Ahsanullah University of Science and Technology

PS2 Project Report

Course Name **:** EEE-4154

Course Title **:** Power System-2 Laboratory

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Submitted by

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Group: 1

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Index

1. **Project Title:** Voltage instability protection.

2. **Objective:**

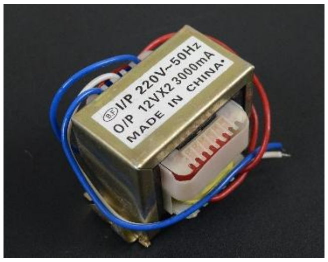
- For High voltage, load will be OFF
- For Threshold voltage, load will be ON after 10second delay
- For Low voltage, load will be OFF

3. **Iist of Equipment:**

1. Transformer (220V-12V)
2. Diode (1N4001)
3. Capacitor (470u, 1000u)
4. Resistor (1k, 15k,100k,10k)
5. Zener Diode (1N4741A)
6. Relay (12V)
7. LED
8. Bulb (20W)
9. IC-555 (NE 555)
10. Pot (10k,100k)
11. Transistor (2N2222)
12. Variac
13. Project board
14. House wiring cable
15. Bulb holder

4.Description of elements used

Transformer:



A transformer is a device that transfers electric energy from one alternating-current circuit to one or more other circuits, either increasing (stepping up) or reducing (stepping down) the voltage. In our project we are used 220V-12V step down transformer.

Variac:

A variac is an adjustable transformer that is used to control the output voltage of an AC power source. It works by varying the turns ratio between the primary and secondary windings of the transformer, which in turn changes the output voltage. Variacs are often used in applications where a variable AC voltage is required, such as for testing and development of electronic devices, for adjusting the speed of motors, and for controlling the brightness of lamps. They are also used in laboratory and industrial settings for applications such as testing the tolerance of electronic equipment to different voltage levels. Variacs can provide a continuously adjustable AC voltage, and are often used in conjunction with a voltmeter to accurately measure the output voltage.

Diode(1N4001):

The 1N4001 diode belongs to the family of the 1N400x diode series, which are most commonly used in household electronic appliances. It allows the flow of current only in one direction, that is from anode terminal to cathode terminal just like a normal diode.

Zener Diode(12V):

A Zener diode is a type of diode that is designed to allow current to flow in the reverse direction when the voltage across it exceeds a certain value known as the Zener voltage. Unlike a standard diode, which would break down and become an open circuit under reverse bias, the Zener diode remains in a reverse-biased state and conducts current in the reverse direction. In forward bias condition the Zener diode works like normal signal diode. This makes it useful as a voltage regulator, where it can be used to maintain a stable voltage in a circuit. Zener diodes are also used for protection against overvoltage and for voltage reference applications.

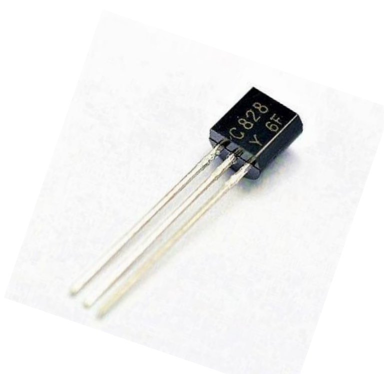
Relay:

A relay is an electrically operated switch that is used to turn on or off a circuit by using a small amount of electrical energy. It consists of an electromagnet that moves a set of contacts, which in turn opens or closes the circuit. When a current is applied to the electromagnet, it generates a magnetic field that causes the contacts to close, allowing current to flow through the circuit. When the current is removed, the magnetic field collapses and the contacts open, breaking the circuit. Relays are used in a wide range of applications, including control systems, power supplies, and telecommunications.

IC-555 Timer:

The 555 timer IC is a widely used integrated circuit that can be used as a timer, oscillator, flip-flop, or voltage comparator. It was first introduced in 1972 and is still widely used due to its low cost, ease of use, and versatility. The 555 timer can be configured in various modes to perform different functions, such as timing, frequency generation, and astable (continuous) oscillation. It is widely used in electronic projects and is known for its stability and reliability. The 555 timer is available in a variety of packages and can operate over a wide range of temperatures and voltage levels.

Transistor(C828):



A transistor is a type of semiconductor device that is used to amplify or switch electronic signals. It consists of three layers of a semiconductor material, with each layer having a different type of doping (impurities added to the material). The three layers are called the source, the drain, and the base. By controlling the flow of current through the base, the transistor can regulate the flow of current between the source and the drain, effectively amplifying or switching the signal.

Capacitor:

A capacitor is an electronic component that stores electrical energy in an electric field between two conductive plates. It can be used to store and release electrical energy as needed in a circuit. Capacitors can be found in many different types of electrical devices, including power supplies, radios, televisions, and computers.

Resistor:

A resistor is an electronic component that resists the flow of electrical current, thereby limiting the amount of electrical energy that can flow through a circuit. Resistors are commonly used to regulate the current in a circuit, to control the voltage level, and to provide a specific amount of resistance to the flow of current. They are available in various shapes, sizes, and resistance values, and are used in a wide range of electrical and electronic applications.

POT:

"Pot" is short for potentiometer, which is a type of variable resistor. A potentiometer is a device that can be used to adjust the resistance in a circuit and to control the flow of electrical current. Potentiometers are widely used in a variety of applications, including volume control in audio equipment, position sensing in robotics and automation, and as voltage dividers in power supplies.

LED:

LED stands for Light Emitting Diode, which is a type of semiconductor device that emits light when an electric current is passed through it. LEDs are small, efficient, and long-lasting compared to traditional light sources, such as incandescent bulbs. They are widely used in a variety of applications, including electronic displays, lighting, indicator lights, and automotive lighting. LEDs are also used in high-brightness applications, such as traffic lights, stage lighting, and advertising displays, due to their high brightness and low power consumption.

Bulb:

A bulb is a device that generates light by passing an electric current through a filament, which produces heat and light. The filament is typically made of tungsten and is enclosed in a vacuum or an inert gas, such as argon, to prevent oxidation and prolong the life of the filament.

Bulb Holder:

A bulb holder is a device that is used to secure and electrically connect a light bulb to a power source. It typically consists of a socket, which holds the bulb, and a base, which connects to the power source. The socket is typically made of metal or plastic and is designed to fit the base of the bulb, while the base is made of metal or plastic and is designed to connect to the power source.

Project Board:

A project board refers to a type of board or platform used to mount, assemble, and test electronic components and circuits. Project boards come in a variety of shapes and sizes, and can be made of materials such as fiberglass, plastic, or cardboard. They are used for both educational and hobby purposes, as well as for the development of prototypes and small-scale production of electronic devices.

Wiring Cables:

Wiring cable refers to a cable used for the transmission of electrical power or signals between two or more devices or components. It typically consists of one or more conductors, which are surrounded by an insulating material and covered by a protective jacket.

Breadboard:

A breadboard is used for building temporary circuits. We use a breadboard to implement our circuit. It’s an easy way to implement and recorrect a circuit.

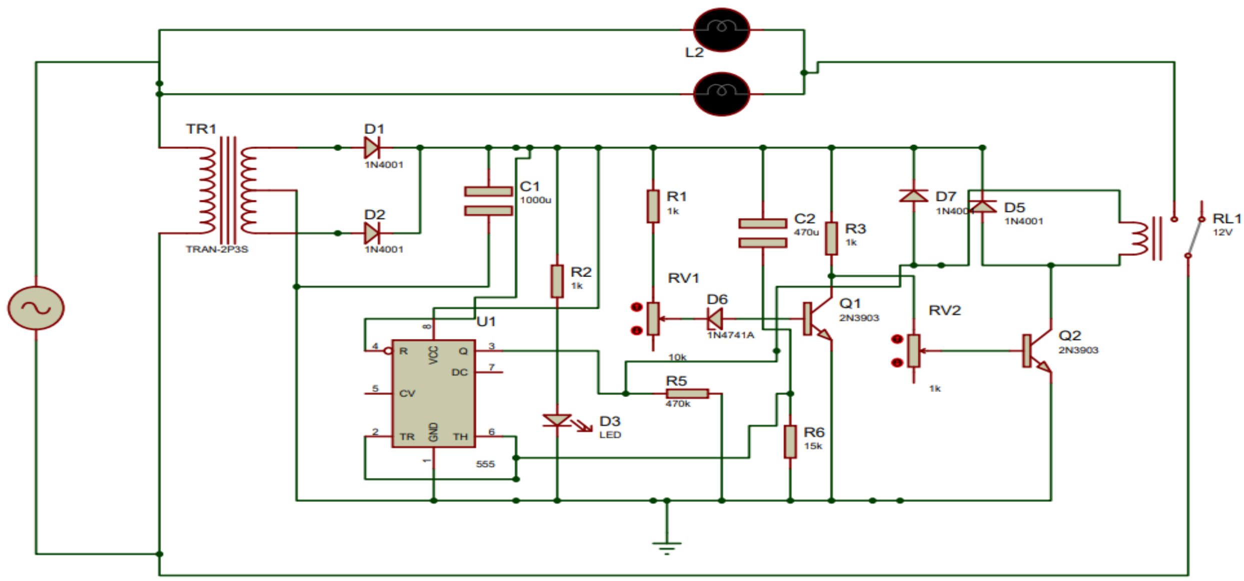
Jumper wire:

Jumper wire are electrical wires with with connector pins at each end.

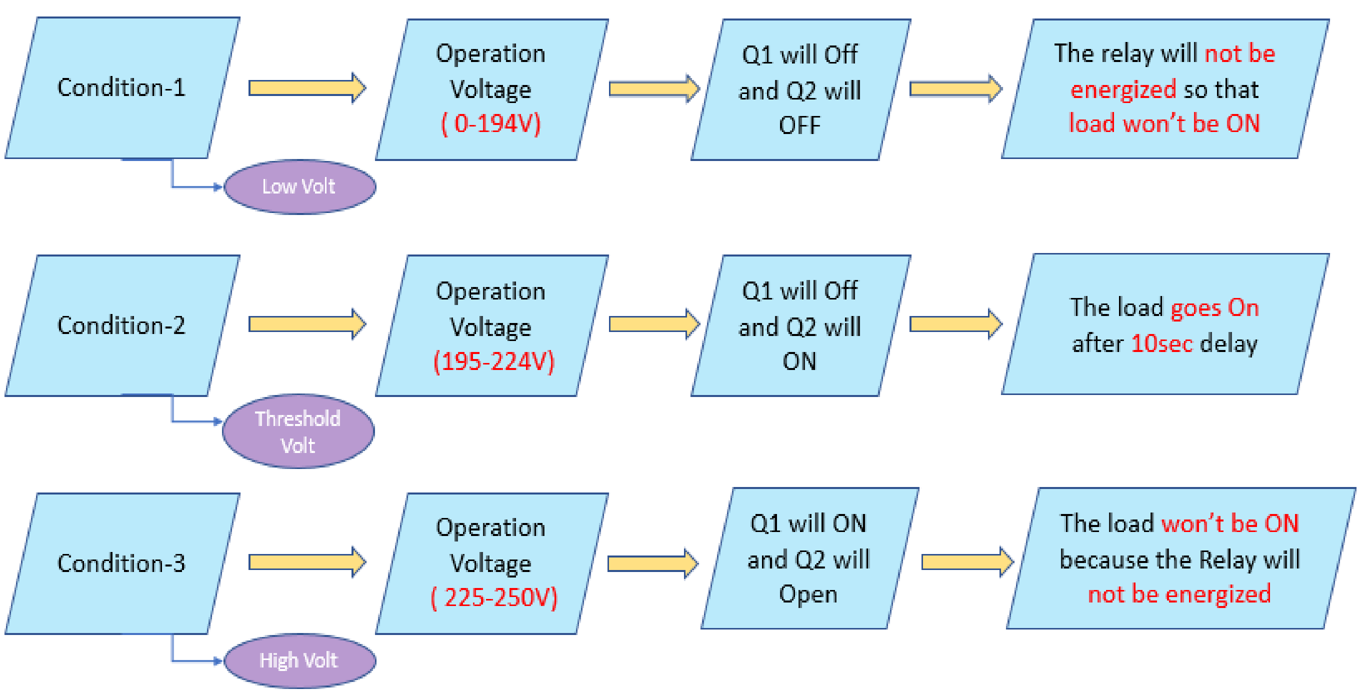
- Male to Male(M2M)
- Male to Female(M2F)
- Female to Female(F2F)

We use Male to Male and Male to Female in our project.

5. Circuit Diagram



6. Methodology.



For delay calculation we use a formula: 1.1*R*C

For 10sec delay we use 22k resistor and 470uF Capacitor.

7.Working Principle

Condition 1:

When I supply 180V to the Primary side of the transformer then in the secondary side I have 9.8V after Rectifying. We use a Zener diode in the voltage of 12V.So if Q1 is active they need 12.7V to activated. So in the terminal R1 there was a voltage drop which is (1/1+10 * 9.8) and RV1 ther was also a voltage drop which is (10/1+10 * 9.8) .So in the zener dide terminal they have 9.7 V. So Q1 remain Off. Similarly Q2 will be off and when Q1 and Q2 will be off then relay will not energized and can't move Normally Open (NO) terminal to the Normally Closed(NC) terminal. So the current can't pass through a relay and the relay will be off also load will be OFF.

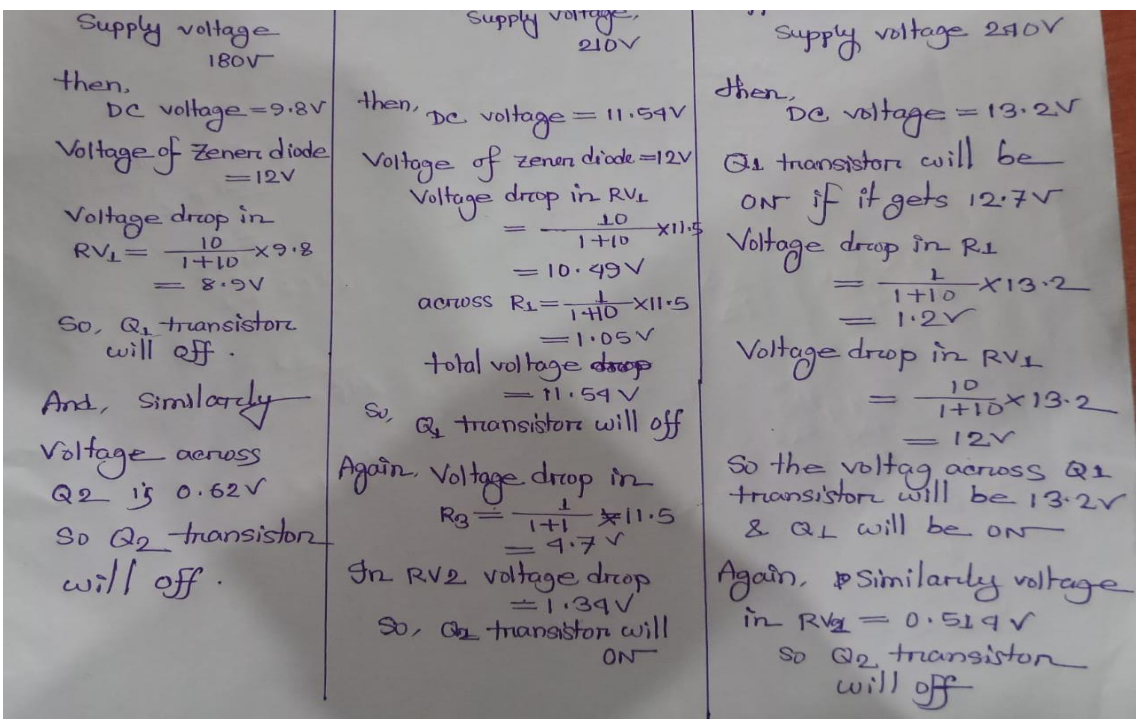
Condition 2:

When I supply 210V to the Primary side of the transformer then in the secondary side I have 11.54V after Rectifying. If Q1 is active they need 12.7V to activated (Zener diode voltage=12V and transistor volatge=0.7V). So in the terminal R1 there was a voltage drop which is (1/1+10 * 11.5) and RV1 ther was also a voltage drop which is (10/1+10 * 11.5) .So in the zener dide terminal they have 11.54 V. So Q1 remain Off. Similarly Q2 will be ON because in the transistor side the have 1.34V where it requires 0.7V to to ON condition, and when Q1 Off but Q2 will ON so the emmiter and base terminal will be short and current flow through emitter to collector and for this relay will be energized and move Normally Open (NO) terminal to the Normally Closed(NC) terminal. So the current pass through a relay and the relay will be ON also load will be ON.But we set a condition in the 555 timer that when light will be ON it takes 10sec delay. So after 10sec Light will be ON.

Condition 3:

The last case is When I supply 240V to the Primary side of the transformer then in the secondary side I have 13.2V after Rectifying. We use a Zener diode in the voltage of 12V.So if Q1 is active they need 12.7V to activated. So in the terminal R1 there was a voltage drop which is (1/1+10 *13.2) and RV1 ther was also a voltage drop which is (10/1+10 * 13.2) .So in the zener dide terminal they have 12.77V. So Q1 will be ON. When Q1 will be ON then emmiter and collector will be short and the current pass to the ground through collector to emmiter terminal. So current can't pass to the Q2 side and then relay won't be energized so that load will be OFF

When,



Supply voltage 180V

then,

DC voltage $= 9.8V$

Voltage of Zener diode $= 12V$

Voltage drop in $RV_1 = \frac{10}{1+10} \times 9.8 = 8.9V$

So, Q_1 transistor will off.

And, similarly Voltage across Q2 is $0.62V$

So Q2 transistor will off.

Supply voltage, 210V

then, DC voltage $= 11.54V$

Voltage of zener diode $= 12V$

Voltage drop in $RV_1 = \frac{10}{1+10} \times 11.5 = 10.49V$

across $R_1 = \frac{1}{1+10} \times 11.5 = 1.05V$

total voltage ~~drop~~ $= 11.54V$

So, Q_1 transistor will off

Again, Voltage drop in $R_3 = \frac{1}{1+1} \times 11.5 = 4.7V$

In RV2 voltage drop $= 1.39V$

So, Q_2 transistor will ON

Supply voltage 240V

then, DC voltage $= 13.2V$

Q_1 transistor will be ON if it gets $12.7V$

Voltage drop in $R_1 = \frac{1}{1+10} \times 13.2 = 1.2V$

Voltage drop in $RV_1 = \frac{10}{1+10} \times 13.2 = 12V$

So the voltag across Q_1 transistor will be $13.2V$ & Q_1 will be ON

Again, Similarly voltage in $RV_2 = 0.519V$

So Q_2 transistor will off

10sec delay procedure:

We connect a 470µF capacitor to the positive voltage supply and then to pin 2. We connect pin 6 to pin 2 and then connect a 22K resistor to ground. We connect pin 4, the reset pin, to the VCC. The reset pin is active low. So in order for reset not to be triggered, we connect this pin permanently HIGH. Pin 3 is the output pin. Therefore, we connect the LED along with the 470Ω resistor.

The combination of the resistor and capacitor forms the RC network. This network determines the length of time it takes to charge the capacitor.The reason why the circuit doesn't turn on automatically is because pin 2, the trigger pin, initially when the power turns on, is HIGH. This is because the capacitor hasn't charged up yet. Until the capacitor charges up, this pin is HIGH. Since the trigger pin is active LOW, the output will be off until this pin goes LOW. As the capacitor charges up and gets near the supply voltage it is connected to, the voltage at pin 2 decreases. When the voltage at pin 2 gets below 1/3 of the supply voltage, the pin is now LOW. When it is LOW, this is when the output goes HIGH and the LED turns on.There is a delay of about 10 seconds with this circuit. once you turn the power on, the LED doesn't turn on until about after 10 seconds.The RC network is what determines this. The bigger the resistor and capacitor value, the longer the delay. So if you want to increase the time of the delay, you would choose a bigger resistor and capacitor. If you want to shorten the time of the delay, you would choose a smaller resistor and capacitor value. And this is how a delay before turn on circuit works with a 555 timer.

8.Application

Voltage instability has several real-world applications in the power system, including:

Power System Planning and Design: Voltage stability analysis is used to evaluate the performance of power systems under different operating conditions and to identify potential voltage collapse scenarios. This information can be used to design power systems that are more resilient to voltage instability and to plan for mitigation measures.

Power System Operation: Real-time monitoring and control systems are used to detect and prevent voltage instability during normal power system operation. This can include automatic voltage control systems, load shedding, and reactive power control.

Renewable Energy Integration: With the increasing integration of renewable energy sources into the power system, voltage stability is becoming a more pressing issue. Analysis of voltage stability can help identify potential challenges posed by these new energy sources and guide efforts to integrate them into the power system in a stable and efficient manner.

System Reliability: Voltage instability can lead to power outages and equipment damage, reducing the overall reliability of the power system. By detecting and preventing voltage instability, power system operators can improve the reliability of the system and reduce the risk of blackouts and Lightning Sparks.

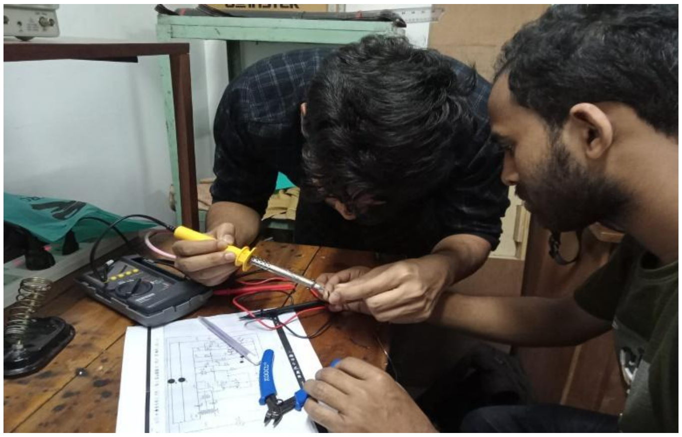
Overall, voltage stability is a critical aspect of power system operation, and its analysis and control play a vital role in ensuring the stability, reliability, and efficiency of the electrical power supply

9.Discussion

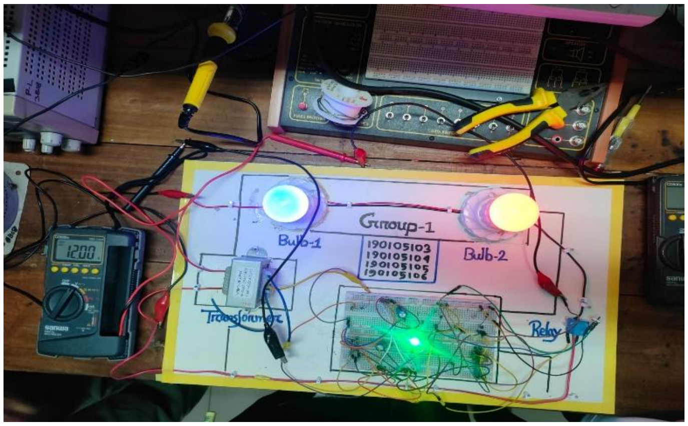
You know, its not a big project but we make it more easy and efficient by our team work. Some difficulties that we faced is-

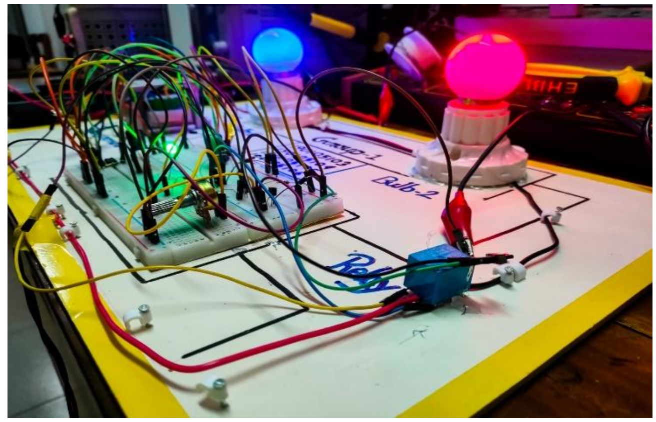
First of all we complete the cicuit in protius simulation. When we run the circuit then its not working properly. Then changing the value and the circuit diagram we successfully verify all the conditions. It’s a diffcult work for us. Then we collect all the components and initially we setup the circuit in veroboard by solder. After soldering when we run the circuit and incresing the voltage by using bariac. All on a sudden the capacitor will blust and we really shocked and fear. It’s a new experience for us. Then we change our plan and implement the circuit in breadboard. We works continuously for a long time in project lab and finally finished after 1day before project submission date.

Here is some picture during our team work:



Here is our final output:





10.[**Conclusion**]

In conclusion, voltage instability is a critical issue in the power system that can lead to significant problems such as blackouts, equipment damage, and reduced system efficiency. The root cause of voltage instability is the mismatch between power demand and supply, which can be exacerbated by factors such as network congestion, system faults, and the integration of renewable energy sources. To address this issue, it is essential to have a deep understanding of the power system's behavior and to develop effective monitoring and control methods. This may include the use of advanced analytical tools, real-time monitoring systems, and sophisticated control strategies to maintain voltage stability and prevent power disruptions. Despite ongoing research and advances in technology, voltage instability remains a challenge in the power system, and ongoing efforts will be needed to address this issue and ensure a stable, reliable, and sustainable electrical power supply.

11.Future Work

Voltage instability remains an important area of research in the electrical power system field. In the future, work will likely focus on developing more advanced analysis and control methods to prevent voltage instability, improving monitoring and early warning systems, and exploring new technologies and solutions to enhance voltage stability. Additionally, with the increasing penetration of renewable energy sources and decentralized generation, there is a need to address the challenges posed by these new systems and incorporate them into the existing power grid in a stable and efficient manner. This will likely involve exploring new grid architectures, improving power flow control, and developing more sophisticated voltage stability management techniques.

12. References

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13. Particular Contribution of each member

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