clock Enabler

- **Core components**




If counter NOT EQUAL Input Switch
Clock is ON

Figure1. A block diagram of a complete system

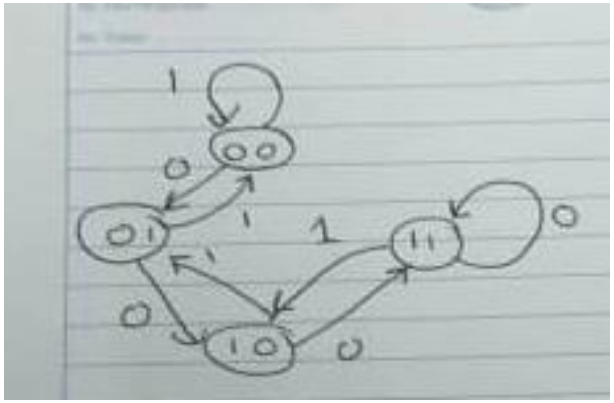
**Clock Disabler (Pattern Detector)**

When counter NOT EQUAL Input Switch
Clock is Active
When counter EQUAL Input Switch
Clock is NOT Active

# Example Design:

Spec counter:

- 2 bit up/down counter
- Synchronous
- Using D Flip Flop



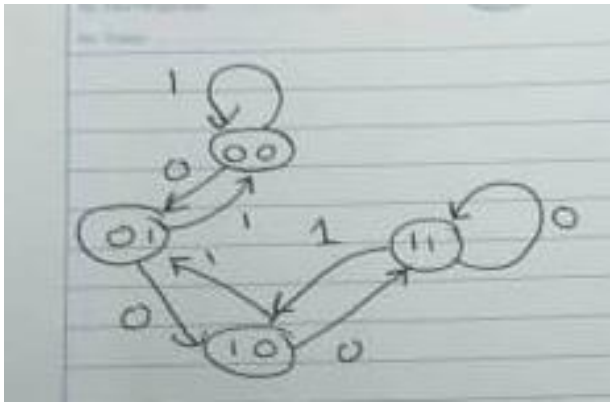

State diagram: 2 bit up/down counter (saturated)

Design step:

- Create next state and flip-flop transition table
- Get SOP expression for D flip-flop input
- Get clock enabler circuit (use AND gate). This is for pattern bit detector to control the main clock of the counter.
- Input of the clock enabler circuit will be possible advance feature
  - E.g. power on, start, password, ID staff, comparator level, etc.

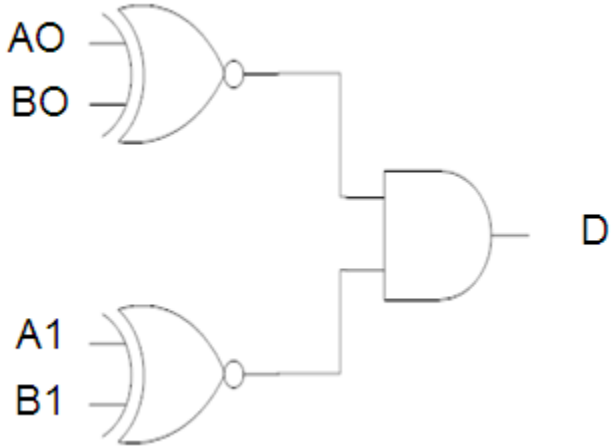
Circuit simulation using Deeds

# Pattern Bit Detector - Decoder




State diagram: 2 bit up/down counter (saturated)

2-Bit Equality Comparator



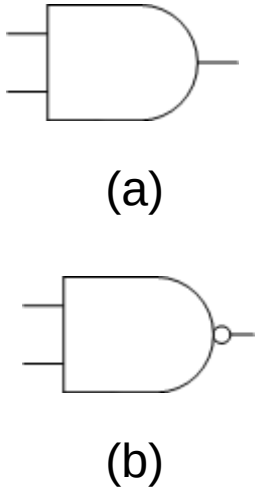

Output Active HIGH

A=B, D=1

A!=B, D=0

Output Active LOW?

Decoder (Pattern Detector) -clock disabler



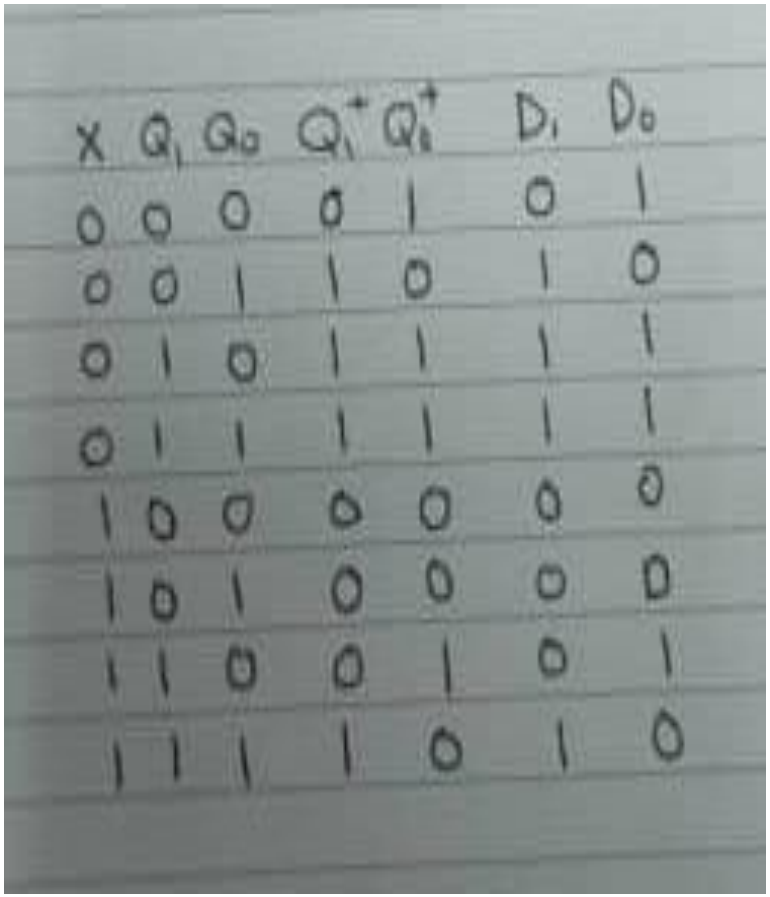
(a)

(b)

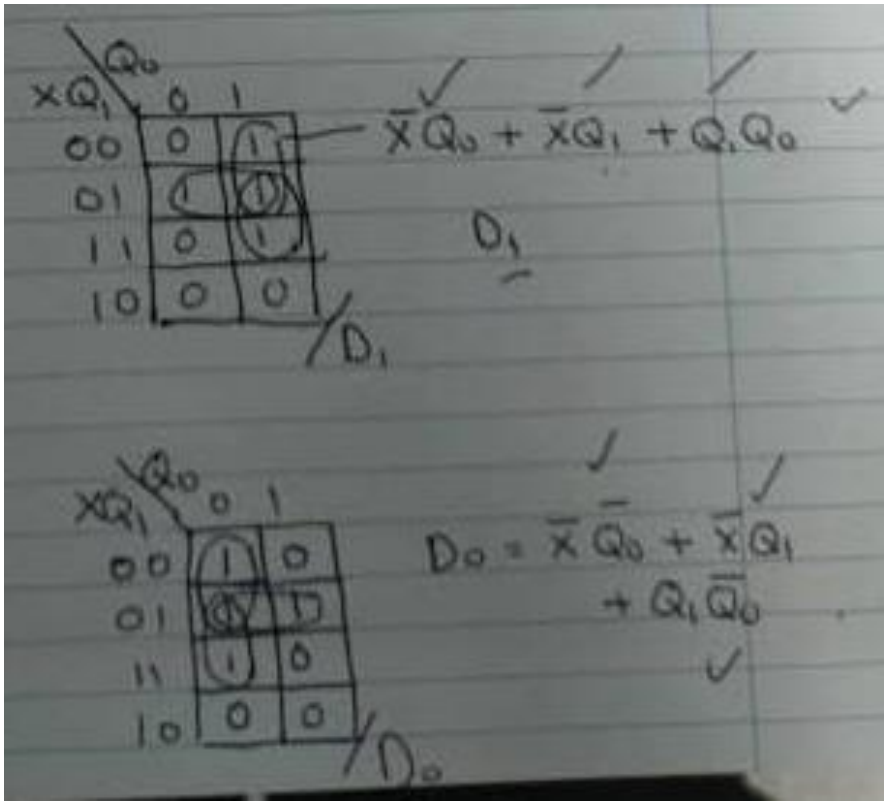
(a) Output Active HIGH

(b) Output Active LOW

# NEXT STATE AND FLIP-FLOP TRANSITION TABLE AND EQUATION INPUT D FLIP-FLOP (SOP)

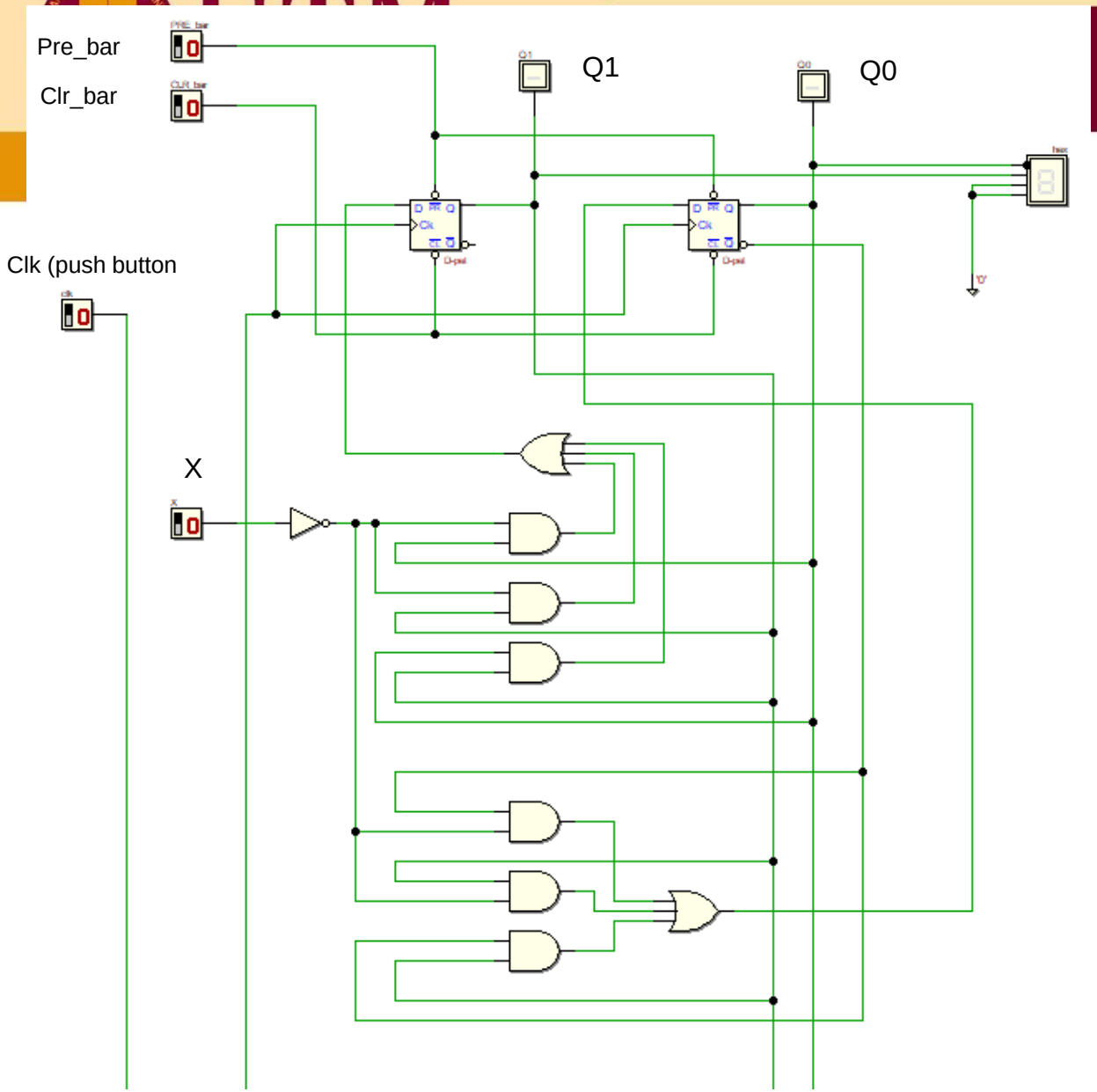


| X | $Q_1$ | $Q_0$ | $Q_1^+$ | $Q_0^+$ | $D_1$ | $D_0$ |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 | 0 |



# COMPONENT DEEDS

- Flip-flop using D Flip-flop
- Comparator for current state counter and targeted level floor using XNOR and NAND (output active low for disable clock)
- Pattern detector for clock enabler using AND gate. If output AND gate is HIGH, clock is enable and counter can run.
- Use push button instead of clock generator. This is to eliminate unwanted state during transition state




2 bit up/down counter using D flip-flops

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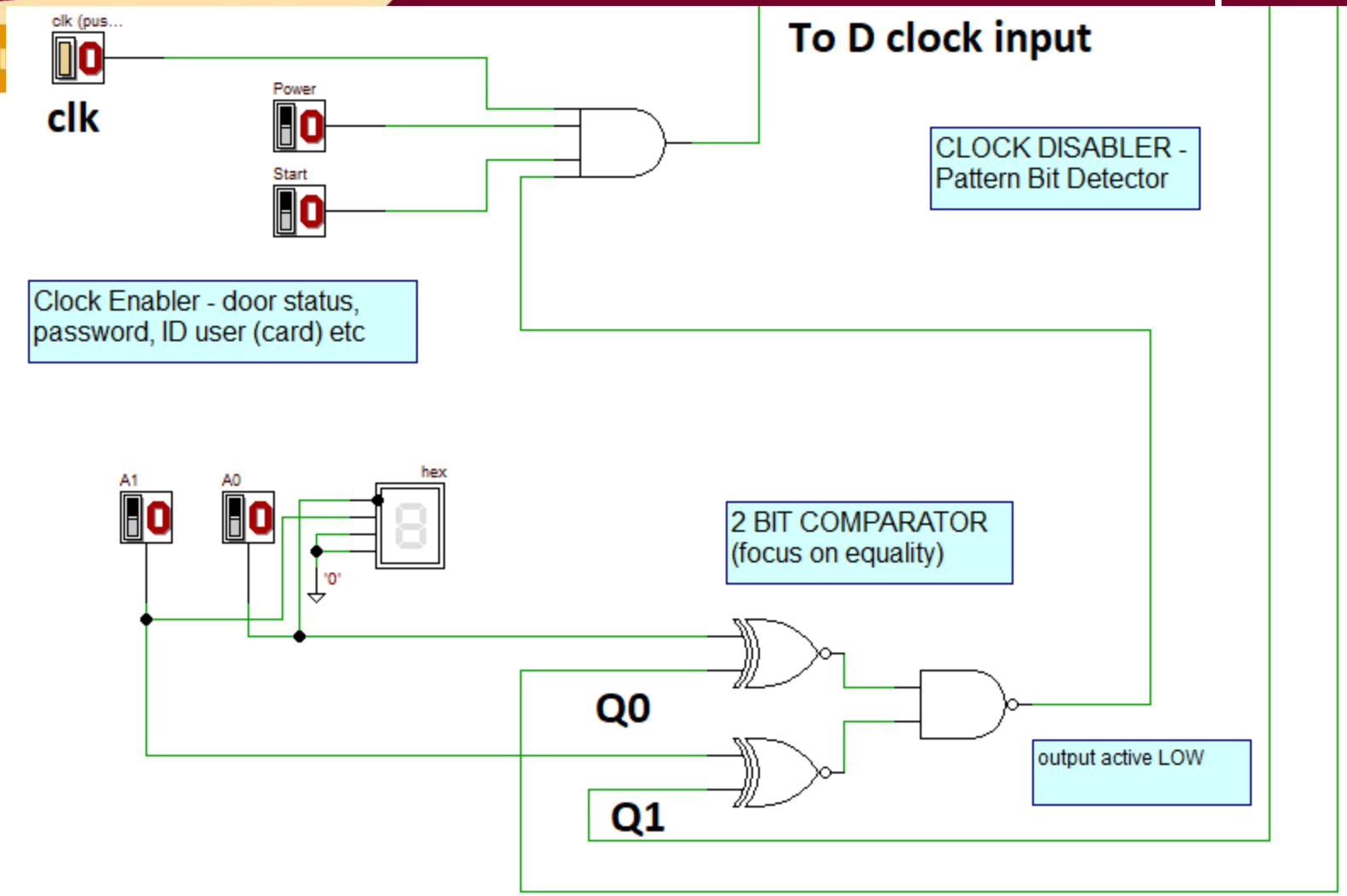
# Clock Enabler and Comparator



# Clock Enabler and Comparator

Rule

1. Clock to the counter will enable when HIGH input goes to clock D flip-flop
2. Gate AND will goes HIGH when CLK (push button) is HIGH AND Power is HIGH AND Start is HIGH AND output comparator IS NOT EQUAL.
3. If comparator is equal, then NAND gate will generate output LOW, Thus, will disable the clock to D flip-flop..

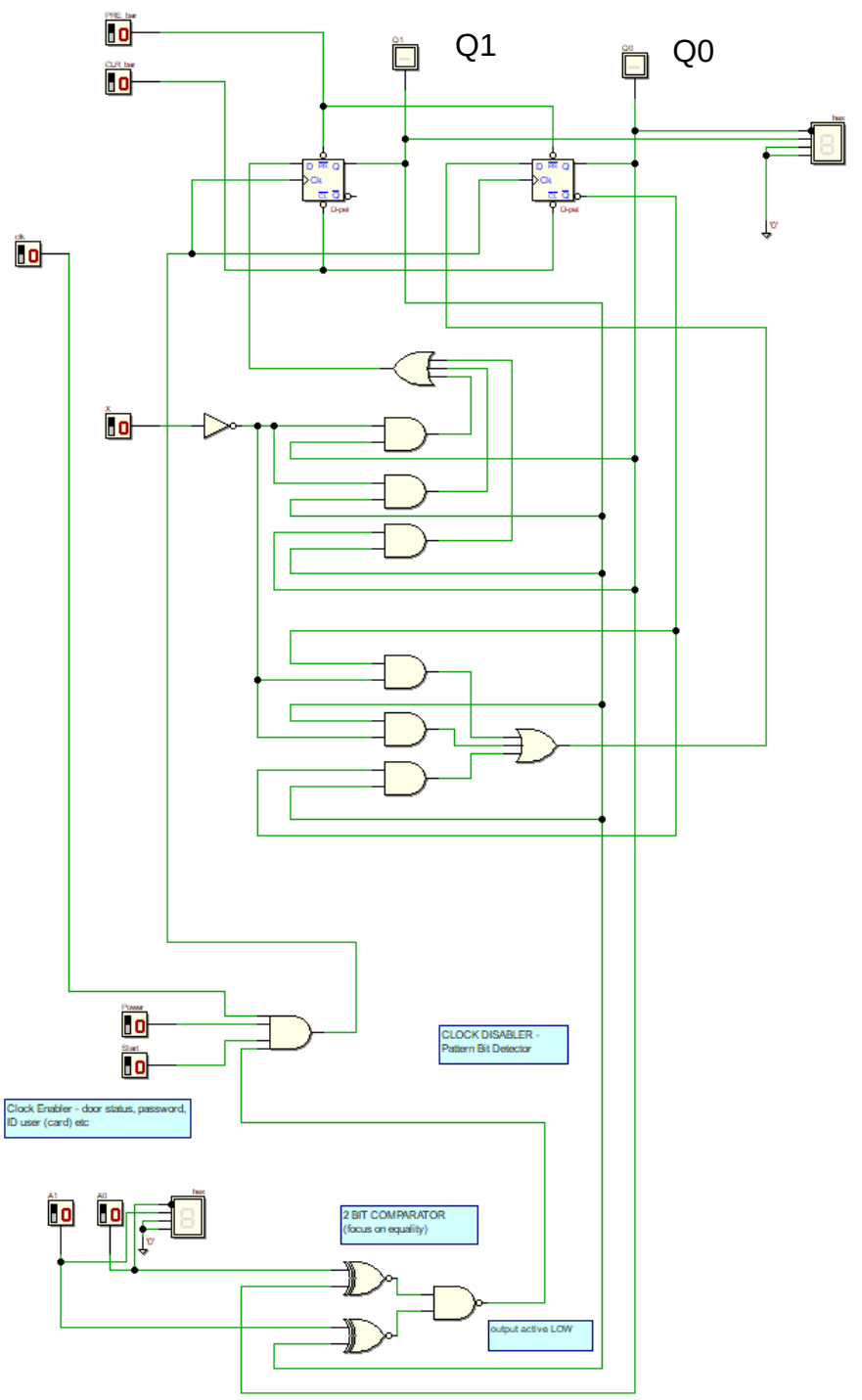
**Operation:**

Set value (UP)

- PRE_bar=CLR_bar= 1
- X=0 (count up)
- Power=1
- Give desired floor, e.g = 3 (from current floor = 0)
- Start=1
- Enable Clock
- Push clock button, counter will do count up from initial (current 0) to desired floor 3.

Set value (Down)

- PRE_bar=CLR_bar= 1
- X=1 (count down)
- Power=1
- Give desired floor, e.g = 0 (from current floor =3)
- Start=1
- Enable Clock
- Push clock button, counter will do count down from initial (current 3) to desired floor 0.



# Advance Floor Controller Design

- From the example 2 bit count up/down synchronous counter, design either
  - 3 bit up/down synchronous counter
  - 4 input Kmap (X,Q3,Q2,Q1,Q0)

  Using either JK, D, or T flip-flop
  - Introduce more features as input controller variables, and more output features (in addition to Display Floor Level (indicate by QN..Q0)

# Advanced Deeds Circuit

- Introduce advance features as much as possible
- Implement the features using concept of MSI (in Chapter 6)
- Develop and implement the simulation system using Deeds

# Integration

INTEGRATE COMBINATIONAL & SEQUENTIAL CIRCUITs

Options of System Controller in real life (other possible simulation system)

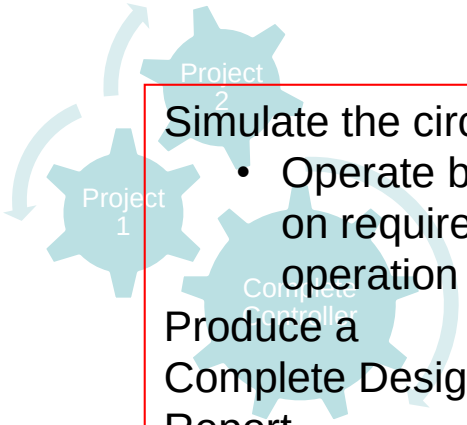
- Lift/Elevator Building
- Photostat Machine
- Car Park
- Washing Machine
- ATM machine (Bank)

Lift Building UP

- Lift UP
  - Key in level up
  - Tag in card hotel
  - Door Close
  - Lift goes up to destination
  - Lift stop at destination
  - Sound notification
  - Door Open

Lift Building DOWN

- Lift DOWN
  - Key in level down
  - Tag in card hotel
  - Door Close
  - Lift goes down to destination
  - Lift stop at destination
  - Sound notification
  - Door Open




Simulate the circuit

- Operate base on required operation

Produce a Complete Design Report

Accessories / Advanced Features

- E.g. Welcoming Notes, security element, Interactive Display System, Etc

# Report Format

**Format**

- Times New Roman 12 font
- 1.5 spacing
- Turn on MS Word spell and grammar checker

**What should be in the report?**

- TITLE PAGE
- DEDICATION & ACKNOWLEDGEMENT
- TABLE OF CONTENTS
- REPORT CONTENT
- REFERENCES
- APPENDICES

Under Appendices

- list of tasks distribution among members of group
- Photo(s) of your group working together
- And others supporting materials that will strengthen the explanation of your project.

# PROJECT REPORT CONTENT

You may use the lab manual, book, or others as guidance and inspiration. Don't forget to cite the manual.

1) The background
2) The Problem
3) Suggested Solution (must Include the block diagram and explain)
4) The Requirement
5) System Implementation (must include DEEDS drawing and explain)
6) Conclusion and Reflection
   - Summarizes the whole project. Write your reflections.
   - Describe your achievements, strength and weaknesses.
   - Propose future work to improve your design

# Project Timeline

| Date | Activity |
|---|---|
| 1 | Briefing & group setup |
| 2 | Work on Part 1 (project idea) and discuss enhancement with lecturer |
| 3 | Receive approval/comments for improvement |
| 4 | Submit Part 1 (initial design and idea) |
| 5 | Work on project |
| 6 | Project report develop/improve (discuss with lecturer) |
| 7 | Submit Project .pbs, Project Report, Presentation/Demo Video |

- * All e-learning deadline at 11:00pm