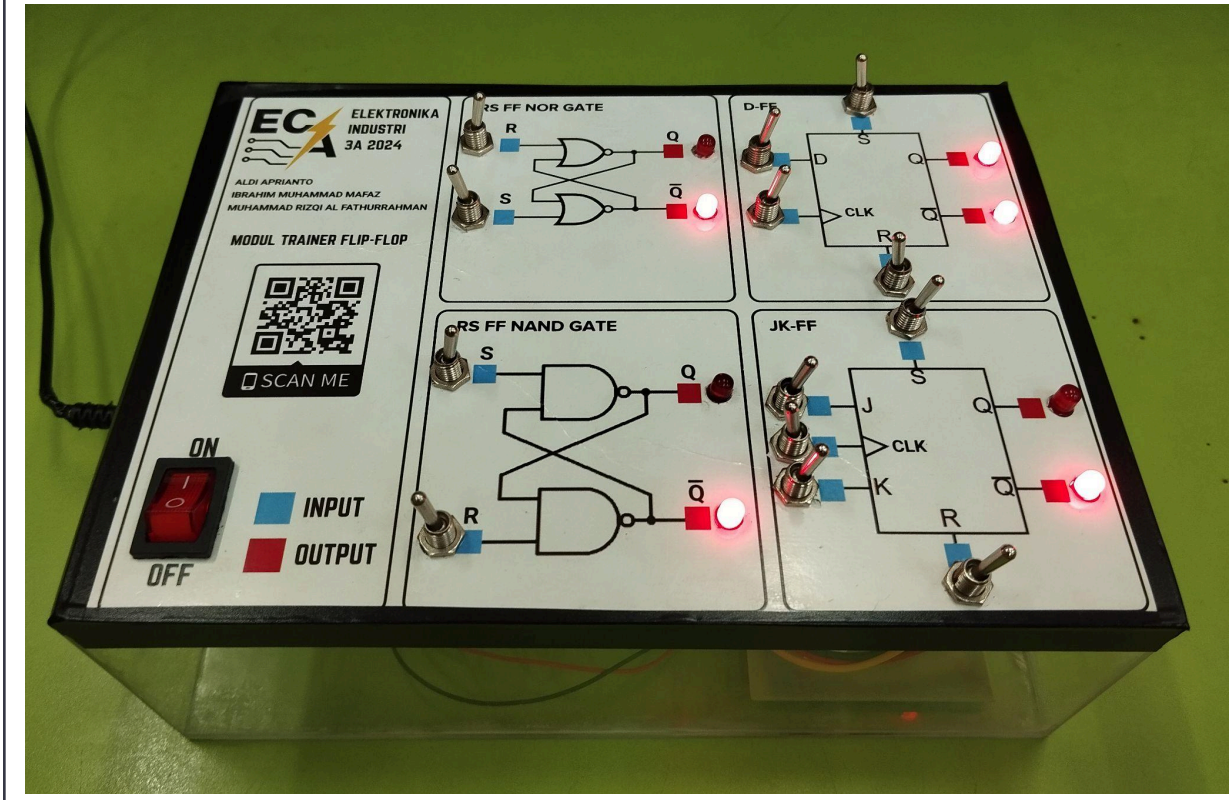



# Flip-Flop Trainer Module

**Keywords: Digital Electronics | Flip-Flop | Logic Gates | PCB Fabrication**

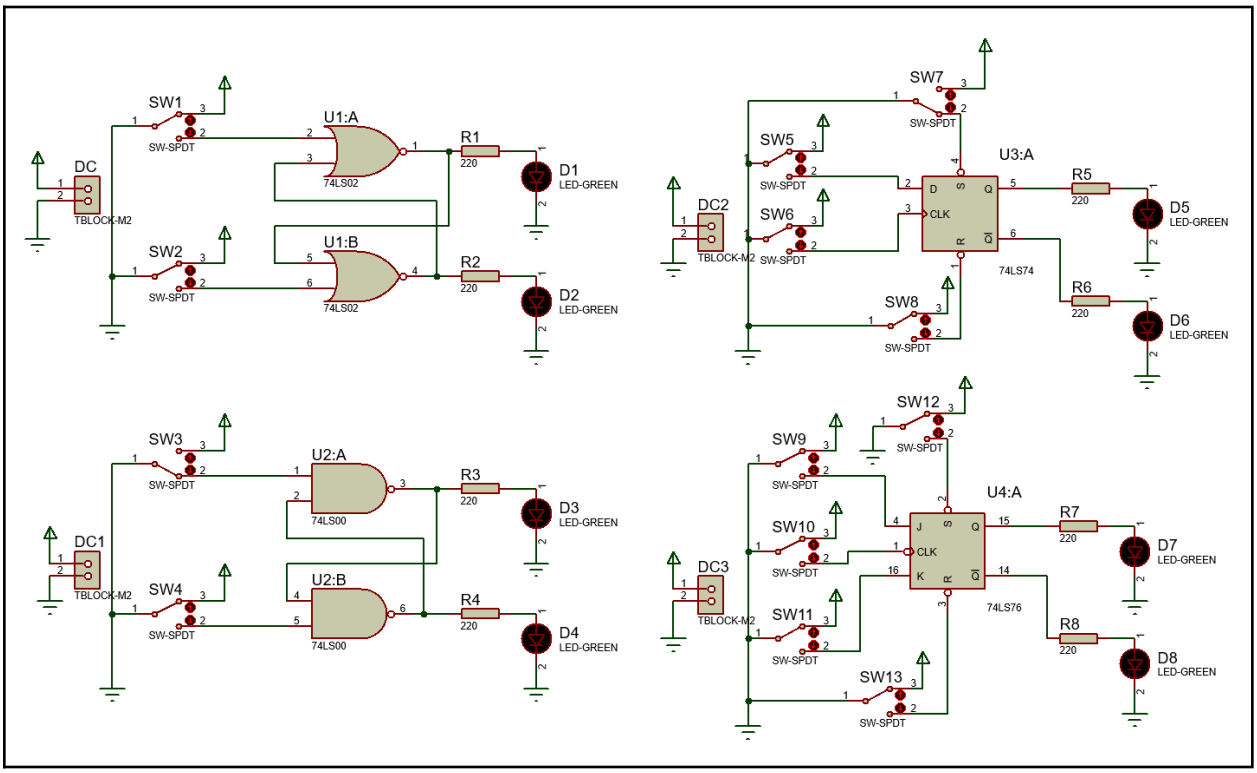
**Muhammad Rizqi Al F**
3rd semester project
Politeknik Negeri Jakarta

**Timeline: December 2025**

## OVERVIEW

The goal of this group project is to build a flip-flop trainer that performs the functions of 4 types of flip-flop: Set-Reset Flip-Flop NOR Gate, Set-Reset Flip-Flop NAND Gate, D Flip-Flop, and JK Flip-Flop. The trainer is made to be operated interactively using toggle switch as input and LED as output. The input logic state depends on the toggle switch position: right represents logic 1 or HIGH and left represents logic 0 or LOW. The trainer also comes with a manual that provides explanation and truth tables for every flip-flop which allows the operator to match the inputs and the outputs.

## SCHEMATIC DESIGN

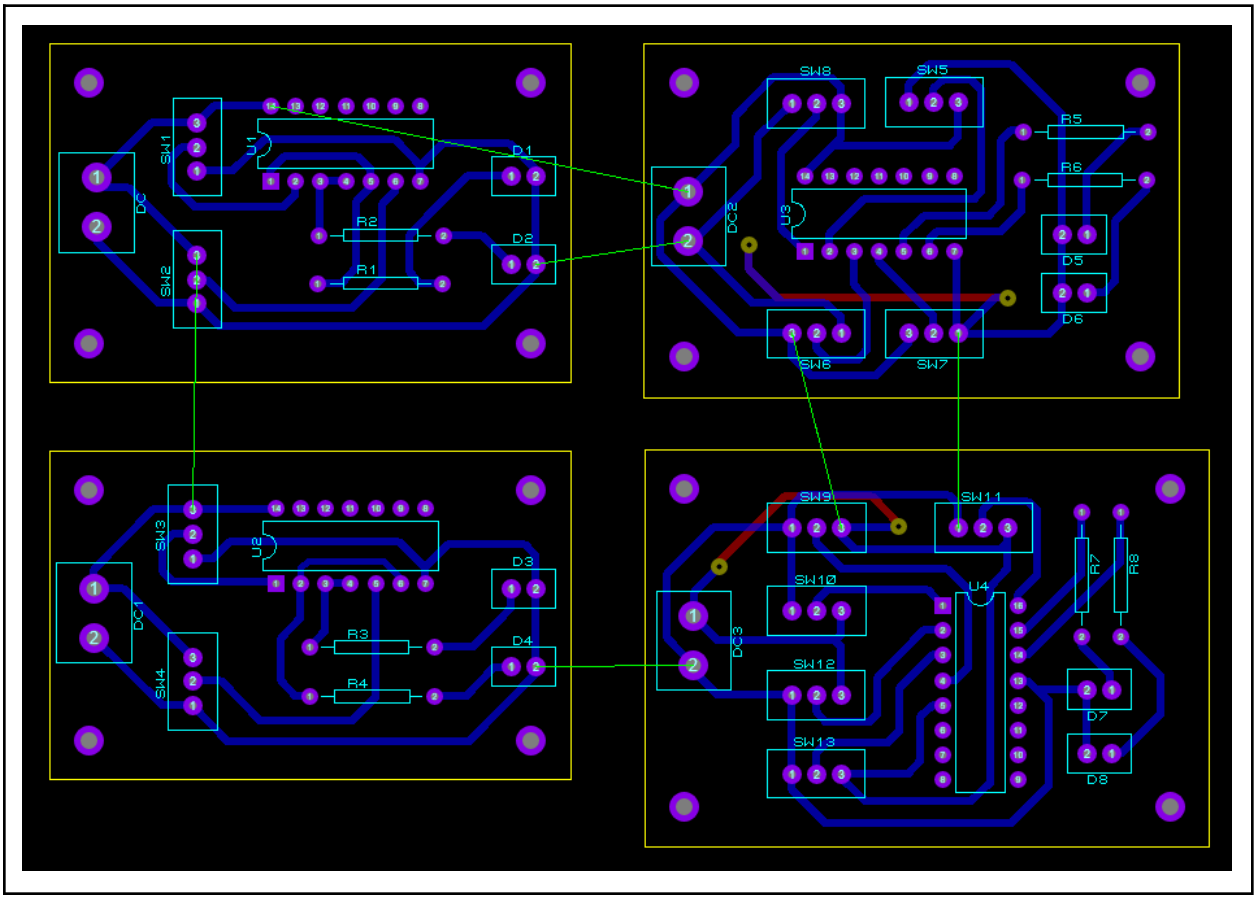



The schematic design is divided into 4 parts:

1. Set-reset flip-flop NOR gate (used 74LS02 IC)
2. Set-reset flip-flop NAND gate (used 74LS00 IC)
3. D flip-flop (used 74LS74 IC)
4. JK flip-flop (used 74LS76 IC)

**Software used:** *Proteus 8 Professional*

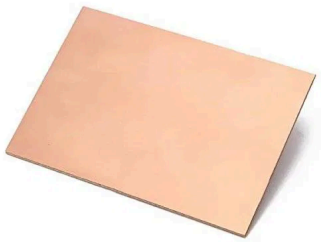
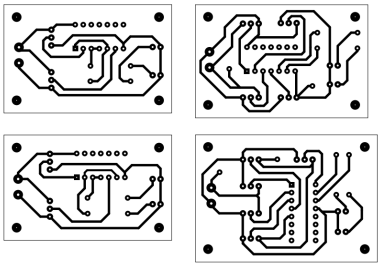
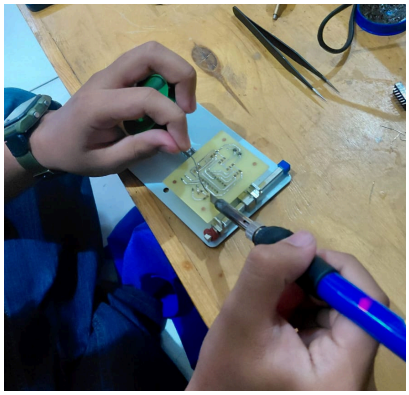
## PCB Design




The PCB design is made into 4 separated PCBs. Each PCB has a terminal block for power (Vcc and GND) that's connected with wires.

**Software used:** *Proteus 8 Professional*

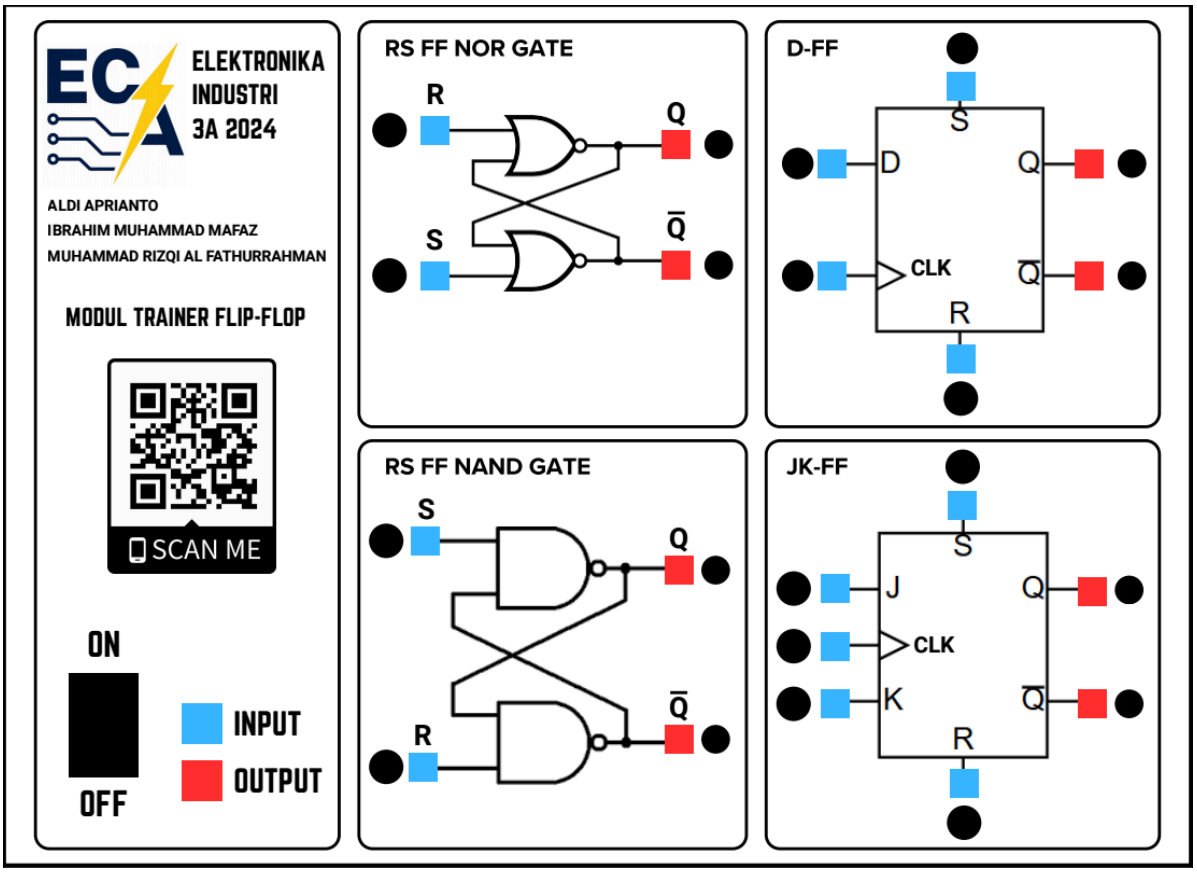
## PCB Fabrication

| No | Image | Process |
|---|---|---|
| 1 |  | A plain copper board is used for the PCB. It's then cut into 4 parts using a box cutter. |
| 2 |  | PCB layout is printed on a copy paper using a laser printer. Subsequently, chemical toner is used to transfer the PCB layout from the paper to the copper board by separating the ink and the paper. Leaving only the desired trace on the copper. |
| 3 |  | After transferring the PCB layout, the etching process is done by putting the copper boards in a container with *Ferric Chloride* ($FeCl_3$) powder mixed with some water to dissolve the unwanted copper. During this process, the trace is protected by the ink. |
| 4 |  | After etching, the PCBs are cleaned using water and scrubbed with steel wool to remove the remaining ink. Subsequently, the PCBs are drilled and the components are soldered on the PCBs. |

## Enclosure Design

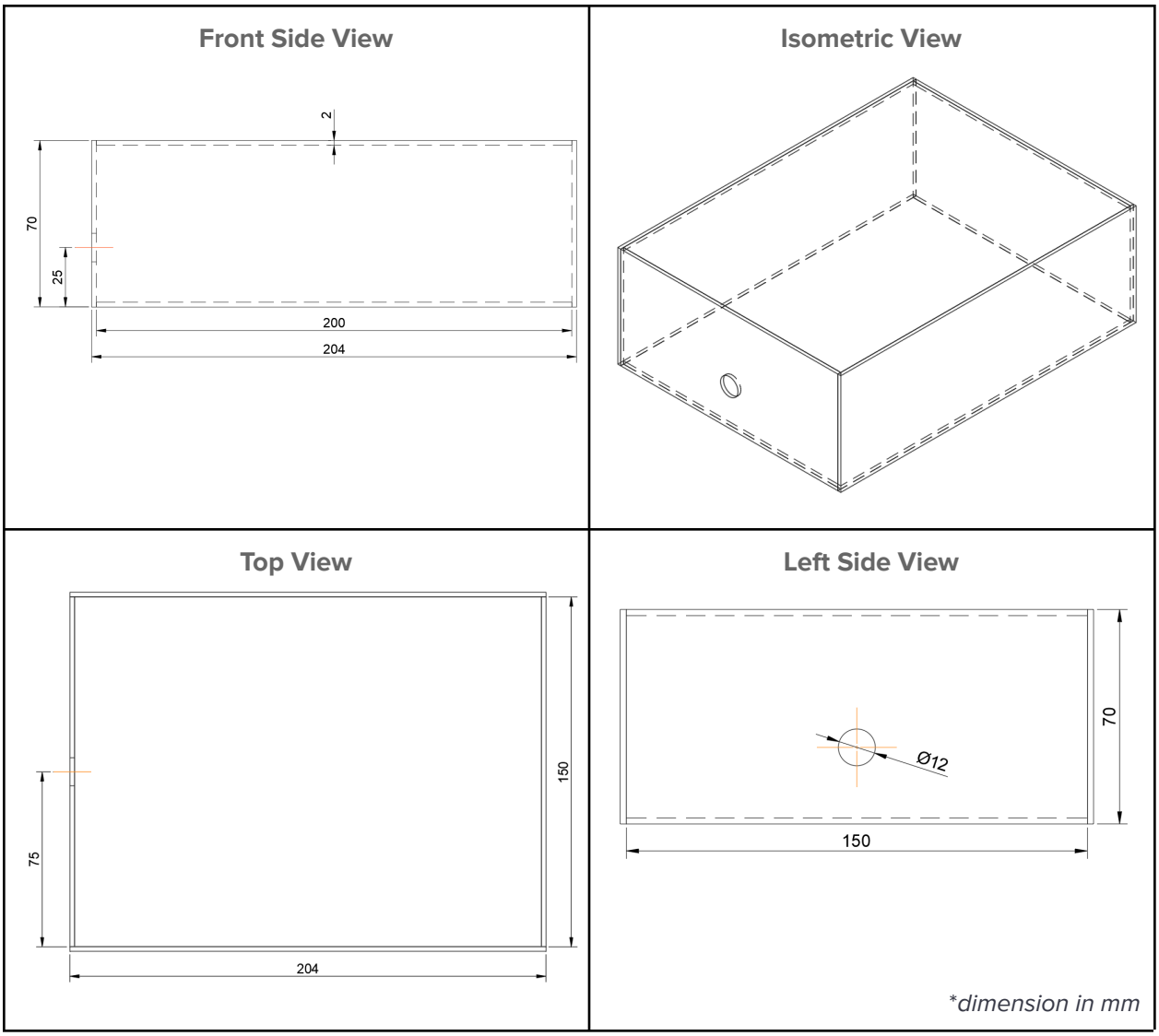
Enclosure is a very important aspect that keeps the internal electronic components safe and integrated. The material used for the case is a transparent acrylic board with 2mm of thickness. It allows the user to see the PCBs and the wiring while being protective.

1. **Top panel design (200mm x 150mm)**
   The circles mark the drilling point for toggle switches and LEDs. The diameter for toggle switch (input) is 6mm and the diameter for LED (output) is 5mm. The design is then printed on waterproof sticker paper.




**Software used:** *canva.com*

## 2. 3D design and dimension

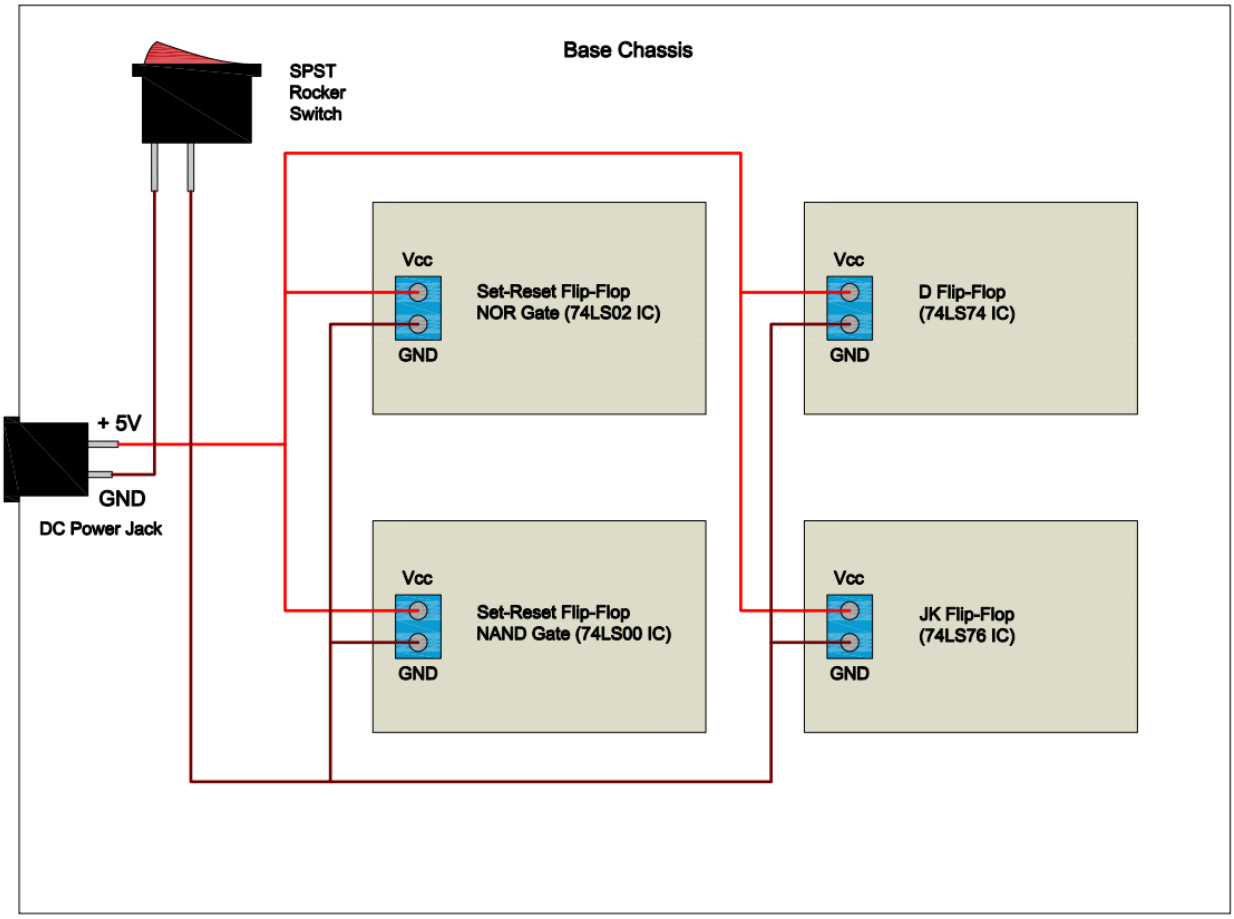



A 12mm hole is added to the left side of the chassis for the DC power jack.

**Software used:** *Autodesk AutoCAD*

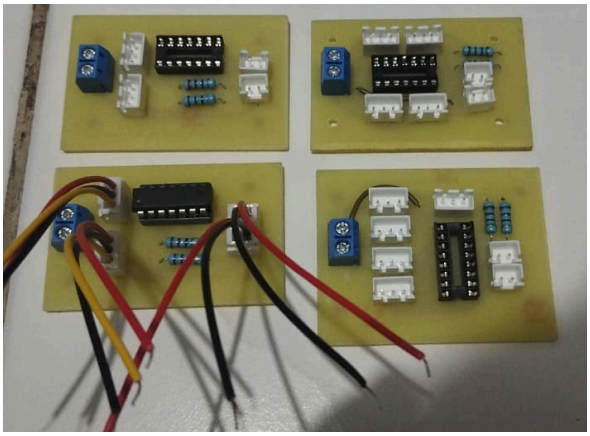
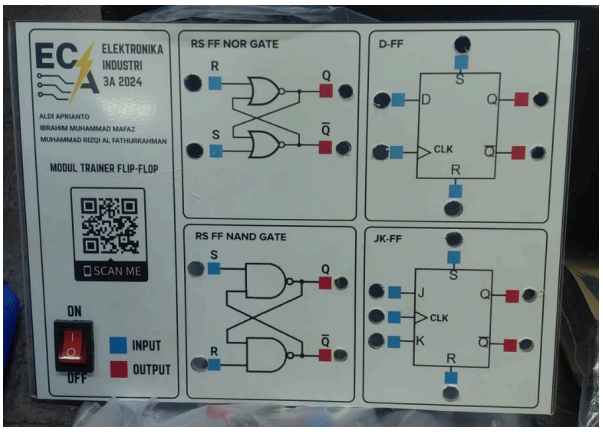
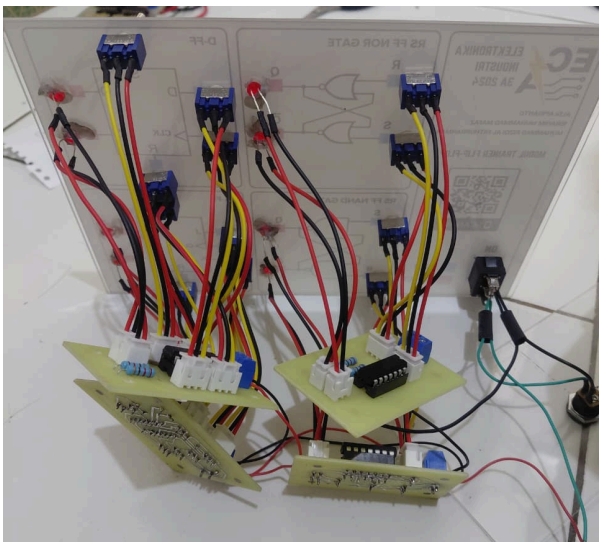
## Wiring Diagram

Below is the wiring diagram that shows how the 4 PCBs are connected to the power. The voltage source comes from a DC 5V adapter with male power jack. The trainer is also equipped with a rocker switch (on-off) that's attached to the top panel.




**Software used:** *Autodesk AutoCAD*

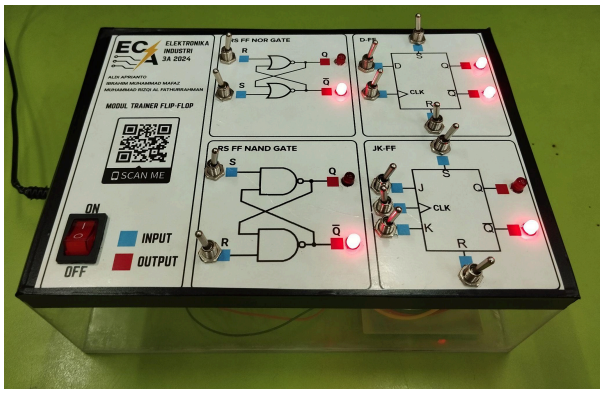
## Assembly and Details

| No | Image | Description |
|---|---|---|
| 1 |  | Before mounting the PCBs to the base chassis, JST XH connectors are used to provide strong connection between the PCB and the user interface components. 3-pin connectors are used for toggle switches and 2-pin connectors are used for LEDs. |
| 2 |  | The top panel is applied with the designed sticker and drilled according to its size. |
| 3 |  | After assembling all components, wiring process is done to make sure that the DC power jack, rocker switch, and the Vcc and GND terminals are well connected to maintain voltage stability across all PCBs. |

| | | |
|---|---|---|
| 4 |  | For the chassis assembly, super glue is applied to the edges of the acrylic boards. As for the top panel, insulation tape is used to keep it integrated without making a permanent connection, allowing the top panel to be opened when necessary. |

When the assembly process is complete, testing is done by matching the outputs indicated by LEDs with the truth table for every type of flip-flop.

## Results

| | |
|---|---|
|  |  |
| Switch position: off | Switch position: on, tested using truth tables |